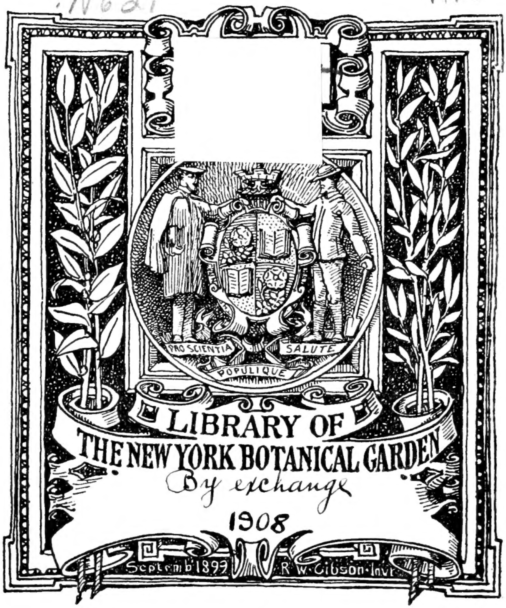

PRO SCIENTIA
SALUTE
POPULIQUE
LIBRARY OF
THE NEW YORK BOTANICAL GARDEN
By exchange
1908
Septemb 1899
R.W. Gibson. Inv.

ANNALS

OF THE

NEW YORK ACADEMY OF SCIENCES

VOLUME XVIII

1908

Editor

EDMUND OTIS HOVEY

New York
Published by the Academy
1908 - 1909

THE NEW YORK ACADEMY OF SCIENCES.

(Lyceum of Natural History, 1817–1876.)

Officers, 1908.

President — Charles F. Cox, Grand Central Station.
Vice-Presidents — A. W. Grabau, Frank M. Chapman,
D. W. Hering, Adolf Meyer.
Recording Secretary — Edmund Otis Hovey, American Museum.
Corresponding Secretary — Henry E. Crampton, Columbia University.
Treasurer — Emerson McMillin, 40 Wall Street.
Librarian — Ralph W. Tower, American Museum.
Editor — Edmund Otis Hovey, American Museum.

SECTION OF GEOLOGY AND MINERALOGY.

Chairman — A. W. Grabau, Columbia University.
Secretary — Charles P. Berkey, Columbia University.

SECTION OF BIOLOGY.

Chairman — Frank M. Chapman, American Museum.
Secretary — R. W. Miner, American Museum.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

Chairman — D. W. Hering, New York University.
Secretary — William Campbell, Columbia University.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

Chairman — Adolf Meyer, Ward's Island.
Secretary — R. S. Woodworth, Columbia University.

CONTENTS OF VOLUME XVIII.

DATES OF PUBLICATION OF AUTHORS' SEPARATES.

The edition of authors' separates for Part I was 50 copies, 47 of which were given to the author; beginning with Part II of this volume, the regular edition has been 75 copies, 50 of which have been given to the author.

(Part I) Art. 1, pp. 9–19, 29 January, 1908.
pp. 21–31, 29 January, 1908.
pp. 42–45, 29 January, 1908.
(Part II) Art. 2, 22 January, 1908.
Art. 3, 4 April, 1908.
Art. 4, 15 April, 1908.
Art. 5, 23 April, 1908.
Art. 6, 11 May, 1908.
(Part III) Art. 9, 29 August, 1908.
Art. 10, 16 December, 1908.
Art. 11, 10 February, 1909.
Art. 12, pp. 511–536, 16 June, 1909.

LIST OF ILLUSTRATIONS.

Plates.

Text Figures.

ERRATA.

Page 40, line 2.— Instead of "Sachalin," read "Saghalin."
Page 68, line 5.— Instead of "jeter", read "lever."
Page 147, line 29.— Instead of "Mitchell," read "Mitchill."
Page 281, line 31.— Instead of "*eocystides*," read "*eocystites*."
Page 316, line 15.— Instead of "Northrup", read "Northup."
Page 324, line 29.— Instead of "cen²", read "cm²."
Pages 329 and 330.— Instead of "*Bufo aqua*", read "*Bufo agua*."
Page 339, line 19.— Instead of "F. W. Pedersen", read "F. M. Pedersen."
Page 341, line 18.— Instead of "Size", read "Pfizer."

NOTE REGARDING THE CHESTER MASTODON.

The attention of the Editor has been called to the account of the finding, exhumation and character of the remains of the Chester, N. Y., mastodon [1] which was printed in *The American Monthly Magazine and Critical Review*, Vol. I, pp. 195, 196, New York, July, 1817. This publication is so rare that the account is reprinted here.

LYCEUM OF NATURAL HISTORY.

Sitting of June 2.

Dr. Mitchill, the president of the Lyceum, and Dr. Townsend, the committee appointed, by a resolve of the society, to visit and explore the tract between the Highlands and the Catskill Mountains, made a report in part; from which report the following is an extract:

"It was the good fortune of the commissioners to find another skeleton of that huge creature the Elephas Mastodon, which though apparently extinct, was formerly an inhabitant of New-York. This happened on the 27th and 29th of May, upon the farm of Mr. Yelverton, near Chester, a village in the town of Goshen. The soil is a black peat or turf, sufficiently inflammable to be employed for fuel. Its surface is overgrown with grass, forming a luxuriant meadow for grazing.— The herbage and the bottom in which it grows, have a near resemblance to the turf meadow of Newton, in Queen's County, Long Island. The sward and turf covering the skeleton are about

[1] Noted with facsimile reproduction of Dr. Townsend's drawing in this Volume, p. 147, Pl. V.

four feet deep. Beneath these is a stratum of coarse vegetable stems and films, resembling chopped straw or drift stuff, along the sea-shore, about a foot and a half thick; and under this is a stratum of fine bluish and soft clay. Specimens of these are brought away, and are herewith presented. The bones raised were parts of a lower jaw with its teeth, of a scapula, of a humerus, of an ulna and radius, of the bones of the feet, of ribs, and of vertebræ. The upper maxillary bone was found, with its grinders and tusks, in their natural situation. Dr. Townsend and Dr. Seely, who had from the beginning aided with their own hands the acquisition of these curious remains, now laboured with the greatest assiduity in the pit to uncover completely, and elevate connectedly, these important parts of the animal. The unparalleled association of bones, teeth, and ivory prongs, were, after much exertion, denuded of their mud and developed to view. They lay upside down, or, in other words, their natural position was inverted, as if the creature had died in a supine posture. The palate bones were perfectly in sight, with the huge molares on each side. From the point forward where the palate joins the upper maxillary bone in other animals, two ivory tusks proceeded. These were not inserted in sockets; at least no such holes or sockets could be found; but they seemed to be formed by a gradual change of bone to ivory, or of osseous to eburneous matter. In this respect the conversion resembled the jaw and tooth of the Saurian reptile of Nevesink, already in the cabinet of the Professor of Natural History; in which organization the jaw is converted gradually to tooth. Their direction was forward, with a bold curvature outward and upward. Between the tusks could be seen and felt the nasal processes to which the proboscis had formerly been attached. They were short and ungular. On attempting to loosen the left tusk from its clayey bed, it broke across, though touched in the most delicate manner. Though approached with the gentlest touch, it flaked off in considerable portions, and cracked through in several other places. Finding it wholly impossible to preserve its entirety, recourse was had to measuring the relics as they lay, and of making drawings from them as accurately as possible. And as the fragments of the tusk were handed up, Dr. Mitchill measured them by a rule, and found their amount, reckoning within bounds, to be eight feet and nine inches; or taking into calculation the space of connexion with the jaw as being three inches, or perhaps more, the length of the tusk was nine feet, or upwards, of *solid ivory*.*

The circumference at the base was two feet and two inches, making a diameter of eight inches and two-thirds! The taper was easy, gradual, and smooth, like the tusks of other elephants. Dr. Townsend made a sketch of the parts *in situ*, before they were removed; by which it will be seen how the grinders are situated in relation to the tusks, and how tusks are to be considered as holding a middle place, in their anatomical structure and use, between teeth and horns. The various parts of the animal which were disinterred, and the drawings and illustrations, are herewith submitted to the society.

"Although the fragile and friable nature of these bones might render it impossible ever to connect them into a complete skeleton, the commissioners state it as a matter of the highest probability, that at the aforesaid place, the remainder of a mammoth, as huge perhaps as ever walked the earth, reposes in the swamp, not more than fifty-four miles from the site of this institution.— He has already heard the resuscitating voice of the Lyceum."

* The tusks, though solid, are changed in their nature. Professor MacNeven, honorary member of the Lyceum, mentioned, in the society, that he had found their substance to be converted into carbonate of lime.

VOL. XVIII PART I

ANNALS

OF THE

NEW YORK ACADEMY OF SCIENCES

EDITOR

Edmund Otis Hovey

NEW YORK

PUBLISHED BY THE ACADEMY

1908

NEW YORK ACADEMY OF SCIENCES.

OFFICERS, 1908.

President — CHARLES F. COX, Grand Central Station.
Recording Secretary — E. O. HOVEY, American Museum.
Corresponding Secretary — H. E. CRAMPTON, Barnard College.
Treasurer — EMERSON MCMILLIN, 40 Wall St.
Librarian — RALPH W. TOWER, American Museum.
Editor — EDMUND OTIS HOVEY, American Museum.

SECTION OF GEOLOGY AND MINERALOGY.

Chairman — A. W. GRABAU, Columbia University.
Secretary — C. P. BERKEY, Columbia University.

SECTION OF BIOLOGY.

Chairman — FRANK M. CHAPMAN, American Museum.
Secretary — ROY W. MINER, American Museum.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

Chairman — D. W. HERING, New York University.
Secretary — WILLIAM CAMPBELL, Columbia University.

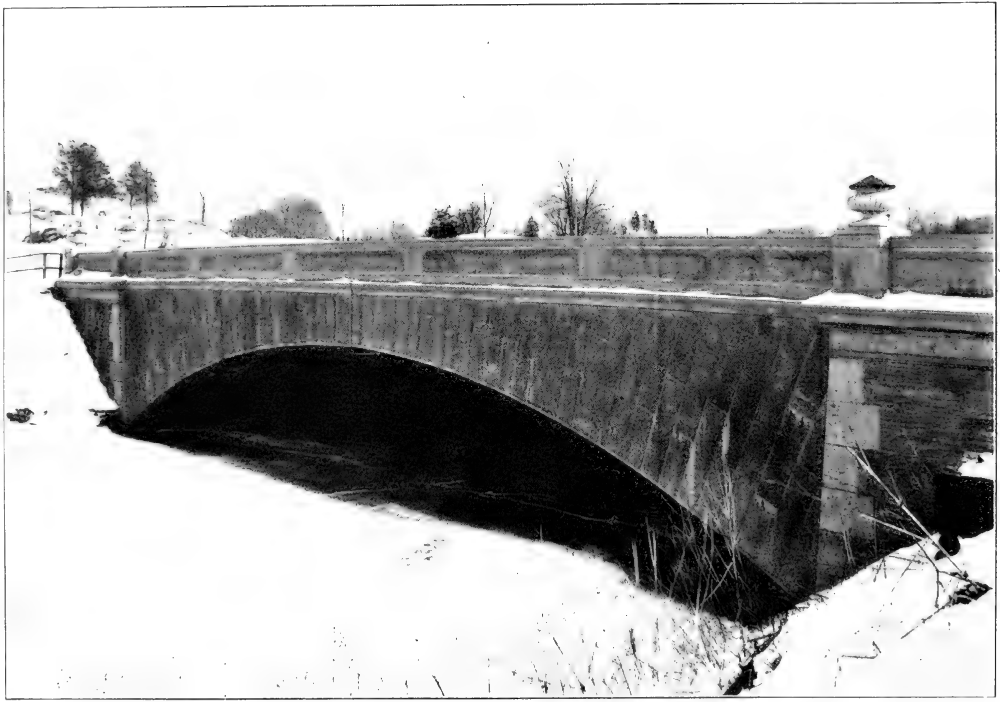
SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

Chairman — ADOLF MEYER, Ward's Island.
Secretary — R. S. WOODWORTH, Columbia University.

Sessions of 1908.

The Academy will meet on Monday evenings at 8:15 o'clock from October to May, inclusive, in the American Museum of Natural History, **77th Street and Central Park, West.**

Annals N. Y. Acad. Sci., Vol. XVIII, Part I, January, 1908.



THE LINNÆUS BRIDGE, BRONX PARK, NEW YORK CITY.

Dedicated May 23, 1907.

Annals N.Y. Acad. Sci., Vol. XVIII, No. 1, Part I, pp. 1–90. January, 1908.]

THE BICENTENARY OF THE BIRTH OF CAROLUS LINNÆUS.

By Edmund Otis Hovey,

Recording Secretary.

On May 23, 1907, the New York Academy of Sciences, in common with many other scientific societies and institutions throughout the world celebrated the two hundredth anniversary of the great Swedish naturalist Carl von Linné, who is better known perhaps by his Latin name Linnæus. In preparation for the event, the following invitation was sent out to sister societies throughout the world and to the Honorary Members of the Academy.

The New York Academy of Sciences
will celebrate on May 23, 1907, the
Two Hundredth Anniversary of the Birth of Carl von Linné.

At this time, commemorative exercises will be held at
The American Museum of Natural History, The New York Zoölogical Park,
The New York Botanical Garden, The New York Aquarium,
The Brooklyn Institute of Arts and Sciences.

A beautiful bridge crossing the Bronx River between the Botanical Garden and the Zoölogical Park will be dedicated to the distinguished Swedish naturalist.

(*The Royal Swedish Academy of Sciences*)

is invited to take part in this celebration by contributing an official document, appreciative of the works of Linné, to be read before the members of the New York Academy of Sciences and assembled guests.

N. L. Britton,
President.

E. O. Hovey,
Secretary.

The invitation was accompanied by an illustration of the Linnæus Bridge, to which reference was made.

To all sister societies in the United States, Canada and Mexico, the following additional invitation was sent.

(*The National Academy of Sciences*)
is cordially invited by the
New York Academy of Sciences
to participate in its exercises
commemorative of the two hundredth anniversary
of the birth of the Swedish naturalist
Carl von Linné
through an authorized representative
as well as by the official document asked for
in the accompanying invitation

An early reply is desired

On the day of the anniversary the committee charged by the Council with making arrangements for the celebration carried out the following program.

PROGRAM OF EXERCISES

MORNING

9:00–12:00.— At the American Museum of Natural History
Exhibition of American Animals known to Linnæus
In charge of F. M. Chapman, W. M. Wheeler, W. Beutenmueller
Exhibition of Shells, Minerals and Rocks known to Linnæus
In charge of L. P. Gratacap, E. O. Hovey
10:30.— Reading of letters from other Societies by the Secretary of the Academy
11:15.— Address by J. A. Allen on "Linnæus and American Zoölogy"

AFTERNOON

2:00–4:00.— At the New York Botanical Garden, Museum Building, Bronx Park
Exhibition of American Plants known to Linnæus
In charge of L. M. Underwood, J. K. Small, P. A. Rydberg, M. A. Howe, G. V. Nash
Exhibition of the Botanical Writings of Linnæus and of Portraits of Linnæus
In charge of C. B. Robinson, J. H. Barnhart
3:10.— Address by P. A. Rydberg on "Linnæus and American Botany"
3:40.— Exhibition of selected lantern slides of Flowers of North American Plants known to Linnæus. In charge of H. H. Rusby

4:00–4:30.— Walk South from Museum Building through the Grounds of the Garden to the Linnæus Bridge
W. A. Murrill will point out characteristic American trees known to Linnæus

4:30.— At the Bridge over the Bronx River on Pelham Parkway
Unveiling of a Bronze Tablet Commemorating Linnæus
Address by the President of the Academy, and placing of documents in the tablet
Singing by the American Union of Swedish Singers: "Hear us, Svea" — *Wennerberg*

Acceptance of the tablet on behalf of the City of New York by the Hon. JOSEPH I. BERRY, Commissioner of Parks of the Borough of the Bronx

Acceptance of the key of the tablet by the New York Historical Society for safe keeping until May 23, 1957

Singing by the AMERICAN UNION OF SWEDISH SINGERS: "Battle Hymn" — *Lindblad*

Address by G. F. KUNZ, President of the American Scenic and Historic Preservation Society

Address by E. F. JOHNSON, President of the United Swedish Societies of New York

Singing by the AMERICAN UNION OF SWEDISH SINGERS: "Banner Song"— *Wennerberg*

5:15–6:30.— At the New York Zoölogical Park

Examination of the Collections with special reference to Animals known to Linnæus

In charge of W. T. HORNADAY, C. W. BEEBE, R. L. DITMARS, W. REID BLAIR

EVENING

8:00.— At the Museum of the Brooklyn Institute, Eastern Parkway

Opening address by F. A. LUCAS

Address by E. L. MORRIS on the "Life of Linnæus"

Musical number by the Glee Club of the UNITED SWEDISH SOCIETIES

Address by F. A. LUCAS on "Linnæus and American Natural History"

Musical numbers by the Glee Club of the UNITED SWEDISH SOCIETIES

Exhibition by means of lantern slides of "Plants and Animals known to Linnæus." In charge of Dr. A. J. GROUT, F. A. LUCAS

8:30–10:30.— At the New York Aquarium, Battery Park

(Admittance by invitation only)

Reception given by the New York Zoölogical Society to the New York Academy of Sciences and Guests

Demonstrations of features of Marine Life known to Linnæus

Commemoration of the centennial of the Aquarium building

First view of the collections of the Aquarium by night. Music

NATHANIEL L. BRITTON
HERMON C. BUMPUS
WILLIAM T. HORNADAY
FREDERIC A. LUCAS
CHARLES H. TOWNSEND
WILLIAM MORTON WHEELER
Committee

EDMUND OTIS HOVEY, *Secretary*
American Museum Natural History

The carrying out of the plans of the Committee was made possible through a special fund of about $1000, the subscribers to which were

Adams, Edward D.
Adler, I.
Amend, B. G.
Armstrong, S. T.
Atkins, George F.
Avery, Samuel P.
Barron, George D.
Baskerville, Charles
Beck, F. C. T.
Beckhard, Martin
Berthoud, Edward S.
Beuren, F. T. van
Bird, Henry
Bristol, John I. D.
Brown, Edwin H.
Bumpus, H. C.
Bunting, Martha
Burgess, E. S.
Call, A. Ellsworth
Cassabeer, H. A., Jr.
Chamberlain, Leander T.
Chandler, C. F.
Chubb, S. H.
Cline, Miss May
Cohn, J. M.
Corning, C. R.
Cox, C. F.
Davenport, Mrs. Elizabeth B.
Davidson, Miss Mary E. S.
Davies, J. Clarence
Dean, Bashford
Demorest, W. C.
Dodge, C. H.
Donald, James M.
Douglas, James
Draper, Mrs. Henry
Dunham, E. K.
Dwight, Jonathan, Jr.
Dwight, Melatiah E.
Foot, Miss Katharine
Ford, James B.
Frissell, A. S.
Gooch, F. C.
Greenwood, Isaac J.
Haupt, Louis
Herrman, Mrs. Esther
Hess, Selmar
Holden, E. R.
Hooker, Miss Henrietta E.
Hornaday, William T.
Huntington, Archer M.
Hussakof, L.
Jesup, Morris K.
Kaufman, Miss Pauline
Kemp, James F.
Kuntz, C.
Kunz, George F.
Lagerberg, J. de
Langeloth, I.
Langmann, G.
Levy, Miss Daisy
Low, Seth
Lucas, F. A.
Matthew. G. F.
McKim, H.
McMillin, Emerson
McNeil, C. R.
New York Academy of Sciences
Nichols, John Treadwell
Oettinger, P. J.
Osborn, H. F.
Osborn, W. C.
Osburn, Raymond C.
Owens, William W.
Parsons, Mrs. Edwin
Parsons, John E.
Pederson, Frederick M.
Perkins, W. H.
Perry, C. J.
Phipps, Henry
Pinchot, Gifford
Post, Abram S.
Ramsperger, G.
Riker, Samuel
Robb, J. Hampton
Robinson, Miss Winifred J.
Rydberg, P. A.
Seabury, George J.
Seitz, Charles E.
Sellew, T. G.
Shannon, William Purdy
Smith, Eugene

Stetson, Francis Lynde	White, I. C.
Stolpe, Mauritz	Wicke, William
Thorburn & Co., J. M.	Williams, R. S.
Townsend, C. H.	Wilson, Edward B.
Tuckerman, Alfred	Wood, Miss Cynthia A.
Watson, J. H.	Woodward, Robert S.
Yatsu, Naohidé	

The Academy also acknowledges the co-operation of the American Museum of Natural History, the New York Botanical Garden, the New York Zoölogical Society, the Museum of the Brooklyn Institute of Arts and Sciences, the American Union of Swedish Singers and the Glee Club of the United Swedish Societies, in making the celebration dignified and successful.

After the inspection of the special exhibits in the American Museum, the literary exercises began with the reception by President Britton of the official delegates of societies as follows, each presenting the greeting of his society.

Royal Swedish Horticultural Society	J. de Lagerberg
Society of Friends of Natural Sciences, Ekaterinburg, Russia	George F. Kunz
Sociedad Cientifica "Antonio Alzate," Mexico	J. J. Stevenson C. T. Stevens J. F. Kemp
Boston Society of Natural History	J. A. Allen
Museum of Comparative Zoölogy	William Brewster
Natural History Society of West Newbury, Mass.	William Merrill
American Journal of Science	Herbert E. Gregory
Connecticut Academy of Arts and Sciences	Alexander W. Evans
Linnæan Society of New York	Jonathan Dwight, Jr.
New York Botanical Garden	Addison Brown
New York Zoölogical Society	H. F. Osborn
American Museum of Natural History	G. H. Sherwood
Torrey Botanical Club	H. H. Rusby
New York Entomological Society	E. B. Southwick
New York Microscopical Society	J. L. Zabriskie
New York Historical Society	Samuel V. Hoffman
American Institute of the City of New York	Robert Rutter
Buffalo Society of Natural Sciences	T. G. Smith
Brooklyn Institute of Arts and Sciences	A. J. Grout F. A. Lucas
Staten Island Association of Arts and Sciences	Arthur Hollick
Maryland Academy of Sciences	C. C. Plitt
American Philosophical Society	J. W. Harshberger
American Entomological Society	J. W. Harshberger
National Academy of Sciences	H. F. Osborn
Biological Society of Washington	Edward L. Morris

Ohio Academy of Sciences	Raymond C. Osborn
Indiana Academy of Sciences	Guy West Wilson
Colorado Scientific Society	E. J. H. Amy E. M. Rogers B. B. Lawrence E. E. Olcott W. S. Morse

Telegraphic greetings were read from

The Royal Swedish Academy of Sciences, Stockholm
The Royal University, Upsala
The Royal Botanic Gardens, Edinburgh
The Royal Dublin Society, Dublin
The Gothenburg Society of Science, Gothenburg
The Imperial Academy of Sciences, St. Petersburg
The Uralian Natural History Society, Ekaterinburg
The Royal Linnæan Academy, Rome
The Botanical Garden, Rio de Janeiro

After the reading of these greetings, the Secretary submitted the following complete list of the societies, other organizations and individuals sending greetings.

Foreign Societies

The Linnæan Society, London
The British Association for the Advancement of Science, London
The Society of Arts, London
The Royal Cornwall Polytechnic Society, Falmouth
The Cambridge Philosophical Society, Cambridge
The North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne
The Royal Scottish Geographical Society, Edinburgh
The Royal Botanic Garden, Edinburgh
The Royal Philosophical Society of Glasgow, Glasgow
The Royal Dublin Society, Dublin
Den Norske Gradmaalingskommission, Kristiania
The Royal Swedish Academy of Sciences, Stockholm
The Royal Swedish Horticultural Society, Stockholm (Delegate)
The Gothenburg Society of Sciences, Gothenburg
The Royal University of Upsala, Upsala
The University of Lund, Lund
The Geological Commission of Finland, Helsingfors
The Imperial Academy of Science, St. Petersburg
The Uralian Natural History Society, Ekaterinburg (Delegate)
Koninklijke Akademie van Wetenschappen te Amsterdam, Amsterdam
Senaat der Rijks Universiteit te Leiden, Leiden
Königlich Preussische Akademie der Wissenschaften, Berlin
Berliner Entomologische Verein, Berlin

Kommission zur wissenschafflichen Untersuchung der deutschen Meere, Kiel
Kaiserliche Leopoldinisch-Carolinische deutsche Akademie der Naturforscher, Halle, A.S.
Verein für vaterländische Naturkunde in Württemberg, Stuttgart
Thurgauische Naturforschende Gesellschaft, Frauenfeld
Kaiserliche Akademie der Wissenschaften, Wien
Regia Societas Scientiarum Bohemica, Prague
The Royal Hungarian Society of Natural Sciences, Budapest
The Transylvanian Museum Society, Kolszvar
La Société de Physique et d'Histoire Naturelle de Genève, Suisse
L'Akademie de Médecine, Paris
Société Linneénne de Normandie, Caen
Société des Amis des Sciences de Rouen, Rouen
Société Géologique du Nord, Lille
Université de Lyon, Lyons
La Société des Sciences de Nancy, Nancy
Société d'Histoire Naturelle de Toulouse, Toulouse
Real Academia de Ciencias Exactas, Fisicas y Naturales, Madrid
Specula Vaticana, Rome
The Royal Linnæan Academy, Rome
The Australian Museum, Sydney
Koninklijke Natuur Kundige Vereeniging in "Nederlandsch–Indie," Weltevreden (Batavia)
Royal Society of Canada, Ottawa
Ottawa Field Naturalists' Club, Ottawa
Entomological Society of Ontario, Toronto
Sociedad Cientifica "Antonio Alzate," Mexico
The Botanical Garden, Rio de Janeiro
Museu Nacional do Rio de Janeiro

Honorary Members

Sir Archibald Geikie, London
Sir James Dewar, London
Dr. Hans Reusch, Kristiania
Professor Hugo de Vries, Amsterdam
Professor A. A. W. Hubrecht, Utrecht
Prof. Dr. Karl von den Steinen, Berlin
Prof. Dr. Wilhelm Pfeffer, Leipzig
Prof. Dr. H. Rosenbusch, Heidelberg
Professor Charles Barrois, Lille
Prof. Dr. F. Leydig, Rothenburg
Professor Edward S. Dana, New Haven
Dr. H. R. Storer, Newport
Professor A. E. Brown
Professor George Macloskie, Princeton
Professor Edward L. Berthoud, Boulder, Colorado

Domestic Societies

Portland Society of Natural History, Portland, Me.
Natural History Club of West Newbury, West Newbury, Mass.
Boston Society of Natural History, Boston, Mass. (Delegate)
Boston Scientific Society, Boston, Mass. (Delegate)
Massachusetts Horticultural Society, Boston, Mass.

Museum of Comparative Zoölogy, Cambridge, Mass. (Delegate)
Newport Natural History Society, Newport, R.I.
American Journal of Science, New Haven, Conn. (Delegate)
Connecticut Academy of Arts and Sciences, New Haven, Conn. (Delegate)
New York State Museum, Albany, N.Y.
Linnæan Society of New York, New York, N.Y. (Delegate)
New York Botanical Garden, New York, N.Y. (Delegate)
Torrey Botanical Club, New York, N.Y. (Delegate)
New York Entomological Society, New York, N.Y. (Delegate)
New York Microscopical Society, New York, N.Y. (Delegate)
New York Historical Society, New York, N.Y. (Delegate)
New York Zoölogical Society, New York, N.Y. (Delegate)
American Museum of Natural History, New York, N.Y. (Delegate)
New York Academy of Sciences, New York, N.Y. (Delegate)
American Scenic and Historic Preservation Society, New York, N.Y. (Delegate)
American Institute of the City of New York, New York, N.Y. (Delegate)
Medico Legal Society of New York, New York, N.Y. (Delegate)
United Swedish Societies of New York, New York, N.Y. (Delegate)
Brooklyn Institute of Arts and Sciences, New York, N.Y. (Delegate)
Staten Island Association of Arts and Sciences, New Brighton, N.Y. (Delegate)
New York State Education Department, Science Division, Albany, N.Y. (Delegate)
Buffalo Society of Natural Sciences, Buffalo, N.Y. (Delegate)
Stevens Institute of Technology, Hoboken, N.J.
Academy of Natural Sciences of Philadelphia, Philadelphia, Pa. (Delegate)
American Philosophical Society, Philadelphia, Pa. (Delegate)
American Entomological Society, Philadelphia, Pa. (Delegate)
Zoölogical Society of Philadelphia, Philadelphia, Pa. (Delegate)
Carnegie Museum, Pittsburgh, Pa. (Delegate)
Natural History Society of Delaware, Wilmington, Del.
Maryland Scientific Society, Baltimore, Md. (Delegate)
National Academy of Sciences, Washington, D.C. (Delegate)
Smithsonian Institution, Washington, D.C. (Delegate)
Biological Society of Washington, Washington, D.C. (Delegate)
Library of Congress, Washington, D.C. (Delegate)
Philosophical Society of Washington, Washington, D.C. (Delegate)
Ohio Academy of Science, Gambier, O. (Delegate)
Indiana Academy of Sciences, Bloomington, Ind. (Delegate)
Wisconsin Academy of Sciences, Arts and Letters, Madison, Wis.
St. Paul Academy of Science, St. Paul, Minn.
Academy of Science of St. Louis, St. Louis, Mo.
Missouri Botanical Garden, St. Louis, Mo.
Colorado Scientific Society, Denver, Col. (Delegate)

The audience then listened to the following address.

Courtesy N.Y. Botan. Garden.

LINNÆUS AT THE AGE OF THIRTY, IN LAPLAND DRESS.

Courtesy N.Y. Botan. Garden.

LINNÆUS AT THE AGE OF FORTY.

LINNÆUS AS A ZOÖLOGIST.

By J. A. Allen, Ph. D.

Carolus Linnæus, later known as Carl von Linné, was born at Råshult, in the province of Småland, Sweden, May 13, O.S., 1707, and died at Hammerby, near Upsala, on Jan. 10, 1778. His grandfather was a farmer; his father, a clergyman. Young Linnæus, the future naturalist, was intended by his parents for the ministry, and his early education was conducted with this end in view. At the age of ten he was sent to the Latin School at Wexiö, but after seven years at this school he was found to be so deficient in his scholastic studies that his parents thought of apprenticing him to a shoemaker.

While at Wexiö, much of his time was devoted to the study of plants and insects, an inclination apparently favored by his master, who was himself greatly interested in botany. Fortunately young Linnæus was rescued from his threatened degradation by Dr. John Rothman, a physician of Wexiö, who recognized his superior abilities, and appreciated his interest in natural history. He took him into his own home, where for a year Linnæus continued his botanical studies, aided by the advice and library of his patron. At the age of twenty he entered the University of Lund, where he soon found himself without means of support, through the death of his patron and friend, the kind-hearted physician of Wexiö. Fortunately he soon won the friendship of Dr. Kilian Stobæus, the professor of botany and medicine, who made him a member of his family. Here he had access to books and to a small museum of natural history, and found much leisure for exploring the neighboring country and for collecting objects of natural history. At the end of a year he went to Upsala, where, under Rudbeck and Roberg, he advanced rapidly in medicine and botany. Here he won the friendship of the renowned Olaf Celsius, whom he later characterized as the best botanist in Sweden, and of Artedi, a fellow-student, who afterwards became the founder of ichthyology. During his whole course at Upsala, it is said that he did not hear a single public lecture on either anatomy, botany or chemistry, but he and Artedi, in good-tempered rivalry, were devoting their energies to natural history,— Linnæus to plants, birds and insects, and Artedi to amphibia and fishes. Linnæus here also began the preparation of his epoch-making works on botany and of the first edition of his "Systema Naturæ," published a few years later in Holland.

In 1732, at the age of twenty-five years, he was commissioned by the Upsala Academy of Sciences to make a tour of exploration in Lapland in the interest of natural history. He left Upsala on the 12th of May, and after an absence of five months returned to Upsala on the 10th of October. This remarkable journey of 4600 miles was made partly on horseback, partly by boat, and partly on foot; it extended northwestward across the Norwegian Alps to the coast of Norway beyond the Arctic Circle; the return journey was made by way of eastern Finland It was an undertaking of great hardship and much danger, being performed alone, aided only by local guides employed to conduct the way from one point to another. On his return a report of his journey was presented to the Academy, but it remained in manuscript until translated and published in English by Dr. James Edward Smith, the first president of the Linnæan Society of London, in 1811.[1] The botanical results, however, were published separately by Linnæus himself, in 1737.

The following year was spent at Upsala, where he attempted to eke out his scanty means of support by giving lectures on botany, mineralogy and chemistry. This proved contrary to one of the statutes of the university, to the effect that no one should give public lectures who had not obtained his doctor's degree, which statute was invoked against him by Rosen, the successor to Rudbeck in the professorship of medicine and anatomy, who was jealous of Linnæus's abilities and attainments. Deprived of this financial resource, he took some of his pupils on excursions into the neighboring mountains, where he met the governor of the province of Dalecarlia, who sent him to explore and report on certain copper mines in which he was interested. While on this journey he gave lectures at Falun on mineralogy and assaying. Here he made the acquaintance of Dr. Moræus (a learned and wealthy physician of the district) and his two daughters, to one of whom he became betrothed; the father, however, insisted on deferring the marriage till Linnæus had completed his professional studies and obtained his medical degree. For this purpose, in the spring of 1735, he journeyed to Lubeck and Hamburg, and later to Holland, where, in June, he received from the University of Harderwijk the degree of doctor of medicine. At Leyden he became acquainted with the leading men of science of that city, which soon led to his engagement by Dr. George Cliffort, a wealthy burgomaster of Amsterdam, to take charge, at a liberal salary, of his extensive

[1] The herbaria, library (about 2500 volumes), manuscripts and correspondence of Linnæus, were offered by his widow and daughters, "by the advice of friends," to Sir Joseph Banks, "for the sum of a thousand guineas." Sir Joseph, not feeling inclined to the purchase, recommended it to the consideration of his friend, Dr. (later Sir) J. E. Smith, by whom these treasures were secured, and transferred to England (TURTON, *Life and Writings of Linnæus*, 1806, p. [39]), and later passed into the possession of the Linnæan Society of London, founded in 1788 through the efforts of Dr. Smith, who was its first president. (See JARDINE'S *Naturalist's Library*, Vol. I, 1833, p. 58.)

museum and botanic garden. Later he was sent by him to England to secure rare plants for his garden, with a letter of introduction from the great Boerhaave to Sir Hans Sloane. He thus came in contact with the botanists of London, where, however, his reception was not always cordial.

On his return to Holland he was offered the position of government physician to the Dutch colony in Surinam, which he prudently declined, and became an assistant to his friend Van Royen at the botanic garden in Leyden. After a brief visit to Paris he returned to Stockholm in September, 1738, where he determined to settle as a physician. Notwithstanding his fame abroad and his skill as a botanist, the pecuniary returns from his profession were at first small, but they gradually increased; and, obtaining some government patronage, his marriage to Miss Moræus was celebrated on June 26, 1739.

He remained only three years in Stockholm, during which period he helped to found the Royal Academy of Sciences of that city, and served as its first president. In 1741, under an order from the government, he made a journey through Öland and Gothland. In the same year he was called to the chair of botany at the University of Upsala, a position to which he had long aspired, and which he filled for thirty years, when impaired health compelled him to resign his official duties and to discontinue his literary labors. The University of Upsala, through the fame of Linnæus, became widely renowned as a seat of learning, and attracted students from various parts of Europe. During these years of almost uninterrupted activity, most of Linnæus's numerous botanical and other works were published, the material for which reached him in ever-increasing abundance, not only from distant parts of Europe, but from Siberia, China, India, Egypt, South Africa and North and South America.

Academic honors were showered upon him by all the learned societies of Europe; a gold medal was struck in his honor by the nobles of Sweden; and in 1757 he was created by King Frederic a Knight of the Polar Star, and admitted to hereditary nobility. Foreign courts made overtures for his presence, and his own country neglected no opportunity to do him honor. His death in 1778, after six years of invalidism resulting from an attack of apoplexy, was recognized as a national calamity; the University of Upsala went into mourning, and the King ordered a medal to be struck in his memory.

Although cramped by poverty during the earlier part of his career, prosperity did not long withhold her smile. Not only were the nobles of his country his patrons, but he was an especial favorite of both King Frederic and his queen. Through various emoluments showered upon him, he was able, later in life, to purchase a large estate and to construct for himself a museum, wherein he gathered the largest collection of botanical treasures that at that time had anywhere been brought together. He was happy in his domestic relations, and lived to see his son succeed to his chair at the University of Upsala.

Although Linnæus's publications relate mainly to botany and medicine, they cover the whole realm of natural history. His earliest contribution to science is generally considered to be his "Florula Lapponica," the first part of which appeared in the Transactions of the Swedish Academy in 1732.[1] This was followed by the first edition of his "Systema Naturæ," published in Leyden in 1735. The "Fundamenta Botanica" followed in 1736, and was later enlarged and republished as the "Philosophia Botanica," in 1751. During the next ten years various other botanical publications appeared in rapid succession. His "Fauna Suecica," published in 1746, was his first special work relating to zoölogy. It is also notable as being the first work especially devoted to the entire fauna of any country. It was republished, with many additions, in 1761. Other botanical and several medical works followed during the next seven years, including his monumental "Species Plantarum," published in 1753. In the same year also appeared the "Museum Tessianum," consisting chiefly of descriptions of minerals and fossils, the latter mainly shells and corals, and in 1754 the "Museum Adolphi Friderici," relating exclusively to exotic animals. This was a folio with thirty-three plates, the most extensive and most elaborately illustrated of all of Linnæus's works. Two important medical works appeared in 1760, and his third zoölogical work, the "Museum Ludovicisæ Ulricæ," in 1764, a thick octavo, to which was annexed the second part of the "Museum Adolphi Friderici."

During these thirty years of marvelous scientific activity, Linnæus also contributed many papers to the Transactions of the Upsala and Stockholm academies and to the "Amœnitates Academici." The latter, in ten octavo volumes, consist of dissertations or academical theses, mostly by his students, selected, edited and published by him, and thus may be regarded as of equal authority with his own writings. Seven of these volumes were published during his lifetime, and contain a number of his own minor papers.

This brief outline of Linnæus's life, his opportunities, and the published results of his scientific labors, affords the basis for the consideration of Linnæus as a zoölogist. As has been shown, he was primarily a botanist; he was also a mineralogist, an entomologist and a conchologist, but only incidentally a vertebrate zoölogist. In this field his interest was less strong, his opportunities for research the most restricted. His zoölogical writings,

---

[1] His Hortus Uplandicus is said to have appeared one year earlier. See List of the Works of Linnæus, in Jardine's Naturalist's Library, Vol. I, 1833, p. xvii, footnote.

exclusive of a few minor papers, are comprised in the "Fauna Suecica," the "Museum Adolphi Friderici," the "Museum Ludoviciæ Ulricæ" and the several editions of his "Systema Naturæ." The first edition, appearing in 1735, was a folio of only 12 pages, consisting merely of a conspectus of his Systema in tabular form. The second edition, published in 1740, was an octavo of 40 pages, in which were added, for the animal kingdom, the characters of the groups. The sixth, published in 1748, was greatly enlarged, the zoölogical part alone consisting of 76 pages, illustrated with six plates, or one for each of his six classes of animals. The tenth, published in 1758, was in two octavo volumes, of which the zoölogy formed the first volume, consisting of 824 pages. The twelfth, and the last edition revised by the author, was issued in three volumes, the first of which, containing the zoölogy and comprising 1427 pages, appeared in 1766. Thus in thirty-three years this work grew from a brochure of 12 pages to a work of 2400 pages.

The first edition of the Systema was published when the author was only twenty-eight years old, during his sojourn in Holland. He had never previously been beyond the confines of southern Sweden, except on his journey to Lapland and Finland in 1732, and he had had access to no large collection of animals. Thus his resources for such an important undertaking were extremely limited, being restricted to his own considerable first-hand knowledge of the fauna of Sweden, to the few specimens of exotic animals he had been able to see in Lund, Upsala and Stockholm, and to the scanty literature of the subject there available. When the second edition appeared, in 1740, he had spent less than three years and a half in foreign countries, mainly in Holland with single brief visits to London and Paris; but his interests on these occasions were botanical and not zoölogical.

The sixth edition (the third revised by the author), published in 1748, was in effect a synopsis of the fauna of Sweden, filled in, as regards the fauna of the rest of the world, by compilations from his predecessors. Strange as it may seem, outside of the tropical genera *Simia, Bradypus, Dasypus, Myrmecophaga* and *Manis,* this edition enumerates only thirteen species of mammals not found in Sweden. Only 140 are recorded for his whole class Animalium quadrupedium, one-third of which are Scandinavian.

This analysis could be extended to other classes with practically similar results. The class Insecta, for example, includes only thirteen species that are not also recorded in the "Fauna Suecica," showing how limited was his knowledge of the world's fauna at 1748.

The tenth edition (the fourth revised by the author), published in 1758, is *the* epoch-making work in the history of zoölogy, as in this the binomial system of nomenclature for the whole animal kingdom is introduced for the first time. The work is also greatly enlarged, and the classification greatly improved, especially that of the mammals, which class is now for the first time aptly designated Mammalia. The ordinal term Primates is substituted for Anthropomorpha of the sixth and previous edition, the sloths (genus *Bradypus*) are removed from it, the genus *Lemur* is added as a new genus, and the bats are transferred to it from the Feræ. A new order, Bruta, is made up of his former third order Agriæ (now suppressed) and of such other extremely heterogeneous elements as the elephant, the manatee, sloths, ant-eaters and the scaly ant-eaters. The order Feræ consists of six properly associated genera; the armadillos, insectivores and bats, formerly included in it, being removed elsewhere. His fourth order, Bestiæ, is a new group, composed of the pigs, armadillos, opossums and insectivores. The fifth order, Glires, is a natural group, except for the inclusion of the genus *Rhinoceros,* now most strangely placed with the squirrels and mice. His sixth order, Pecora, is retained as in the previous editions, and is also a natural group. The seventh, Belluæ, is a new ordinal group, consisting of the genera *Equus* and *Hippopotamus*, transferred from the here disrupted order Jumenta of previous editions. The Cete, now removed by him from the fishes, form his eighth and last order. This reconstruction of the ordinal groups is a great improvement: five new genera are added, two old ones eliminated, and the number of species is increased from 140 to 185. In some of the other classes there are similar radical changes, but there is not time to refer to them.

The twelfth, and the last edition revised by the author, published in 1766, shows many improvements over the tenth. It is greatly increased in bulk through the addition of many new genera and a large number of new species. The classification is also judiciously modified at many points. Taking again the class of mammals for illustration, the number of orders is reduced from eight to seven, through the suppression of the grossly unnatural order Bestiæ and the transference of its genera to other associations, with, however, the retrograde change of placing the insectivores and the genus *Didelphis* among the Feræ. The Glires is modified by the removal of the genus *Rhinoceros* to the order Belluæ and the addition to it of *Noctilio*, a genus of bats. The order Bruta is the same incongruous association of elephants, manatees, sloths and ant-eaters as in the tenth edition.

The orders of mammals as now left correspond in several instances very nearly with those of our modern systems, notably the Primates, Glires, Pecora and Cete. The Feræ of the tenth edition corresponds to the modern Carnivora, but in the twelfth he made the mistake of putting back into it the marsupials and the insectivores. His order Belluæ being essentially the modern suborder Perissodactyla, his order Bruta is the only grossly incongruous association of types.

The only previous classification of mammals with which Linnæus's need to be compared is Ray's, published in 1693, whose system, taken as a whole, is far more artificial than Linnæus's. Naturally there are some striking coincidences of grouping, and in the characters employed by the two authors. As to the latter, Ray so well covered the field that there was little left for Linnæus to add, since during the interval between Ray and Linnæus not much was learned about the anatomy and relations of the ordinal groups of mammals. Doubtless Linnæus was influenced, in his removal of the cetaceans from the fish to the mammal class, by the systems of his contemporaries, Klein (1751) and Brisson (1756), in which respect only are their systems better or less artificial than his. Inasmuch, however, as Brisson divided mammals into eighteen orders instead of seven, he escaped some of the grotesque combinations made by Linnæus: on the other hand, he gave undue emphasis to relatively unimportant differences.

Linnæus's classification of birds is closely modeled upon that of Ray, and his departures from it are seldom improvements. His lack of knowledge of ornithology is strikingly apparent through his repeated association of very unlike species in the same genus, as where a penguin is combined with a tropic bird to form his genus *Phaëthon,* and another species of penguin with an albatross to form his genus *Diomedea.* In the tenth edition he recorded only about 550 species of birds; in the twelfth, this number was raised to nearly a thousand, mainly on the basis of Brisson's great work, which appeared in 1760. The greater part were based on the writings of previous authors; probably less than one-fourth of them being known to him from specimens.

His class Amphibia contained four orders, of which the fourth consisted of cartilaginous and other wholly unrelated fishes, and shows how slight was his acquaintance with the lower classes of vertebrates. His first order, Reptilia, includes such diverse animals as turtles, lizards, salamanders, frogs and toads. The snakes formed his second order, Serpentes.

His arrangement of the fishes was originally based on that of Artedi, whose "Ichthyologia" Linnæus published while sojourning in Holland, in 1738, after Artedi's untimely death by accidental drowning.

His class Insecta is nearly equivalent to the modern subphylum Arthropoda, as it includes the Arachnida and the Crustacea.

His class Vermes was the waste-basket of his system, including all the forms of animal life that were neither vertebrates nor insects, which he distributed into five orders, some of them as heterogeneous in character as the class itself. The second order, Mollusca, comprised all sorts of soft-bodied animals, mostly marine, as slugs, sea-anemones, ascidians, holothurians, cuttle-fishes, star-fishes, sea-urchins and jelly-fishes. The animals now commonly known as Mollusca formed his third order, Testacea.

It is not, however, just to judge Linnæus's work by the standards of to-day. The above comparison of the zoölogical part of the "Systema Naturæ" with our present knowledge of animals is not to be taken as a disparagement: we merely note the progress of zoölogy during the last century and a half of the world's history. Linnæus was a born systematist; his energy and industry were enormous; his isolation promoted independence and originality. He devised new classifications, and thoroughly systematized not only the knowledge of his predecessors, but the vast increment he himself added. He inspired his students with his own enthusiasm, taught them his own advanced methods, and influenced a goodly number of them to undertake natural history explorations in distant and zoölogically unknown parts of the world.

In special lines of research he was far behind several of his contemporaries, notably Brisson, in respect to both mammals and birds. But he nearly doubled the number of known forms of reptiles, amphibians and fishes, and increased many fold the number of species of Cœlenterates, on the basis of wholly new material gathered through his own efforts.

Disgusted with the needlessly detailed accounts and repetitions that characterized the writings of most of his predecessors, he unfortunately adopted the extreme of condensation, thereby adding greatly to the difficulties of his successors in determining to just what forms the thousands of new names he introduced really belonged. Many of his species, based on the accounts given by previous authors, were also composite, often containing very diverse elements. But this detracts little from his credit. As one of his appreciative biographers has tersely put it, "He found biology a chaos; he left it a cosmos."

Linnæus's beneficent influence upon biology was hardly less as a nomenclator than as a taxonomist. He not only invented a descriptive terminology for animals and plants, but devised a system of nomenclature at once simple and efficient, and which for a hundred and fifty years has been accepted without essential modification.

Linnæus divided the three kingdoms of nature into classes, the classes into orders, the orders into genera, the genera into species, under which latter he sometimes recognized varieties. Of these groups, as he understood them, he gave clear definitions, but they were in most cases much more comprehensive than the limits now assigned to groups of corresponding rank. His genera correspond in some cases to groups now termed orders, and frequently to the modern idea of family; in some cases they contained species now placed in separate orders. Prior to Linnæus, these groups had less definite significance, and were often designated by a phrase instead of a single word. Species were indicated only by a cumbersome diagnosis intended to express their chief distinctive characters. For this, Linnæus substituted a single word, an innovation the merits of which were at once almost universally recognized. But Linnæus reached this solution of a grave inconvenience somewhat slowly, and not till 1753 did he fully adopt the *nomen triviale,* when he introduced it into botany in his "Species Plantarum," which is taken by botanists as the point of departure for the binomial system. In the following year, 1754, he introduced it into zoölogy, using it throughout his "Museum Adolphi Friderici" for all the animals catalogued or described in this superb work; namely, 39 species of mammals, 23 of birds, 90 of reptiles and amphibians, 91 of fishes and 64 of invertebrates, or for an aggregate of 307 species of animals. Four years later, in the tenth or 1758 edition of his "Systema Naturæ," he adopted it for the whole animal kingdom, which date is now generally taken as the beginning of the binomial system for zoölogy. The importance and utility of this simple innovation in a matter of nomenclature are beyond estimate, and if Linnæus had done nothing else for the advancement of biology, he would be entitled to a conspicuous niche in the temple of fame and to the gratitude of all subsequent workers in this field. He for the first time gave technical standing to the systematic names, both generic and specific, of all the plants and animals known at the dates when he introduced the *nomen triviale* into the nomenclature of botany and zoölogy.

It is of interest in this connection to note the number of species of animals known to Linnæus at the date of publication of the last edition of the "Systema Naturæ," — the number known to him personally, and the number recorded respectively from North America and from South America.

Of mammals, the whole number of species recorded is 190, of which three-fourths are based on the descriptions of previous authors. Only 48 were American,— 12 from North America and 36 from South America. The 5 North American mammals known to Linnæus from specimens were the raccoon, star-nosed mole, common mole, flying squirrel and chipmunk. The number of species at present known from North America is 600, excluding subspecies. The number for the world, including the extinct as well as the living, is about 10,000 as against less than 200 recorded by Linnæus.

Of birds, about 925 are recorded of the 15,000 known to-day. The 200 known from America are divided about equally between North America and South America, only 50 of which were described from specimens.

The amphibia and reptiles number collectively about 250, of which about one-third are American, 40 per cent of the latter being North American and 60 per cent South American. The North American include 3 salamanders, the box-turtle, the six-lined lizard, the blue-tailed lizard and 14 snakes. The greater part of the 20 North American species of reptiles and amphibians known to him personally were based on specimens transmitted by his former student, Dr. C. D. Garden, from the Carolinas, and on a few sent from Pennsylvania by Pehr Kalm, also one of his students. Thus the greater part of the snakes of the eastern United States became known to Linnæus prior to 1766.

About 500 species of fishes are recorded, of which 100 are American, divided about equally between North and South America. Forty of the nearly 60 North American species described are based on specimens sent from the Carolinas by Dr. Garden, the others mainly on specimens in the museum of King Frederic.

There is not time to notice in detail the various classes of Cœlenterates. A few words about insects will serve as a general illustration for this phylum. Linnæus recorded about 2400 species, the greater part of which he was the first to describe; about 300,000 are now recognized. Of the insects known to him, 65 per cent are recorded in the second (1761) edition of his "Fauna Sueccia," and many of the remainder are European, so that his knowledge of exotic species was exceedingly restricted. Of Coleoptera he recorded about 800 species; the number now known is estimated at 12,000. Of Lepidoptera he recorded about 800; 7000 are now known from North America alone. Of Diptera he recorded 278 species, of which 200 were from Sweden; 12,000 are now known from North America.

Linnæus's system of classification was based on a few external characters, and was recognized by himself as artificial and provisional. It was intended only as a stepping-stone to better things, when the structure and affinities of animals should become better known. The statistics already given indicate how limited was his knowledge of the world's fauna; his classification of animals shows how little he knew of their structure, and how often he was misled by superficial resemblances. Yet his "Systema Naturæ" was the working basis of all naturalists for the next half-century.[1] Twelve editions were published during his lifetime, and it was later translated into several of the continental languages. To such an extent was it regarded as final by many subsequent naturalists that, when his groups began to be changed and new genera interpolated, it was deemed by some of them little less than sacrilege. When convenience demanded subdivision of the larger genera, owing to the great number of new species that had become known since 1766, it

[1] Turton, in his Life and Writings of Linné, says, "To this system may be justly applied the nervous observations of Dr. Johnson, in his delineation of the character of Shakespeare: 'The stream of time, which is continually washing away the dissoluble fabrics of other systems, passes without injury by the adamant of Linné.'" — WILLIAM TURTON: *A General System of Nature . . . by Sir Charles Linné*, Vol. VII, 1806, p. [42].

was quite common to consider the new groups as sections, and to give them merely vernacular names, or, if their authors were bold enough to designate them by Latin names, they were commonly called subgenera.

It was not till near the close of the eighteenth century that there arose a new class of naturalists, the anatomical school, led by the elder Geoffroy and G. Cuvier, who studied the internal structure of animals as well as their external parts. It was, however, many years before the new systems began to displace or greatly to modify the long-accepted and strongly intrenched Linnæan methods of grouping animals.

The great advance in biologic knowledge since the time of Linnæus cannot be easily measured; it can be suggested by noting the fact that comparative anatomy, embryology, histology, paleontology, evolutionism and many kindred lines of research, have nearly all had their origin or principal development within the last century, all converging for the solution of the genetic relationships of animals and the origin of life. Linnæus, in an oration delivered in 1743,[1] held that each species of animal originated from a single pair, citing as incontrovertible proof the Mosaic account of the creation. It is indeed a long look back to the middle of the eighteenth century, when his labors marked a new era in the history of biology. In commemorating to-day the two hundredth anniversary of his birth, we honor ourselves by showing our esteem for the greatest naturalist of the eighteenth century.

---

[1] In his oration De telluris habitabilis incremento, delivered and first published in 1743 and republished in 1744, and again in the second volume of the Amœnitates Academicæ, in 1751, he gives his reasons for believing "that at the beginning to the world there was created one single sexual pair of every species of living thing.

"To the proofs of this proposition," he continues, "I request those who are my auditors to lend a favorable ear and willing attention.

"Our holy Faith instructs us to believe that the Divinity created a single pair of the human kind, one individual male, the other female. The sacred writing of Moses acquaint us that they were placed in the Garden of Eden, and that Adam there gave names to every species of animal, God causing them to appear before him.

"By a sexual pair I mean one male and one female in every species where the individuals differ in sex." — J. F. BRAND's translation, in *Select Dissertations from the Amœnitates Academicæ*, 1781, pp. 75, 76.

The following address was prepared for the celebration, but was read only by title. It is inserted here on account of its close relations with the address of Dr. Allen.

LINNÆUS AS AN INTERMEDIARY BETWEEN ANCIENT AND MODERN ZOÖLOGY; HIS VIEWS ON THE CLASS MAMMALIA.

By W. K. Gregory, M. A.

In connection with the two hundredth anniversary of the birth of Carl von Linné, or Carolus Linnæus, it may not be inappropriate to consider him in his capacity of bridging over the gap between ancient and medieval zoölogy on the one hand and modern zoölogy on the other, and further to glance at the principles and facts upon which he based his two great contributions to the broader knowledge of the class of which man is the dominating member. For this purpose the history of zoölogy may be divided, in a general way, into seven epochs: the Aristotelian, the Scholastic, the Renaissance, the Raian, the Linnæan, the Cuvierian, and the Darwinian. There are also two axioms which it will be well to bear in mind. The first is, that Linnæus became a point of departure in the history of modern biology, only because he was in turn the product of the intersection of many important historical series which ramify and intertwine indefinitely, and stretch back into the remote past of every aspect of life. The second axiom is, that every new idea, or, for that matter, every new event, is the fertile hybrid resulting from the fortuitous crossing of several specifically distinct old ideas or events.

The Aristotelian Epoch.

The first epoch under consideration is that of Aristotle, of the fourth century B.C., and it may be characterized as the initial analytical epoch. Aristotle's theory of the genetic relationship of the chain of beings from polyp to man did not, of course, materially influence Linnæus. The idea of evolution was not destined to come to its fruition through Aristotle, the schoolmen, or even in Linnæus or Cuvier. The true relation of Aristotle as a systematic zoölogist to Ray and Linnæus is exhibited in the following well-known citations from "The Parts of Animals."

"Some animals are viviparous, some oviparous, some vermiparous. The viviparous are such as man and the horse, and all those animals which have hair; and of the aquatic animals, the whale kind, as the dolphin and cartilaginous fishes [in reference to the viviparity of certain sharks] (Book I, Chap. V). Of quadrupeds which have blood and are viviparous, some are (as to their extremities) many-cloven, as the hands and feet of man. For some are many-toed, as the lion, the dog, the panther; some are bifid, and have hoofs instead of nails, as the sheep, the goat, the elephant, the hippopotamus; and some have undivided feet, as the solid-hoofed animals, the horse and ass. The swine kind share both characters [an allusion to the 'mule footed' swine, monstrosities in which the median digits are fused, and terminate in a solid composite hoof]" (Book II, Chap. V).

Ray and later writers probably had this passage in mind when they used the descriptive terms "multifido," "bifido," "solidungula," "ungulata," "unguiculata," fissipedes." Here, also, attention is directed to the feet as exhibiting characteristic differences. In another passage Aristotle says,—

"Animals have also great differences in the teeth both when compared with each other and with man. For all quadrupeds which have blood and are viviparous have teeth. And in the first place some are ambidental[1] (having teeth in both jaws); and some are not so, wanting the front teeth in the upper jaw. Some have neither front teeth nor horns, as the camel; some have tusks,[2] as the boar; some have not. Some have serrated teeth,[3] as the lion, the panther, the dog; some have the teeth unvaried,[4] as the horse and the ox; for the animals which vary their cutting teeth have all serrated teeth. No animal has both tusks and horns; nor has any animal with serrated teeth either of those weapons. The greater part have the front teeth cutting, and those within broad" (Book I, Chap. II).

This passage evidently directed the attention of later writers to the importance of the teeth as a means of distinguishing and hence of classifying mammals, and we shall see that Ray and, later, Linnæus were quick to avail themselves of the suggestion.

Aristotle was quite unconscious of the classification that has been ascribed to him, as Whewell[5] shows; but "Aristotle does show, as far as could be done at his time, a perception of the need of groups and of names of groups in the study of the animal kingdom, and thus may justly be held up as the great figure in the prelude to the formation of systems which took place in more advanced scientific times." Whewell also quotes passages that show Aristotle's recognition of the lack of generic names to denominate natural groups. Aristotle says that "of the class of viviparous quadrupeds there are many genera,[6] but these again are without names, except specific names, such as man, lion, stag, horse, dog and the like. Yet there is a genus of animals that have manes, as the horse, the ass, the *oreus*, the *ginnus*, the *innus* and the animal which in Syria is called *heminus* (mule) . . . Wherefore," he adds (that is, because we do not possess genera and generic names of this kind), "we must take the species separately and study the nature of each." "*These passages*," Whewell continues, "*afford us sufficient ground*

[1] Αμφόδοντα.
[2] Χαυλιόδοντα.
[3] Καρχαρόδοντα.
[4] Ανεπάλλακτα.
[5] *Op. cit.*, III., p. 350.
[6] Εἴδη.

for placing Aristotle at the head of those naturalists to whom the first views of the necessity of a zoölogical system are due" (*Op. cit.*, p. 352).

The Scholastic Epoch.

From the time of Aristotle and his classical successors until the rise of scholasticism in the eleventh century, Europe, as every one knows, was too much preoccupied with world-wide displacements and readjustments of peoples and of institutions to pay particular attention to natural science; and even the Scholastic Epoch in the history of philosophy and science was chiefly occupied with the further development and systematization of the great body of religious and metaphysical doctrines. So far as natural history is concerned, it is perhaps rather a further interregnum than an epoch, rather an era or lapse of uneventful time than a time of the slow ascension of some great illuminative idea. The anthropocentric idea dominated in natural history as the geocentric idea dominated in astronomy; hence a knowledge of the real or supposed properties of animals and particularly of plants was chiefly cultivated in connection with alchemy, magic and materia medica. The medieval imagination, full of mysticism, eager for the uncanny and fantastic and teeming with images of ubiquitous devils, flourished on the marvelous tales of a "Sir John Maundeville," and peopled the earth with the monsters which so long survived and ramped in the Terræ Incognitæ of world maps. In the schools, citations from authorities were accepted in lieu of proof, and the simple zoölogy of Aristotle and the scriptures was deeply covered by the accretions of learned exegesis.

Scholasticism reached its prime as early as the thirteenth century, in the system of the illustrious St. Thomas Aquinas, the "princeps scholasticorum." Afterward, while the renaissance movement was discovering new worlds in all directions, scholasticism in general (but with some brilliant exceptions) rapidly reached the "phylogerontic stage" of its evolution, and produced all sorts of bizarre specializations in terminology and in dialectics.

It has been said of the scholastic philosophy that it "vigorously exercised the understanding without bringing it to any conclusions." However this may be, it cannot be doubted that the very excesses of scholasticism stimulated the reactive return to experience, which gave rise incidentally to biological science. The schoolmen furthermore perpetuated and aroused interest in Aristotle's analyses, and gave currency to many methods of analysis and description. Among these we may cite, first, the dichotomous method of division, which is a forerunner of modern classifications; second, the logical concepts of genus and species. Especially noteworthy was the expansion of classical Latin into a highly specialized language of philosophy and science.

The Renaissance Epoch.

Biological science, and especially zoölogy, did not respond fully to the impulse of the Renaissance movement until literature, politics, astronomy and geographical discovery had made the most signal advances. Hence in Aldrovandi (1522–1605) and Gesner (1516–65) the superstitions and myths of the middle ages still linger, while the systematic work of future generations is initiated in the extensive illustrated catalogues and descriptions of plants and animals. On the philosophical side of zoölogy, the Englishman Wotton, in his "De Differentiis Animalium" (Paris, 1552), "rejected the legendary and fantastic accretions [of medieval zoölogy] and returned to Aristotle and the observation of nature" (Lankester[1]). One of the contemporaries of Gesner and Wotton was the founder of anatomy, Andreas Vesalius (1514–64), who boldly broke with tradition, and declared that the source of knowledge of the human body should be, not Galen, but the human body itself.

Near the end of this period, the botanist, Cesalpino (Cæsalpinus) of Arezzo (1519–1778), a celebrated scholastic philosopher, published his voluminous work "De Plantis" (1583). In this work, which was inspired by the new idea of direct observation, the confused arrangements of plants of the earlier herbalists were replaced by an orderly classification suggested by the brigades of an army, and founded upon the number, the position and the figure of the reproductive parts. He divided plants into ten great classes, which were again subdivided; to these assemblages he gave monomial names in substantive form. Linnæus himself says of him, that, "though the first in attempting to form natural orders, he observed as many as the most successful later writers" (Whewell, *Op. cit.*, pp. 282, 283).

A reason for this precocious development of a natural classification of plants may be sought in the very multiplicity of kinds and the large herbaria and horticultural gardens in existence, which necessitated some sort of orderly arrangement and which would assist the eager student to recognize related series. We note in contrast the delayed progress of the classification of the mammals due to the comparative fewness of known forms, the greater complexity of organization and the difficulties of observation.

The Raian Epoch, the Dawn of Modern Zoölogy.

Among those who contributed the data for Linnæus's generalizations, no name is more important, at least in the history of vertebrate zoölogy, than

[1] E. Ray Lankester, The History and Scope of Zoölogy, in The Advancement of Science London, 1890, p. 293.

that of John Ray. Accordingly, the fourth epoch under consideration may be termed the Raian Epoch, and culminates with the publication in 1693 of Ray's "Synopsis Methodica Animalium Quadrupedum et Serpentini Generis," which is one of the great landmarks in the history of classification. Ray's debt to the past is shown in the facts that his lucid tabular analyses of the common structural features of animals are arranged dichotomously; that in each division and subdivision a single adjective or adjectival phrase indicates the most important common feature of the animals in question, and that these terms are, as we have seen, in many cases borrowed from Aristotle.

Ray, like Linnæus, gave more attention to plants than to animals, and depended upon his colleague, Willughby, for much of the data, especially in the fishes. Like Linnæus also, Ray had a superb gift of order and a philosophical mind that made him a worthy countryman and contemporary of Sir Isaac Newton.

In his tabular analysis, Ray distinctly foreshadows Linnæus in the following points: —

1. The higher vertebrates are contrasted with the fishes as breathing by lungs instead of gills.

2. The whales are classed with the viviparous animals and expressly removed from the fishes, from which they were further distinguished by the horizontality of the tail-fin. This step, however, was felt to be so radical that Ray afterwards constructed a definition which included both whales and fishes.

3. As remarked by Gill, the terrestrial or quadruped mammals are bracketed with the aquatic as "Vivipara," and contrasted with the "Ovipara" or "Aves." "The Vivipara are exactly co-extensive with Mammalia, but the word 'vivipara' was used as an adjective and not as a noun." [1] This distinction seems to have been an important one, when substance was so carefully distinguished from attribute. Ray emphasized the common *attributes* of all the terrestrial hairy quadrupeds, of the amphibious hairy animals such as the seals and manati, and of the purely aquatic and fish-like Cetaceans; but he does not seem to have insisted that all these animals agreed in essence and substance as well as in attribute, so that they should require a new substantive name such as Linnæus afterward applied to them.

4. The double ventricle is noted as characteristic of both Vivipara and Ovipara.

5. In order to associate the "manati" and other amphibious mammals with their terrestrial congeners, the term "hairy animals" is employed as more comprehensive than quadrupeds.

---

[1] The Story of a Word Mammal, in *Popular Science Monthly*, Vol. LXI. September, 1902, pp. 434–438.

Ray further set the standard for Linnæus in his concise descriptions of European and foreign mammals, especially those described by travelers in America and in the East. Ray often used the term "species" merely as the equivalent of the middle English "spece," which survives in our word spice," and meant "kind:" it was also equivalent to the logical "species" (*cf.* the Greek εἶδος) of the schoolmen, and is exemplified in Ray and Willughby's "Historia Piscium" in such phrases as "clarias niloticus Belonii mustelæ fluviatilis species," "bagre piscis barbati ac aculeati species." But Ray also used the term "species" in quite a Linnæan manner, as in the names *Ovis laticauda*, *Ovis strepsiceros* and *Ovis domestica*. In form, at least, this foreshadows the binomial system of nomenclature and the recognition of the species in general as a supposedly objective reality and the unit of classification. The form of Ray's specific definitions seems, however, to imply that the term "species" in Ray's mind was often more a "differentia," or specific adjective modifying the generic concept than a fully developed substantive name, and Ray did not apparently realize the convenience of applying the binomial method of nomenclature universally. Even Linnæus at first introduced the specific, "trivial," or common name, merely as a marginal index or symbol of the full specific phrase. Ray recognized the considerable variability of species, but believed also in their separate creation and fixity. He frequently adverts to the internal characters of animals; and his book shows, that even by his time a considerable number of observations on the soft parts of animals had already accumulated.

The Linnæan Epoch.

The work of Ray in botany and zoölogy fully prepared the way for Linnæus, whose epoch may be characterized as the Legislative Epoch, because his methods of description and classification, and especially his nomenclature exerted such profound formative and regulative influence upon the work of his contemporaries and successors that he was called the "lawgiver of natural history."

Linnæus's Broader Contributions to the Class Mammalia.

One of the most enduring claims of Linnæus upon the grateful memory of posterity arises from his felicitous coinage of the word "mammalia" (animals with mammæ or breasts after analogy with Latin words like animal [1]) as a class name for the forms characterized by Ray as "viviparous hairy animals." Thus not only the terrestrial hairy oviparous quadrupeds,

[1] Theodore Gill, *l. c.*

but also the aquatic Vivipara now called Cetaceans and Sirenians, were for the first time definitely included under a single class name.

In attempting to appraise Linnæus's contributions to the broader knowledge of the class of mammals, we must bear in mind what Dr. J. A. Allen has well shown,[1] namely: that Linnæus was primarily a botanist, that his interest in mammals was incidental, that his opportunities for studying them were very limited, that his first-hand knowledge of extra-European mammals was practically *nil*, and finally that several of his ordinal groupings of mammals (*e. g.*, rhinoceros with the rodents) now appear highly unnatural and even ludicrous.

On the other hand, there are certain considerations which may prevent us from thinking any the less of his judgment and genius on that account. Although Linnæus may have known very little about extra-European mammals, he had, nevertheless, a fairly good conception of the essential features of mammals as a class, as shown by his definition in the tenth edition of the "Systema Naturæ" (1758). Here in concise phrase he states that mammals have a heart with two auricles and two ventricles, with hot red blood; that the lungs breathe rhythmically; that the jaws are slung as in other vertebrates, but "covered," *i. e.*, with flesh, as opposed to the "naked" jaws of birds; that the penis is intromittent; that the females are viviparous, and secrete and give milk; that the means of perception are the tongue, nose, eyes, ears and the sense of touch; that the integument is provided with hairs, which are sparse in tropical and still fewer in aquatic mammals; that the body is supported on four feet, save in the aquatic forms, in which the hind limbs are said to be coalesced into a tail (the only erroneous idea in the whole definition).

Many of these characters had previously been noticed by Ray in his description of the hairy quadrupeds. It is not impossible, too, that Linnæus may have been assisted to the comprehension of the essential features of the mammals through his friendship with Bernard de Jussieu, who is said by Isidore Geoffroy Saint-Hilaire to have induced him to include the Cetaceans in the class Mammalia; and possibly he also owed something to the researches of Klein and Brisson. In spite of all this, Linnæus's own studies in medicine, in Holland, doubtless made him familiar with the anatomy of at least one mammal, man; and on his journeys through the north of Europe he must have observed many other mammals at close range.

Thus was Linnæus prepared for the clear recognition and emphasis of another fact of far-reaching importance. It was evidently well known that the anatomy of the hairy quadrupeds was similar in plan, if not in detail,

---

[1] See pp. 9 ff.

to that of man, and we find Descartes (for example, in his "Discourse on Method" Part V., 1637) advising those who wished to understand his theory of the action of the lungs and circulatory system, "to take the trouble of getting dissected in their presence the heart of some large animal possessed of lungs, *for this is throughout sufficiently like the human*" (ital. mihi). And it was further known that of all animals the monkeys are most nearly like man, both externally and internally. This was asserted by Aristotle and other classical authors, but was fully demonstrated in a carefully prepared and illustrated work [1] on the anatomy and appearance of animals from the Jardin du Roi, by a committee of savants of the French Academy, appointed by the Grand Monarch.

This work and these important observations may or may not have come under the notice of Linnæus on the occasion of his visit to Paris in 1738. At any rate, he did not hesitate to follow the logical consequences of these facts, namely, that in a strictly zoölogical classification, man would be grouped not only in the class Mammalia, but even in the same ordinal division with the monkeys. Accordingly, in the tenth edition of the Systema the earlier name Anthropomorphæ is replaced by Primates, and the genera *Homo, Simia, Lemur* and *Vespertilio,* are grouped under that order. The Primates were thus regarded as the chiefs of the hierarchy of terrestrial beings, and consequently, as in nearly all subsequent schemes down to the Darwinian Epoch, head the classified legions of creatures. Linnæus was too often at fault in surmising the generic and ordinal affinities of the species of the lower vertebrates; but this bold allocation of man to the order Primates surely bears the marks of genius, and led the way to the modern generalization that man is knit by ties of blood kinship to the Primates, and more remotely to the whole organic world.

Linnæus's Principles in his Classification of the Mammalia.

The diagnostic definition given by Linnæus of the order Primates may be cited because it rests upon the principles and theories which guided him in classification and which led to his most successful groupings, as well as to his serious blunders. This definition is as follows:—

Inferior front teeth iv, parallel, laniariform [canine] teeth solitary [that is, in a single pair above and below].

Mammæ pectoral, one pair.

The anterior extremities are hands.

The arms are separated by clavicles, the gait usually on all fours ("incessu tetrapodo volgo").

They climb trees and pluck the fruits thereof.

[1] Mémoires pour servir à l'histoire naturelle des animaux, à la Haye, 1715 (4to, 2 vols.), redigées par Perrault et Dodart.

This definition was clearly insufficient to exclude all extraneous genera from this really natural order; for (1) under *Lemur* Linnæus included, not only all the then known forms now recognized as the suborder Lemuroidea, but also the "Flying Lemur," *Galeopithecus*, which properly either forms an order by itself with no near affinities with the Primates, or is at most a suborder of the Cheiroptera; (2) the definition also included "Vespertilio," *i. e.*, the bats, excepting *Noctilio*, an order more nearly related to the Insectivores than to the Primates.

Many of the characters selected by Linnæus for his ordinal diagnoses were of the "adaptive" or superficial kind, which are now known to have been most easily modifiable by changes in the external or internal environment. The reason for this mistake was, that Linnæus regarded the mode of sustenance of a group as one of its most deep-seated attributes and most surely indicative of more or less hidden affinities with other groups. Linnæus was constantly searching for natural groups, but he did not realize that the natural affinity of the members of the larger groups was due to descent from common ancestors, just as in the case of members of the same species. An example of his reliance upon sustenance is seen in his definition, in the tenth edition of the Systema, of the order Feræ, the Carnivora of later authors. Here "sustenance by rapine, upon carcasses ravenously snatched" is evidently felt to be connected with "front teeth in both jaws: superior vi, all acute," with "laniariform teeth [canines] solitary," with "claws on the feet acute."

One of his dicta in botany was, that a character of great systematic importance in one group may be very variable in another; consequently he did not mention "sustenance" under Bruta, but contented himself with the two characters "front teeth none either above or below" and "gait awkward (*incessus ineptior*)." As this order included the elephant, the manatee, the sloth, the great ant-eater and the scaly ant-eater, it has been justly cited as a grossly unnatural assemblage, and the grouping accounted for by Linnæus's ignorance of the animals composing it.

Now it is possible that Linnæus himself did not regard this assemblage as natural, but merely as a convenient artificial grouping. But I am more disposed to attribute its existence to his habit of searching for hidden affinities below the most obvious external differences, as when he placed the seals in the order Feræ, joined the bats with the Primates, the horse and the hippopotamus, the rhinoceros with the Rodents, and the pig with the Insectivores (in the order Bestiæ).

Linnæus recognized that the ordinal classification of the mammals was a difficult problem, as is shown by the conspicuous changes (not always improvements in our eyes) and redistributions which he made between the first and "tenth" editions of the Systema and further by the fact that Erxleben, who revised and extended the Systema (1777), abandoned the ordinal divisions entirely and merely listed the genera *seriatim*. The difficulty of the problem is indicated by the fact that Cuvier, with far better material and more extensive knowledge, was constantly deceived by "adaptive" (or homoplastic) resemblances. Even Cope, who wrote much on homoplastic and convergent evolution, was himself deceived by the similarities of structure in the marsupial "mole," *Notoryctes*, and the Cape golden mole, *Chrysochloris*, an undoubted insectivore.

The most "inexcusable" blunder of Linnæus, that of placing the rhinoceros with the Rodents under the order "Glires," may have been due, not to carelessness, but to the fact that the Indian rhinoceros has a single pair of close-set cutting incisors in the upper jaw, which oppose the elongate incisor-like appressed canines of the lower jaw and thus show a superficial approach to the rodent dentition. If Linnæus had known that *Hyrax*, which Pallas described as a Rodent ("*Cavia*"), had cheek-teeth like those of *Rhinoceros*, he doubtless might have felicitated himself upon his supposed astuteness.

In brief, Linnæus, as fully shown by Whewell,[1] from his profound and wide botanical knowledge, was acquainted with many natural orders, and strove constantly to recognize others. He knew that a character of great diagnostic and fundamental value in one order may be of slight value in another; he knew that even in a natural order some of the diagnostic and fundamental characters might be absent in certain members otherwise clearly allied to a given series. He knew that a natural series is "natural" because of the totality of its characters, that the "genus makes the character," and not *vice versa*, a hard doctrine to many of his contemporaries. When Linnæus had arrived at a conception of any given natural order, he selected certain characters as diagnostic, but not necessarily universal, and constructed professedly artificial or only partly natural keys to his "natural" orders.

When Linnæus turned his attention to the classification of animals, we may believe that he followed the same principles. In this application of the principles gained in one subject to the data of another, we have a good example of the felicitous union of specifically distinct ideas to produce a line of ideas that are new and very fertile.

The Relation of Linnæus to his Successors.

Linnæus inherited from Ray and from the scholastic system the dogma of the separate creation and objective reality of species, which became

[1] *Op. cit.*, pp. 319–325.

Courtesy N.Y. Botan. Garden. W. A. Murrill, Photo.

FIG. I. HAMMARBY, THE COUNTRY HOME OF LINNÆUS NEAR UPSALA SWEDEN.

Courtesy N.Y. Botan. Garden.

FIG. 2. TABLET PLACED ON THE LINNÆUS BRIDGE BY THE NEW YORK ACADEMY OF SCIENCES.

developed and strengthened in his hands as a result of his observations. His dictum was *species tot sunt diversæ quot diversæ formæ ab initio sunt creatæ.* The resemblances between members of a single species were hence held to be due to descent from an original pair, and the mutual infertility of different species to be the natural penalty of the effort to traverse the gaps established from the beginning.

This view was somewhat modified in later editions of the Systema, in which Linnæus held that "all the species of one genus constituted at first (that is at the Creation) one species, *ab initio unam constituerint speciem;* they were subsequently multiplied by hybrid generation that is by intercrossing with other species." [1]

The general relation of Linnæus to his successors may be summarized in a few words. The sixth epoch in the history of zoölogy extends from the latter part of the eighteenth to the middle of the nineteenth century, and may be called the Anatomical Epoch, because, through the labors of Cuvier and his great English pupil and successor, Richard Owen, the taxonomic studies of the Linnæan school were supplemented by the establishment and great development of the sciences of comparative anatomy and paleontology. In spite, however, of the improvement and expansion of classification, its bearing upon evolution was not generally perceived. Cuvier's researches in these sciences further extended the dogma of the fixity of species; but Owen, through his broader knowledge, gradually gave up the idea and became an evolutionist, although not a selectionist.

The seventh epoch, the Darwinian, in which happily we are living, has seen the overthrow of the traditional doctrine of the fixity of species, and has initiated the re-examination of all morphological phenomena in the light of the doctrine of evolution. These morphological facts are reflected more and more in our evolving classifications, which are the outgrowth of the Linnæan system, and which now aim to express, not only degrees of homological resemblances and differences, but also (secondarily) degrees of genetic kinship.

The great "lawgiver of natural history" is thus seen in his proper perspective in a few at least of the series of historical antecedents and consequents which intersected in him, inheriting, as he did on the one hand, the language and general methods of the past and the doctrine of special creation; inheriting on the other hand the new spirit and contributions of Vesalius, Cesalpino, Ray and many others, and building upon this the foundations of modern botany and zoölogy.

[1] Osborn, H. F. From the Greeks to Darwin, p. 129.

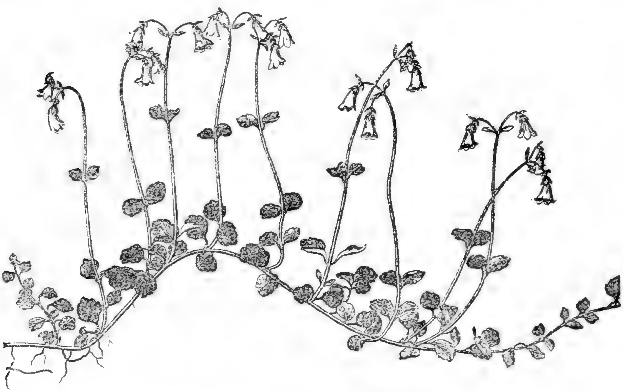
At the close of the reading of Dr. Allen's address, recess was taken till two o'clock, p.m. During this time the Council entertained at luncheon at the Hermitage Hotel, near Bronx Park, the delegates of sister societies and invited guests. Afterward the special exhibits at the Botanical Museum were examined, and then was delivered the following address.

LINNÆUS AND AMERICAN BOTANY.

By Per Axel Rydberg, Ph. D.

Mr. Chairman, Ladies and Gentlemen:

I have been asked to make a short address to you on Linnæus and his relation to North American botany. That the selection fell on me was not because I was the most able one to deliver such an address, for there are



THE TWIN-FLOWER, LINNÆA BOREALIS

A plant especially beloved by Linnæus, and dedicated to him by Gronovius.

many abler men present, but simply because I was born in the same country as Linnæus. In fact, my grandfather came from the same province of Småland and even from a parish adjoining that of Stembrohult, in which my illustrious countryman was born.

In the early part of the seventeenth century there lived in Jonsboda, Småland, Sweden, a farmer named Ingemar Svenson. He had three children, two sons and one daughter, the grandmother of Linnæus. On the Jonsboda farm stood a very large linden-tree, so old and with so many traditions that it was regarded by the people as a holy tree. Any damage done to this tree, it was claimed, would surely bring misfortune upon the head of the perpetrator. When the two sons began to study for the ministry, it was natural that they should think of this tree in selecting a family name. They called themselves Tiliander; *Tilia* is the Latin for the linden or bass-wood, and *andros* the Greek for man. It may not be amiss to state that at that time the common people of Sweden did not have any family names, and this is true to a certain extent even to-day. A man was known by his given name, the given name of his father with the word son appended, and the place where he lived. The farmer mentioned above was known as Ingemar Svenson from Jonsboda. His father's name was Sven Carlson, and that of his grandfather, Carl Johnson. The names of his two sons would have been Carl and Sven Ingemarson, had they remained in the peasant class, instead of Carl and Sven Tiliander.

The daughter married a farmer, Ingemar Bengtson; and her son's name was Nils Ingemarson, until he entered the "gymnasium." He also was born in Jonsboda, and, when selecting a name, he also naturally turned to the same old linden-tree as his maternal uncles had done. He called himself Linnæus. It is remarkable that two of his father's maternal grand-uncles also bore another Latin form of the same name, viz., Lindelius. Some claim that even this name was derived from the same old linden-tree, but this is scarcely in accordance with the facts. More likely it traces its origin from the Linden Farm in Dannäs Parish, where their ancestors lived.

But what has this genealogy to do with Linnæus's relation to North American botany? Perhaps nothing directly, but indirectly a great deal; for the circumstances and surroundings under which a man is born and reared to a certain extent make the man. In his younger days, Sven Tiliander was the house-chaplain of Field-Marshal and Admiral-Viscount Henrik Horn, who was for many years Governor of Bremen and Verden, two cities with territory in Germany acquired by Sweden through the Thirty-years War. During his stay in Germany, Tiliander learned to know and love botany and horticulture, and established around Viscount Horn's residence in Bremen a garden which was remarkable for that period. When both returned to Sweden, Tiliander brought with him the choicest plants from this garden and planted them around the parsonage of Pjetteryd Parish, of which he had been appointed rector. Here at Pjetteryd, Nils Linnæus spent most of his youth, studying in company with his uncle's sons. Later, both as curate at Råshult and as rector at Stenbrohult, he surrounded the parsonages with gardens in which he grew many rare and interesting plants. In the midst of these, Carl Linnæus, the famous botanist, was born and reared. Later, while a student at the university, he spent a summer vacation at home in 1732, and made a list of the plants in his father's garden. This list is still to be seen in the Academy of Science at Stockholm. Although defective, the first four classes being unrepresented, it enumerates 224 species. Of these, many were at that time very rare in cultivation. Professor Theodore Fries in his biography of Linnæus enumerates 36 of the rarest of these. Among them we notice six American plants, viz., *Rhus Toxicodendron*, the poison oak, *Mirabilis Jalapa*, four-o-clock, *Asclepias syriaca*, milkweed, *Phytolacca decandra*, pokeweed, *Antennaria* (now *Anaphalis*) *margaritacea*, pearly everlasting, and *Solanum tuberosum*, the potato. It may be remarked that the cultivation of potatoes was introduced into Sweden about twenty years later. We see from this that Linnæus had learned to know some American plants even in his early childhood.

Carl Linnæus was born the 13th of May, O.S., 1707, at Råshult, an annex to the parish of Stenbrohult. His father was the curate there; but two years later, at the death of his father-in-law, Samuel Broderson, he became rector and moved to Stenbrohult. In the fall of 1714, Carl Linnæus entered the school of Wexiö, and graduated from the "gymnasium" in 1727. His parents, especially his mother, wanted him to study for the ministry; but he had no love for theology, nor for metaphysics, nor the classics. He learned Latin tolerably, however, because that language helped him to study the natural sciences. He decided to study medicine, and entered with that view the University of Lund, which was nearest his home, but remained there only one year, learning that there were better facilities at Upsala. At the latter place he soon became acquainted with Professors Rudbeck and Celsius, two of the most prominent scientists of that time, and was allowed to use their libraries. The former, who had many duties to perform, soon asked Linnæus to give for him the public lectures in botany. The income from these gave Linnæus means to support himself, and linked him closer to his favorite study. He became acquainted with practically all the plants of the gardens and fields of the whole region around Upsala, and learned all the scientific names given in the books at his disposal.

The latter was not an easy matter when we take into consideration the form of scientific names at that period. For example, the most approved name of the common blue-grass that adorns our lawns was, "*Gramen pratense paniculatum majus, latiore folio, Poa Theophrasti.*" Other names of the same grass were, "*Gramen vulgo cognitum,*" "*Gramen pratense* *majus vulgatus,*" and "*Gramen alterum et vulgare.*" In the first publication by Linnæus, it appears as "*Poa spiculis ovatis compressis muticis.*" I think that Linnæus and his contemporaries had much more cause than we to exclaim, "Those horrible Latin names!" To us the same plant is known as *Poa pratensis* L., the name adopted by Linnæus in his "Species Plantarum."

The lectures given by Linnæus for Professor Rudbeck became very popular. This was especially the case after his return from his Lapland journey. Some persons, especially Dr. Nils Rosen, became jealous of his success, and induced the university faculty to pass a resolution by which no one who had not taken the corresponding degree was permitted to give university lectures. Linnæus had not yet received his doctor's degree, and hence was debarred. As Holland was offering at that time excellent facilities both in medicine and in botany, and as living expenses were lower there than elsewhere, Linnæus decided to visit that country and take his examinations there. He received his doctor's diploma at Harderwijk, and afterwards went to Leyden, where he became acquainted with three of the greatest botanists of the time, Boerhaave, Burmann and Gronovius. George Cliffort, the wealthy burgomaster of Amsterdam and president of the East India Company, was a great lover of plants, and had a splendid botanical garden at Hartecamp as well as a rich library and herbarium. On the recommendation of Boerhaave, Linnæus became Cliffort's physician, and curator of his collections and garden. Here he lived in luxury, beloved as a son.

Cliffort furnished Linnæus with means to publish five of his first books, "Systema Naturæ," "Fundamenta Botanica," "Bibliotheca Botanica," "Genera Plantarum" and "Flora Lapponica," the manuscript of which he had brought with him from Sweden. In the first of these, Linnæus presents his system of classification. He divides Nature into three kingdoms,— the mineral, vegetable and animal. In the vegetable kingdom he brings out an altogether new classification, based upon the sexual organs of plants. He divides the kingdom into 24 classes, the first 23 containing the phanerogams, and the last the cryptogams. In the first 11 classes are included plants which have from 1 to 12 free and practically equal stamens; in the 12th and the 13th, plants with many stamens; in the 14th and 15th, plants with 4 and 6 stamens respectively, of which 2 are decidedly shorter. In the 16th, 17th and 18th classes the stamens are united by their filaments, in the 19th they are united by their anthers, and in the 20th they are adnate to the pistil. In the 21st and 22d the flowers are unisexual, i.e., the stamens and pistils are in different flowers (on the same individual in the 21st and on different individuals in the 22d); and the plants of the 23d class have both unisexual and bisexual flowers. The classes were divided into orders. In the first 13 classes the orders were determined by the number of the pistils; in the 14th and 15th, by the fruit; and in the 16th to 18th and 20th to 23d, by the number and distinctness or union of the stamens. The classification of the 19th class is too complex to enter into here. The 24th class was divided into four orders: Filices, Musci, Algæ and Fungi.

This system of classification is purely artificial. Linnæus himself regarded it only as temporary, and expected that it would soon be supplanted by a more rational one, based on natural relationship. The Linnæan system served its purpose, however. It became a means by which it was possible to tabulate every known genus of plants. Before this time there had been no systems at all, or such crude ones as we find even to-day in some popular flower-books, where the plants are classified by the color of their flowers. If the natural systems of DeCandolle, Bentham and Hooker, and Engler and Prantl, are too complicated for popular books, why not go back to the simple system of Linnæus? It would at least give a good insight into the structure of the flower instead of the mere color.

In his "Genera Plantarum," Linnæus applied this system to all known genera of plants, and gave each of them a concise and plain description.

Clifford had many American plants in his garden, but he sent Linnæus to England to visit Sir Hans Sloane, Professor Dillenius and Philip Miller, in order to secure American plants grown by them. Both Sloane and Dillenius treated Linnæus at first with coolness, because he "confounded botany." On his farewell visit to Dillenius, Linnæus politely asked him what he meant by "confounding botany." Dillenius took from the library the first few pages of Linnæus's own "Genera Plantarum," and showed him where there was written at numerous places "NB." Dillenius stated that all the genera so marked were wrongly described. The first example he pointed out, if I am not mistaken, was *Canna*, placed by Linnæus in his first class, which contains plants with but one stamen. Botanists before this time had described it as having three stamens. To settle the dispute they went out into the garden, and the living plant showed that Linnæus was correct. Dillenius then retained Linnæus for several days, and found that the older botanists in most cases were at fault and the young Swede correct. From being an opponent, he became a friend, of Linnæus and let him have all the plants he wanted.

After his return to Holland, Linnæus continued his work in Cliffort's garden with renewed zeal, and completed his "Hortus Cliffortianus," a large folio, in which are enumerated and described all the plants found in Cliffort's collections, together with synonyms and citations of nearly all botanical works then in existence. In preparing this work he became thoroughly acquainted with almost all the literature referring to American botany, such as Morison's "Plantarum Historia," Plukenett's "Almagestrum Botanicum" and "Phytographia," Petiver's "Gazophylacium," Sloane's "Jamaica," Plumier's "Plantarum Americanarum Genera," "Plantarum Americanarum Fasciculus Primus" and "Filicetum Americanum," Catesby's "Historia Naturalis," and, later, Cornuti's "Canadensium Plantarum Historia."

After completing the "Hortus Cliffortianus," Linnæus returned to Leyden, where he spent some time helping Gronovius with the editing of his "Flora Virginica," based on a large collection of plants collected by Clayton. Here again he came in contact with American plants.

Linnæus then returned to Sweden and became a practicing physician. He was soon appointed professor of medicine at Upsala, but by common agreement he exchanged chairs with Rosen, who held the professorship of botany. He now began work upon the most important book of his life, his "Species Plantarum." In this he tried to include a short description of every known species of plant, together with the most important synonyms and citations. In this book the Linnæan binomial system of nomenclature was used for the first time. Linnæus was not the first to give plants names, nor was he the first to name genera. Many Latin plant-names had come down from antiquity, while others had been proposed by his predecessors. Men like Tournefort and Micheli had in some cases clearer ideas of genera than Linnæus himself. Neither was Linnæus the first one to use binomials. In Cornuti's work on Canadian plants, for example, we find almost as many binomials as polynomials; but it is doubtful if Linnæus had seen Cornuti's book when he first wrote his "Species Plantarum." He does not cite it in the first edition, but does so in the second. Linnæus was, however, the first one to use binomials systematically and consistently. Before his time, botanists had recognized genera, and applied to them Latin nouns as names. In order to designate species, they added to these nouns adjective descriptive phrases. These consisted sometimes of a single adjective, as in *Quercus alba*, the white oak, but more often of a long string of adjectives and adjective modifiers, as in the case of the blue-grass mentioned above. The specific name had hitherto been merely a description modifying the generic name; from this time it became really a name, although a single adjective in form. An illustration of the pre-Linnæan form of plant-names might be had if, instead of "Grace Darling," one should say, "Mr. Darling's beautiful, slender, graceful, blue-eyed girl with long golden curls and rosy cheeks." "Grace" is just as descriptive of the girl as this whole string of adjectives. It may be that "Grace" is not always applicable to the person to whom the name is applied; but this is also often the case with many specific plant-names. *Asclepias syriaca* and *Rumex Brittanica* are American plants, and *Rubus deliciosus* is one of the least delicious of the raspberry tribe. This invention and strict application of binomial names could not but cause a revolution in botany. Since the appearance of "Species Plantarum" in 1753, it has been possible to pigeon-hole not only genera, but also species, of plants.

Before this useful book was printed, Linnæus had become better acquainted with North American plants, and in another way. Baron Bjelke, the vice-president of the Court of Appeals of Finland, had proposed to the Royal Academy of Sciences at Stockholm to send an able man to Iceland and Siberia, countries partly in the same latitude as Sweden, "to make observations, and such collections of seeds and plants as would improve the Swedish husbandry, gardening, manufactures, arts and sciences." Dr. Linnæus suggested North America instead, and recommended one of his pupils, Professor Pehr Kalm of Abo, for the proposed expedition. Kalm spent two years in North America, traveling through Pennsylvania, New Jersey, New York and Canada, and making large collections of seeds and plants, which were preserved as living or dried specimens, or as alcoholic material. During his stay at Raccoon, N.J., he discovered our mountain-laurel. The Swedes of Raccoon called it spoon-tree, because the Indians made spoons from its hard wood. Kalm adds in his journal, about this tree, "The English call this tree a laurel, because its leaves resemble those of the *Laurocerasus*. Linnæus, conformably to the peculiar friendship and goodness which he has honored me with, has pleased to call this tree *Kalmia foliis ovalis, corymbis terminalibus*, or *Kalmia latifolia*." Here Linnæus himself gave an illustration of both the pre-Linnæan and the post-Linnæan nomenclature. Kalm became acquainted with several of the naturalists of this country, C. Colden and his daughter Jane, Bartram and Clayton, and through Kalm a correspondence was established between them and Linnæus. Linnæus also corresponded with John Ellis, who resided in the West Indies, and Dr. Gardiner, who botanized in Carolina and Florida. Later he bought a set of plants collected by Patrick Browne in Jamaica, and received a part of the collections made by Jacquin in the West Indies.

When the second edition of the "Species Plantarum" appeared, in 1762, Linnæus knew and had described nearly 1000 plants indigenous to the United States and Canada. Besides these, he described about 1000 more, natives of the West Indies, Mexico and Central America, and 400 or 500 South American plants. His knowledge of American plants was small compared with what he knew of plants of the Old World. "Codex Linnæanus," which enumerates all plants named by Linnæus, contains not fewer than 8551 species.

Linnæus died Jan. 10, 1778, honored and esteemed by all. Some of his work will doubtless live as long as botany is studied by man.

We see from the preceding account that we may consider Linnæus one of our American botanists. Even the little plant which Gronovius dedicated to the Father of Botany, the twin-flower of our woods, with its exquisite perfume and its dainty pink flowers, belongs to a genus essentially North American. The genus *Linnæa* contains four forms, all closely related. One of these, the original *Linnæa borealis*, is confined to the mountain regions of northern and central Europe. Linnæus discovered it on his Lapland journey, and it was then considered a very rare plant. Now it seems to be more widely distributed than it was at the time of Linnæus. Perhaps it is of American origin, and has become modified since it transplanted itself on the other side of the ocean. The other three forms are North American. *Linnæa americana* Forbes, which has usually been confounded with its European cousin, is common in the woods from Labrador to Alaska, and extends in the Rocky Mountains as far south as New Mexico. *L. longiflora* (Torr.) Howell, is found in the mountains from northern California to Alaska. The fourth form is, as far as I know, undescribed and unnamed. It is with great pleasure that I here propose the following name and description for this species.

Linnæa serpyllifolia sp. nov.

A delicate plant with long creeping stems, 1–4 dm. long, sparingly hirsute; petioles 2–3 mm. long, ciliate; blades broadly oval or round-ovate, 5–8 mm. long, minutely crenulate, obtuse, sparingly hirsute, more or less coriaceous and shining, slightly paler beneath; peduncles 3–5 cm. long, sparingly pubescent and more or less glandular above, 2-flowered; bracts 2–3 mm. long, linear or lance-linear, obtuse; pedicels 5–8 mm. long, glandular-pubescent; hypanthium subglobose, in flower slightly over 1 mm. long, glandular-puberulent, purplish; calyx-lobes 2–2.5 mm. long, linear-subulate; corolla pink, open-funnelform with a very short tube, decidedly oblique, about 6 mm. long and 5 mm. wide.

This species differs from *L. borealis* and *L. americana* in the very narrow and almost glabrous calyx-lobes. In this respect, it agrees with *L. longiflora;* but it is distinguished from that species by the differently shaped corolla and by the leaves, which are broadest at or below the middle, instead of above it. It differs from all three in the smaller size of the flower and of the leaves, and in the indistinct toothing of the latter.

Alaska: Cape Nome, 1900, *F. E. Blaisdell* (Type in herb. N.Y. Bot. Gard.); Kotzebue Sound, *Arnott.*

Apparently the same plant has also been collected on the Island of Sachalin by F. Schmidt, but his specimens lack flowers.

After Dr. Rydberg's address, Professor H. H. Rusby gave an exhibition of selected lantern slides of flowers of North American plants known to Linnæus, and then Dr. W. A. Murrill led the party southward from the Museum building, through the Garden, to the Linnæus Bridge, pointing out on the way the following characteristic American trees known to Linnæus.

Tulip-tree	White ash	White elm
Sweet-gum	Sugarberry	Red oak
Red maple	Flowering dogwood	White oak
Red cedar	Sassafras	Hemlock
Sweet birch	Buttonwood	Chestnut-oak
White pine	Butternut	American linden

At the Linnæus Bridge over the Bronx River, on Pelham Parkway, Professor N. L. Britton, President of the New York Academy of Sciences, unveiled the bronze tablet commemorative of Linnæus which had been placed there by the Academy with the consent of the Department of Parks of the city of New York, and made the following address.

ADDRESS BY THE PRESIDENT OF THE ACADEMY.

N. L. Britton, Ph. D.

Director-in-chief, New York Botanical Garden.

The recognition of the work of famous men is one of the happiest duties of mankind. It stimulates our endeavors and encourages us to make efforts which we would probably not make without their examples before us.

To-day we do homage to a distinguished man of science, and the unanimity with which the scientific societies and institutions of the city of New York join in this tribute is in itself evidence of the value which is placed upon his contributions to natural history.

Science has made great progress during the two centuries which have elapsed since the birth of Linnæus. Theories have in large part given place to ascertained facts, or have been replaced by other theories based on more accurate knowledge of natural objects and of natural phenomena. The contributions of science to the welfare, comfort and happiness of mankind, have made present human life widely different from that of two

Courtesy N.Y. Botan. Garden.

THE LINNÆUS BRIDGE AND TABLET.

hundred years ago; and this amelioration of our condition, and the more general diffusion of knowledge, have been accompanied by a vast improvement in morality.

The ceremonies of to-day are worthy of the great naturalist whose birth they commemorate. Societies and institutions all over the world join with us in honoring him, and are represented here by delegates, or have transmitted documents expressing their appreciation of his life and labors. The public natural science institutions of New York have come to take leading parts in the subjects they teach and illustrate. Public and private philanthropy have developed them with a rapidity almost phenomenal, for they are all yet in their infancy and on a scale commensurate with the dignity of the metropolis of America. The cordial co-operation of a municipality with public-spirited citizens to build and maintain such institutions for the welfare of the people and of science, finds here in New York its maximum evolution, which has as yet, however, by no means reached its complete development or its maximum usefulness. What will be said of their position and importance when after fifty years the New York Historical Society opens the tablet which we now place upon this bridge? And what discoveries will science have made for the benefit of the human race during this next fifty years?

The selection of this bridge, recently constructed by the Park Department, as a permanent memorial of Linnæus, is most appropriate. It is situated just outside the New York Zoölogical Park, with the New York Botanical Garden a short distance to the north, being thus between the two institutions which teach the subjects on which the fame of Linnæus chiefly rests. The suggestion that it be known hereafter as the Linnæan Bridge came from the Director of the American Museum of Natural History.

On behalf of the New York Academy of Sciences I now unveil this tablet, and present it to the city of New York, there having been placed in it copies of to-day's program and other documents befitting the occasion.

After Wennerberg's song, rendered by the American Union of Swedish Singers, "Hear us, Svea," Hon. Joseph I. Berry, Commissioner of Parks of the Borough of the Bronx, in a few fitting words accepted the tablet on behalf of the city of New York, and then delivered the key of the box within the tablet to the New York Historical Society, for preservation till May 23, 1957. These ceremonies were followed by the singing, by the chorus, of Lindblad's "Battle Hymn," and then the audience listened to the following two addresses.

ADDRESS BY THE PRESIDENT OF THE AMERICAN SCENIC AND HISTORIC PRESERVATION SOCIETY.

George F. Kunz, Ph. D.

Linnæus was a great scientist, and the conquests of science have done more to advance the world than wars, which science may yet render impossible. It was thirty years of scientific research in Germany that gave us artificial indigo. It was pure scientific research that led Moissan, Cowles and Acheson to discover independently an abrasive substance of a hardness between the diamond and the sapphire; and then Moissan by scientific deduction worked out the genesis of the hardest and most fearless of gems, which, though obtained only in the form of powder, was still the diamond. Within the past quarter of a century we have seen air, oxygen and hydrogen liquefied, giving us temperatures absolutely unknown in nature before, and also the electric furnace, giving an extreme heat such as has perhaps never existed, unless it be on the surface of the sun.

Jade, the Chinese stone, has been known in China for more than a thousand years. Some believe that it was known to a prehistoric race the existence of which was almost unknown to the Chinese, and whose only records extant are found as we find the evidences left of the mound-builders, who passed away before the advent of the white man in North America. It was not until 1866 that Damour, a scientist, separated jade into two distinct minerals, nephrite and jadeite; and one of those into two varieties, jadeite and chloromelanite — facts unknown to the Chinese, though they apparently knew and understood every tiny fragment they had ever seen of this mineral. It was the scientist who took three red stones belonging to the King of Burmah or to the Emperor of China, and proved to him that one was a ruby, one was a spinel, and the third a tourmaline, and not all rubies, as they had been regarded for a century or more previously.

Moses was the first great systematizer, and his original assemblage of the people in tens, hundreds and thousands, is carried out in the military systems of to-day, and is again reflected in our own and in the monetary systems of many of the European nations, and more especially in that indispensable and scientific international system of weights and measures, the metric system. It was Alexander who conquered the eastern world, bringing back with him much refinement, and possibly also the valuable and industrious silkworm; and it was he also who discovered that the carrying powers of his camels were doubled if he employed a gold medium of exchange instead of silver. Cæsar, in his attempt to conquer the world, did much toward the dissemination of education and civilization, from which Rome greatly benefited.

Napoleon upturned and readjusted the treasuries of a number of kingdoms, duchies, cloisters and churches in Europe; and, even though his *régime* was attended by frightful loss of life, marked and permanent improvement has followed it. But it was La Sage, a scientist, who compiled a great work for Napoleon, from which he learned what noble families had lived in all times, and what campaigns had been fought by the various conquerors; and it was a thorough study of La Sage's work that had much to do with giving Napoleon an idea as to what worlds others had conquered, and what parts of this world were left for him to subdue.

It may not be generally known that it was one of our New York scientists, Dr. Melvil Dewey, who introduced the card catalogue system of cataloguing books, which led to the present system of keeping books by the loose-leaf system.

It would be easy to mention many who have materially assisted in the advancement and organization of the multifarious affairs of mankind; but the other and lower creations of nature outnumbered mankind many thousand times, and the co-ordination of scientific nomenclature covering this vast domain is due to the great Carl von Linné. Until his time, an animal was known as a deer in English, a Hirsh in German, a cerf in French, and by fifty other names in as many different languages. By applying two or three words as a name to every creature that flies in the heavens above, that dwells in the earth beneath or in the waters under the earth, he made it possible for the scientist, whether at the Cape of Good Hope, in Greenland, in New York, or in the Sandwich Islands, to know not only just what living form was referred to, but also to understand immediately to just what genus, class, species or variety, this living organism belongs.

The Linnæan system has also greatly aided scientific classification in natural history, which, in connection with medicine, has given us the connecting link in the science of biology and bacteriology. The Linnæan system compares with the natural history of to-day as alchemy does with chemistry, as astrology and fortune-telling with astronomy and medicine of the present time.

It is strange that, as well-planned and admirable and successful as the Linnæan system is when applied to the nomenclature of animate objects, it was absolutely rejected by the then mineralogists and chemists, as the chemical equivalents and the structure are frequently better expressed by a single term than they would be by a binominal system.

Had a Linnæan system existed when Adam and Eve were in the Garden of Eden, there would be no dispute to-day as to whether the "apple" which caused their expulsion from the Garden was the identical kind of apple that has caused so many boys to be driven from gardens and orchards wherein they trespass to-day, or whether it was a pomegranate, an orange, a lemon, or some other fruit of which we have no knowledge. If Noah had known a Linnæan system when he took his animals into the ark, and had so named them, how helpful that would be to us to-day! There would not be the doubt in the minds of the few who still maintain that evidences of the flood are to be found in fossil remains, since these would belong to those animals that were destroyed at the time of the great flood.

We have recorded a history of the past, to-day we have heard much of Linnæus and his time: let us speak now of the present. For a quarter of a century it has been our pleasure to know one of the most ardent disciples of Linnæus that has lived in our land; and had it not been for his untiring zeal, his keen judgment, his constant application, it is a question whether we would be assembled to-day to dedicate this bridge to the memory of Linnæus. We remember twenty-five years ago when he first appeared before the Academy of Sciences, and it is almost that long ago that he first suggested a botanical garden. The Botanical Garden undoubtedly influenced the Zoölogical Park, and each successive scientific institution has strengthened the others, so that, as science stands united to-day, New York is perhaps and will long remain one of the leading scientific cities in the country, if not the foremost; and no one more than our esteemed President of the New York Academy of Sciences, and Director of the Botanical Garden, Dr. N. L. Britton, has assisted in the unification and the advancement of our greatest Academy of Sciences. Dr. Britton was the pioneer with the Botanical Garden. Professor Henry Fairfield Osborn, another disciple of Linnæus, was the pioneer in the Zoölogical Park, which has been so ably conducted and carried on through that indefatigable worker, Dr. W. T. Hornaday, who brought to his task a world-wide experience of animals, their habitats and their characters. Therefore it seems eminently fitting that this bridge should form a connecting link between these two Siamese Twins, as it were, of botany and zoölogy in the United States.

It is science that gives us this well-ordered Bronx Botanical Garden, which, beautiful as it is, is a living botanical exposition, made possible through the organization of Linnæus, the energy, industry and intelligence of a Britton, the generosity of the founders and its trustees and the encouragement of our great city of New York.

Although historic sites and buildings may be marked with tablets or with monuments of stones, yet it was Nero who removed the Greek inscription, and placed his own, over the architrave of the Parthenon. In 1881 we were surprised to see some stone-cutters removing from within the laurel wreaths on the arches of the bridge across the River Seine the raised letter N placed there by Napoleon III, and a few days later to see them incise the letters R. F. (République Française) where the N had formerly been.

The value of preserving historic sites or commemorating historic events by indestructible means, such as medals or engraving in stone or metal, has always served as a great benefit to those who were to follow. A simple tablet on the summit of the Jura Mountains tells one when, where and how the great Napoleon crossed those mountains. A tablet in Russia relates that Napoleon entered Russia at this point with seven hundred and twenty thousand men, and less than a year later returned with an army of only a hundred and twenty thousand, having lost six hundred thousand.

The use of metal and baked tiles for the perpetuation of portraits and historic events forms one of the most feasible and enduring means. It is due to the coins and the medals that have been struck since about the seventh century B.C. that we have an almost unbroken line, for the past twenty-four centuries, of portraits and history; and to Assyrian baked tablets, that we have some four thousand years of history recorded.

There should be a most stringent law, a national law, rigidly enforced, for the punishment of any vandal who destroys, either wantonly or for the purpose of loot, any monument, as, for instance, the André Monument on the banks of the Hudson and the tablet marking the Slocum disaster.

It is the honor and pleasure of the American Scenic and Historic Preservation Society to take part in this historic event, and it is its official function to describe accurately the event in its Annual Report edited by our able Secretary, Edward Hagaman Hall, and published by order of the Legislature of this State. So the record of this event will appear in series with that of the dedication of Stony Point as a park; the re-dedication of the André Monument; the preservation of the Palisades; the McGowan's Pass tablet; more recently the acceptance of the gift of three miles of one of the most beautiful ravines on the continent, containing three fine waterfalls, presented to our State by the Honorable William Pryor Letchworth, for which the Society is to act as a Trustee; and the State's acquisition of Watkins Glen.

ADDRESS BY THE PRESIDENT OF THE UNITED SWEDISH SOCIETIES OF NEW YORK.

Emil F. Johnson.

I do not intend to encroach upon your time by attempting to make a long speech, but I consider it my duty as president of the United Swedish Societies to express to you, Mr. President, and to the members of the New York Academy of Sciences, our gratitude for the opportunity you have given us to take part in honoring the memory of our distinguished countryman Linnæus, whom we are used to call the "Flower King of the North." To be sure, our participation in this celebration is limited to the assistance given by our singing societies and to the presence of a goodly number of our people in the park. The Swedish minister to Washington, Mr. Lagercrantz, is also with us, and I take this opportunity to convey to you, Your Excellency, our appreciation of the interest you have shown by coming to New York to-day. Our consul and vice-consul are also with us.

I saw a statement in a paper a few days ago to the effect that Swedes in New York have presented this beautiful bridge to the city. I only wish that such were the case; but unfortunately we are only about fifty thousand strong in this neighborhood. Such a gift might well be possible out West, where, as you know, most of the Swedish immigrants settle, but not here. Indeed, there are parts of the West and Northwest, where for miles upon miles you will find Swedish settlements almost exclusively, and all in prosperous condition. In Chicago the Swedes have even erected a statue to the memory of Linnæus, a duplicate of one erected in Stockholm just twenty years ago to-day. I remember the date well, because I took part in the celebration, being a student in Stockholm at the time.

It is a great satisfaction to us Swedes, that Linnæus, whose memory is to-day honored all over the globe, was a man of peace. Every one has heard of our Gustavus Adolphus and Charles XII, not to mention the old vikings; but our great scientific men — such as Linnæus, Berzelius, Scheele, Celsius, Edlund, Rudbeck and others — are known only to a select few. Even John Ericsson the great engineer, whose statue has been erected in Battery Park by the city of New York, is remembered and honored only on account of his ship of war, the "Monitor." The fact that he invented the fire-engine, the propeller, the solar engine, the hot-air engine and other wonderful machinery, is well-nigh forgotten, though we have in the city to-day about fifteen thousand pumping engines run with heated air on Ericsson's principles, and the solar engine is being used more and more in California.

His work was work of peace of the very highest character, and to be commended as such.

There is one part of Linnæus's life-work which may not have been referred to to-day, and that is his work as an archeologist. While pursuing his studies in botany and zoölogy, Linnæus naturally traveled a great deal around the country; in doing this, he made careful notes of the mounds, runestones and other marks left by the ancient inhabitants, which marks are very abundant all over Sweden. In fact, his writings on this subject have formed a basis for the very interesting archeology of Sweden. Personally, I have derived much more pleasure from this part of Linnæus's writings than I have from the others, although once upon a time I did know the Latin names of a few hundred plants. Once more I thank you, Mr. President, in behalf of the Swedes of New York, and I will close by proposing a cheer for the memory of Linnæus, and will ask the singers to assist me with a genuine Swedish hurrah.

At the close of the exercises at the Bridge, many people, in spite of the lateness of the hour, walked through the New York Zoölogical Park to note American animals known to Linnæus. The party was under the guidance of Director Hornaday and Messrs. Ditmars, Beebe and Blair.

In the evening the literary exercises of the day were continued at the Museum of the Brooklyn Institute of Arts and Sciences, Eastern Parkway, Brooklyn. After brief opening remarks by Mr. F. A. Lucas, Director of the Museum, the following address was read.

A SKETCH OF THE LIFE OF CARL VON LINNÉ.

By Edward L. Morris.

There is something of human interest in the personal side of any one's life, if we but know an avenue of approach. Such avenues are closed to most of us for most lives. The public careers of great men are matters of recorded or current history. The professional activities and writing of men of science are open to those interested along similar lines; but often there is little opportunity to know the personal and characteristic things which are the real foundation and basis of success among men.

Our presiding officer has elsewhere said, "In some ways the career of Linnæus reminds one of a good old-fashioned fairy story in which the hero continually is being provided for. Time after time, Linnæus was taken up by some man of wealth who practically supported him and gave him opportunities for study and research.

"Either genius was rarer in those days than now, or else it received more substantial recognition."

In 1706, Nils Linnæus, a Swedish pastor, and his bride Christina, began their home life in his parish in Råshult in Småland in southern Sweden. About their cottage he had planted a garden of flowers according to a taste developed while living with an uncle. In this garden the young bride took special delight, only to grieve sorely at the effects of the heavy winter frosts, but reacting to the hope and anticipation of the awakening of spring. Here were more than four hundred species of exotic plants. For such a latitude and for such a period of the world's history, this was a most unusual collection.

In the midst of the spring advent of the flowers, in May, 1707, there was born a son in the home of the parish leader. He was baptized "Carl." To-day we celebrate, in honor and praise, the birth of *Carl Linnæus.*

The following year, the family moved to Stenbrohult, to which were also removed most of the plants from the garden at Råshult.

As soon as the boy Carl could walk, he daily visited the new garden with his father, where he was the more attracted to the flowers because in his babyhood the parents had often attracted his attention by many bright blossoms. A little later he had a bed for his own flowers, which he chose from the main garden. Later still, he was given a plot for his own garden beside his father's. At four years of age, after a visit to a country fair, he so persisted in asking questions that he practically knew all his father could tell him,— the Swedish names and the uses of the native plants.

Typically, his mother delighted in the boy's absorption in the flowers (she was fond of them too), besides, this often kept the boy occupied for hours,— an important item in the daily program of the young housekeeping mother.

Boylike, oftener than not Carl forgot the answers to his questions. His father noticed this and called the habit mischievous, and refused to answer further questions till the boy promised to remember what was told him. This parental training became of the highest value to the future Linnæus.

Many of the relatives of Nils Linnæus were ordained to the service of the church. It was in the wife's heart to have their son be the same. But he was averse to all reading not related to natural history or more particularly to botany. His chief activity was to wander over the fields and through the woods, bring home every new species he found, plant some, and dry and preserve others. With these he brought in several weeds, which caused no end of trouble to his father, as they spread to the beds of exotic plants. He became so proficient in his knowledge of the local plants that the neighbors all called him "the little Botanicus."

The story goes, that one day his mother found that he had even appropriated her much-treasured Bible in which to press some new-found flowers, and she began gently rating him for this.

"Dear child," she said, "you must not put herbs and flowers in my beautiful book. It would be quite a sin to spoil the Holy Bible."

"Pray forgive me, mother! But these are the most beautiful flowers I have ever seen, so I thought I would preserve them best of all, for I have heard both you and father say that the Bible is the Book of Life; and surely, if I put the flowers between its leaves, they will retain their color, the Bible keeping them alive forever."

"Child, when we call the Bible the Book of Life, we mean by that, not the life we see before us, but the spiritual growth of our souls, for every thought we think is a flower culled in the garden of our soul. There, as on earth, grow many various plants, some of wondrous beauty, and others stained with sin. But every time we humbly read in the Sacred Writ, a seed is sown in our heart, which some day will bloom, and bear holy fruit."

"How beautifully you talk, mother!"

"Well, you must diligently read your Bible, and in your heart will grow the seed of goodness and humility; but I fear" —

"What do you fear, mother?"

"I fear you love the fair flowers of the earth too much to care for the seeds that were watered with tears in the Garden of Gethsemane."

"O mother! no, I won't forget my Bible. But when I see a flower I think this way, 'Why does God make the cold, damp earth grow such lovely creatures with such beautiful colors? Why, if not to make us happy with the sight?' And then I almost fancy the flowers saying with their petal lips, 'Look at us, and think how kind and good is God.' O mother! every flower *must* have been a thought by God."

"Why, how you speak, child! Well, yes, you are right: it must be so."

When Carl was ten years old, after an unfortunate experience with a private tutor, he was sent to Wexiö, the capital of the diocese, to the grammar and higher grades. But here he failed because there was no teacher to lead and inspire him, but only those to drive. The boy mentally refused to be driven. Shortly he was put again under a tutor somewhat better than the former one; but in every subject except Nature he was considered a dunce.

In eight years his father, with sorrow in his heart, became convinced that Carl never would make a preacher. His mother, realizing this also, rued the love she had felt for the flowers and the interest on his part which she sadly had fostered, and with pique declared to her second son, Samuel, that he never should devote himself to so useless and wasteful a study as flowers.

In the words of another, "In this great distress, Pastor Linnæus called upon a friend Dr. Rothman, a physician of Wexiö who also taught physiology and botany in the school. His verdict, however, was, 'Well, a preacher Carl certainly never will be, but he might become a famous physician; and that profession will feed a man as well as the church. Your son is far advanced in natural history, and, without gainsaying, the foremost scholar in botany. If you will permit, I will take him into my house: he shall eat at my table *gratis*, and I will myself read with him during the year that remains before he can proceed to a university.' It need not be told how gladly father and son accepted this generous and well-timed offer."

Carl now removed to Dr. Rothman; and this learned gentleman with great discernment made it clear to his *protégé* of what great advantage, and how indispensable, were Latin and Greek for the study of medicine, botany and natural history.

The dead languages now became endowed with a living new interest, and instead of Justinius and Cicero, he studied with enthusiasm Pliny's "Natural History," performing thus a double study at the same time.

Dr. Rothman grew daily more and more attached to his pupil, who made amazing progress, and whose transcendent genius became more and more evident. He found great delight in guiding the young naturalist in his studies, but soon found, with little surprise and no envy, that his pupil far outstripped himself, for Linnæus could acquire no more from him.

Linnæus must enter the university, and nothing remained but to get the certificate from the Wexiö school. It was framed in very quaint and significant words; and it is curious that the trope of a tree, carried all through, should have been applied to the future of the professor of botany. It read as follows: "The youths in schools may be likened unto young saplings in a plantation, where it sometimes happens, although seldom, that young trees, despite the great care bestowed on them, will not improve by being engrafted, but continue like wild untrained stems, and when they are finally removed and transplanted, they change their wild nature, and become beautiful trees that bear excellent fruit. In which this respect, and no other, this youth is now promoted to the University, where, perhaps, he may come to a clime that will favor his further development." With this recommendation Carl Linnæus went to Lund, the southern university of Sweden, in 1727.

Here Linnæus boarded and lodged at the house of one Strobæus, who lectured in the university on natural history, geology, and botany. He was a man of acknowledged great learning in these sciences, and possessed a large private collection of stones, shell, birds and dried herbs. At this house also lived a German student of medicine, Koulas, eight years the senior of

Linnæus, who had the use of Strobæus's library, and who took upon himself secretly to lend his young friend what books he required in botany. The old mother of the learned host had observed that a light burned in the small hours of the night in Linnæus's room, and, fearing fire, told her son, who quietly one night went up to Linnæus's room to surprise the negligent fellow, but was himself surprised to find the student in the dead of night busily comparing the varying opinions of the greatest botanists of his time. This surprise won the admiration of the teacher and his affection, and he at once gave Linnæus the use of his library freely, and the keys to his collections, and, like Rothman, took the liveliest interest in the gigantic strides of progress.

In 1728, Linnæus changed to the University of Upsala to study under the renowned professors Roberg and Rudbeck. Here Linnæus suffered much from poverty, often having barely enough food to sustain life. At length, under dire necessity, he was about to start for home to his father, when he made a last visit to the garden of the university. Just then there was a rare exotic plant in bloom. Linnæus picked the flower, and was sharply reprimanded by a voice behind him. He explained that it was for a memento of the place, which he was now obliged to leave permanently. This aroused the interest and question of the dean, as it proved, — Celsius, senior. A result of this incident was, that Celsius saved Linnæus to science then and there by taking him to his own house, giving him new and large opportunities at the university, tiding over the time of distress, and procuring for him opportunities as private tutor to some of the students below him.

Here Linnæus brought out his little thesis developing his sexual system of grouping plants. From now on, Linnæus had a constant chain of promotions, spiced, disagreeably now and then, by jealousies wrought against him, but consisting of the delights of extensive, dangerous and economic travels, new positions of teaching and lecturing at home and abroad, and finally the full chair of botany at the University of Upsala.

His greatest and ultimate joy was in the knowledge that his system of plant relationships became, before his death, the commonly accepted system of the civilized world.

To his credit be it recorded again, that his system is the foundation of all modern concepts of the sexual evolution and differentiation, and consequent relationships, of all known plants and animals, and especially of their nomenclature.

His personal and professional interest were so broad as to include special studies in insects and birds and in general zoölogy, as time allowed divergence from his life-work in botany. His writings covered the living things of the Old and New Worlds, and comprised some seventy or more titles.

His personality was of the kind which inspired every pupil coming under him to branch out for himself in some line of natural history. His students became scattered throughout the world.

Up to the last, and as much as his failing health would allow, Linnæus kept up a lively and progressive interest in his science.

Finally, tired of life, and forgetful of all honors which had been so keen a delight to him, he passed beyond peacefully on the 10th of January, 1778.

His works and his name live forever.

At the conclusion of Dr. Morris's address a musical selection was rendered by the Glee Club of the United Swedish Societies, after which the following address was delivered.

LINNÆUS AND AMERICAN NATURAL HISTORY.

By Frederic A. Lucas.

I presume that the question first in the minds of many present is, Why have we met this evening? why should we celebrate the two hundredth birthday of Linnæus?

In a general way, Linnæus may be said to have systematized the study of natural history, and arranged its known facts in an orderly manner; but his special claim to our gratitude is the invention or perfection of what is called the "binomial system" of nomenclature, that is, the use of the double name for each species of plant or animal. This may seem a small matter. In fact, those who ask Why doesn't every animal have a common name? might think they had reason to feel anything but grateful; but it was really one of the greatest advances made in natural history. For in science it is not enough to accumulate facts, they must be set in order, or classified, so as to be available. In fact, Huxley termed science "classified knowledge." Before the day of Linnæus, animals were mainly known by their descriptions or their vernacular name. The lion, for instance, would be called the "great tan-colored cat with a mane;" and, in order to indicate what species were related, it would be necessary to specify them each and all.

As the rising tide of commerce of the eighteenth century brought to Europe scores of animals previously unknown, the number of recognized species increased so rapidly that it promised to be a difficult matter to keep track of them. It was at this time that Linnæus devised the plan of applying to each animal a general or generic name which should indicate the immediate group to which the animal belonged, and a special or specific name to apply to that particular kind of animal alone. And so binomial nomenclature was born. It has been claimed that Linnæus was not the first to use the binomial system, but, if not, he was certainly the first to employ it consistently and to frame rules relating to such use. Linnæus wrote in Latin not as a matter of affectation, but because Latin was the common language of culture and science, and to this day many naturalists still write descriptions of new species in Latin, or preface their accounts with a brief diagnosis in that language. Had he written in Swedish, his native tongue, his audience would have been a small one, probably limited to his native land; as it was, his works were understood by all the naturalists of the day. Hence his scientific names which were Latin names are, like a gold coin, current the world over, while the so-called "popular name" is restricted in its use, and circulates only in the country where it is coined.

But Linnæus did much more than devise a scheme of nomenclature: he systematically defined each and every group of plants and animals with which he dealt, giving their chief characters in a few brief words; and the small groups, or genera, he combined in large divisions termed "orders." It matters not that the genera of Linnæus have since been divided and subdivided many times, the underlying principle of assigning certain definite characters to each animal remains the same.

Linnæus was a born classifier. He was not happy until he had duly set in order the facts and objects that came under his notice; and while he did not, it is true, carry this to the extent of the eccentric Rafinesque, who made several genera and species of thunder and lightning, he did propose a system of classification for diseases wherein they were duly assigned to their respective families and genera.

To many the term "classification" is repellant. It seems to signify something with which the ordinary man has nothing to do, when really it is something with which every one is, or should be, concerned; for classification is simply arranging things in their proper places, and putting things of a kind together. And the man who puts his cuffs in one place, his collars in another, and arranges his shoes in a row on the top shelf of a closet, is a classifier.

The naturalist is confronted by the same problem as a general,— that of grouping or arranging the various plants or animals so that he may know where each one is to be found, or where to assign any new form that may come to light. For an army is not merely a large number of armed men, it is an orderly assemblage of men so classed and grouped that they can be handled by one man. And the classification of the animal kingdom, for example, is very similar to that of an army, and to the same end,— that any one may put into its proper place each of the thousands of units with which he has to do.

And Linnæus marshaled plants and animals as a general marshals his troops. And just as an army is composed of thousands of individuals, distinguished as officers and privates, formed into companies, regiments, brigades and divisions, so the thousands of species composing the animal kingdom are grouped into genera, families, orders, classes and phyla. In doing this, Linnæus instituted many minor reforms; for example, his characters were given in a definite order, and following the diagnosis was the synonymy, or list of names under which the animal had been described, and works in which it had been published. He was the first to strip natural history of its verbiage, and express himself in clear and concise language, and, had he lived to-day, I doubt not he would have been an advocate of spelling reform.

And yet, after all, this scheme of nomenclature is but a part of the service Linnæus rendered to natural history. It is not merely that his genius grasped the fact that nature was order, and that he devised methods for expressing this order; his zeal in the pursuit of knowledge gave a stimulus and purpose to the study of natural history that it had never felt before. In a way, his influence may be said to have been much like that of Agassiz in the United States, "He imbued [his pupils] with his own intense acquisitiveness, reared them in an atmosphere of enthusiasm, trained them to close and accurate observation, and then despatched them to various parts of the globe." It was not so much what he knew himself as the enthusiasm he inspired in others, that made him a power felt throughout the world.

It must ever be borne in mind that nomenclature, or the naming of plants and animals, is not the end of natural history, but only a means to an end,— a fact that many of our younger naturalists are prone to overlook. Too many of them seem to think that the great aim of the naturalist is to write "new species" after as many names as possible, when, to my mind at least, the making of new species is the most trivial work of the naturalist. It is important work, but only a step on the pathway of knowledge. The real problems are, Why do these species exist? what forces have brought them into existence? and what are their relations with one another?

The man who heard an overture for the first time, after listening a while turned to his friend with the query, When are they going to stop tuning up, and commence to play? So you may wonder why I chose for the title of this address "Linnæus and American Natural History." The truth is that Linnæus is so intimately connected with *all* natural history, that American natural history forms but a small part of the whole. And yet Linnæus was intimately concerned with the development of American natural history by his acquaintance with those men of science who were gathering and making known the fauna and flora of this continent; and as plants and animals were brought to Europe, most of them found their way to Linnæus, and many were definitely named by him for the first time. The twelfth edition of the famous "Systema Naturæ" describes 210 mammals, 78 of which are American (including under that term North and South America); 790 birds are noted, of which 260 are American; and 88 of the 124 reptiles are also American.

We think of Audubon, Baird, Coues and Ridgway as the great American ornithologists, and they are great; but a glance at the check-list of the American Ornithologists' Union shows how prominent a part was played by Linnæus. The list of 1889 gives 729 species and subspecies. No less than 202 of these were named by Linnæus; while Audubon, the father of American ornithology, named but 33. Twenty-five bear the sign-manual of Coues, and 104 of Ridgway. We must, it is true, remember that a considerable number of the birds named by Linnæus are species common to Europe and North America, but, on the other hand, it must also be borne in mind that many named by Ridgway are what are called subspecies, which were not recognized in the day of Linnæus.

In the time of Linnæus there were few naturalists in the United States, but those were active; and that they approved of his methods is shown by a letter of Collin to Linnæus, in which he says, "Your system I can tell you obtains much in America. Mr. Clayton and Dr. Colden at Albany are complete professors, as is Dr. Mitchell at Urbana, Va." If this seems a pitifully small number to us, it must be remembered that in those days naturalists were few in number, and natural objects studied but little; and twelve years later there were in all England but seven botanists who were followers of the Linnæan methods. Those were the good times when one man knew the plants and animals of the whole globe. Now a naturalist may devote his entire time to the study of one small group, and the names of other plants and animals are often as unfamiliar to him as they are to the average man.

It is interesting, almost amusing, to see how little an idea Linnæus and his contemporaries had of the number of the animals in the world, for their most liberal estimates were very far from the facts. And this lack of knowledge Linnæus realized when he wrote at the end of his "Systema Naturæ," "*Ea qua scimus sunt pars minima eorum quæ ignoramus.*" Thus Ray in 1693, a short time before Linnæus began his career, estimated that there were about twenty thousand animals, including insects, in the whole world; and this was a very liberal estimate, for he actually described less than four thousand.

Now, Ray was what would be termed to-day a "lumper," and divided all living things into four great orders, — insects, fishes, birds and beasts, the last including reptiles. The number of beasts he stated to be a hundred and fifty, adding his belief that "not many that are of any considerable bigness in the known regions of the world have escaped the cognizance of the curious." The birds he considered might reach as many as five hundred. Contrast this with the more than twelve thousand species so far described. The number of insects he considered might possibly reach twenty thousand species, a long way from Sharp and Walsingham's estimate of two millions, or Riley's of ten millions. Nowadays this estimate of Ray provokes a smile, and yet we can find an example of much greater complacency shown by one of our noted scientific men of much more recent date; for Dr. Coues about 1880 thought that few mammals remained to be discovered in North America. How badly he was mistaken is shown by Dr. Allen's review in 1894, showing that the number of recognized species had more than doubled in ten years, rising from 181 in 1880 to 369 in 1890; and since then many more have been described, not merely small creatures that to the ordinary observers are alike, but large animals like bears and mountain-sheep.

It well illustrates the activity displayed by naturalists of that day to say that by 1758 the number of known mammals and reptiles had increased to 334 and of birds to 790; the figures in the one case being an advance of a hundred per cent over those of Ray, and in the other of fifty per cent.

How thoroughly the world is being ransacked for new animals, and how actively naturalists are engaged in their description, may be gathered from the following figures. Up to 1830, species to the number of 71,598 had been described, by 1881 the number had risen to 211,553, and by 1896 to 366,000; more than 150,000 species having been described in fifteen years. And the vast and ever-growing host of living things — the beasts of the field, the birds of the air, the fishes that are in the water about the earth, to say nothing of the myriad species of the plant world — are each and all named in accordance with the method devised by Linnæus two centuries ago. Linnæus builded better than he knew, and his work has stood the test of time; and the methods he devised for classifying and naming animals are those in use now. His details may have been faulty, and the groups he considered as genera may have been divided and subdivided, but his plan stands.

Scores of animals known to Linnæus have been swept out of existence, and thousands that he never knew have been discovered; but the stimulus given by him to the study of nature remains unchecked, and to-day in many countries the members of learned societies have assembled, as we have gathered here, to do honor to the great Swedish naturalist. Sweden, indeed, chanced to be the birthplace of this great man, but genius is not fettered by time and space, belonging rather to all time and to the whole world.

At the conclusion of Mr. Lucas's address the Glee Club sang a second selection, and then the evening exercises ended with an exhibition, by means of stereopticon views, of plants and animals known to Linnæus, in charge of Dr. A. J. Grout and Mr. Lucas.

In the Borough of Manhattan the day was rounded out at the New York Aquarium, Battery Park, where the New York Zoölogical Society gave a reception to the Academy and the guests of the occasion. This function likewise commemorated the centennial anniversary of the erection of the building and gave the first view of the collections by night. A feature of the reception was the exhibition of forms of marine life known to Linnæus.

* * * * * * *

An important and highly interesting feature of the Linnæus celebration lay in the following documents contributed by sister societies in many parts of the world, and letters written by several of the Honorary Members of the New York Academy. Each is reproduced here in the language in which it was sent in.

Kungl. Svenska Vetenskapsakademien, Stockholm.

It is with great pleasure that the Royal Swedish Academy of Sciences has received in these days, from all parts of the world, the most gratifying testimonies of the great admiration and esteem in which our first president, Carl von Linné, is held by all those who love and study nature. Your invitation has also been accepted with great gratitude: it was, however, received so late that it was impossible to take any measures for participating in your celebration in such a way as would have been desirable to us. You have expressed your wishes that we should contribute an official document appreciative of the work of Linné. There is, however, no opportunity now to prepare such a document, and we must thus confine ourselves to a short statement elucidating our opinion.

There were many great naturalists before Linné, if we count from Aristoteles to Ray and Willughby. There was certainly a great amount of knowledge, also, concerning animals and plants; but there was no system, no scientific names or terms. The facts that were known in natural history before Linné were thus heaped without order, or with very little order, like a pile of bricks and stones at a building-place. Linné was the great architect who made the plan for the erecting of the building, — the system; and he furnished at the same time the mortar — the nomenclature — for cementing together the stones and bricks. It may be admitted that more practical and more beautiful buildings have been constructed since that time in the scientific world; but he was and he remains the great master, who, with brilliant genius and admirable skill, first taught us how to put in order and systematically arrange the material, and thus make a true science of natural history. This has also been universally admitted; and the renowned British naturalist Pennant writes about this part of Linné's work, "He hath in all his classes given philosophy a new language; hath invented apt names, and taught the world a brevity, yet a fullness, of description unknown to past ages."

Many persons not familiar with Linné's work have believed that Linné contented himself with describing the exterior of the objects in nature, and then named them. Nothing can be more erroneous; that is proved by the program or the "Methodus" which Linné published even in the first edition of "Systema Naturæ." This "Methodus" is in its thirty-eight short paragraphs the fullest and richest program which any student of natural history has ever published. Referring to this we may affirm that no branch whatever of biological study was neglected or underrated by Linné. He grasped fully the importance of the study of anatomy, and he advised his scholars to dissect animals and also to make a frequent use of the magnifying glass. His ardent love of living nature made him an excellent biologist in the restricted sense of that word.

Even if his greatest works were of a systematic and descriptive nature, it becomes evident to any one who has only a superficial knowledge of what Linné has written, that his genius extended with unbounded flight to cover much wider areas of philosophical speculation. Although he did not see it in the light of the theory of evolution,— it was indeed far too early for that,— the general struggle for existence, as well as the idea of sexual selection, was well known to him. And many other problems of modern times did he touch. Let us only recall the fact that to the pious and pure mind of this great naturalist there was no objection to place *homo sapiens* as the first link in the continuous chain of organisms.

His works may shine with everlasting brightness through all ages, as long as mankind devotes itself to the study of nature. His name is *œre perennius*, but this Academy of Sciences and the whole people of Sweden feel deeply and are gratefully touched by the honor which now is bestowed upon our great compatriot, when his name is given to a monumental bridge connecting the Botanical Garden and the Zoölogical Park in New York.

K. A. H. Mörner.
Chr. Aurivillius, *Secretary.*

Kungl. Svenska Vetenskapsakademien, Upsala.

The Royal Society of Sciences at Upsala has had the honor and the pleasure of receiving your letter, informing them of the impressive manner in which the memory of their great countryman, Carl von Linné, will be celebrated in the metropolis of the United States.

To every Swede, and especially to our Society, whose honor it is to count Linné as the greatest ornament of its ranks, it is highly gratifying to see that the memory of the man whom all the world recognizes as *princeps botanicorum,* is also beyond the Atlantic held so sacred that the two hundredth anniversary of his birth will be celebrated there with the same love and reverence as in his own country. And we fully appreciate the delicate courtesy which has led you to immortalize his name among you by dedicating to him the beautiful bridge which unites your Botanical Garden with the Zoölogical Park.

The necessity of answering your honored letter without delay renders it impossible for the Royal Society of Sciences to enter more fully on the epoch-making significance of the great Linné's life and work. Nor do we consider it necessary for us to do so, least of all in relation to your renowned Academy, which takes the lead in the grand scientific evolution of America. Do we not both realize that Linné's great genius has laid the foundations on which botanical science goes on building this very day? We both realize the unceasing debt of gratitude which both hemispheres owe to his immortal name. And so on both sides of the Atlantic we celebrate with deep-felt enthusiasm the two hundredth anniversary of his birth.

We offer you our best wishes on the memorable day, and congratulate you on your successful work in the immense field of learning.

J. A. Ekman, Archbishop of Sweden,
President.
N. C. Dunér, *Honorary Secretary.*

Professor Hans Reusch, Kristiania, Norway.

(*Honorary Member of the Academy.*)

In my working-room at the Geological Survey of Norway for many years I have had only one portrait hanging, — that of Linnæus. I regard him as the household spirit of every good naturalist.

The Geological Commission of Finland.

On behalf of the Geological Commission of Finland, we desire first of all to express our high appreciation of the honor rendered us in inviting the Commission to take part in the celebration, by the New York Academy, of the two hundredth anniversary of Carl von Linné.

We are proud to think that we have some right to reckon this great memory among our own, because Finland in Linné's time was united to Sweden; and a large number of us Finlanders are still, by language and descent, connected with that land. Among his disciples were also several of our countrymen; and the interest which ever since that period has existed here for the study of botany, and also of zoölogy, we regard as a direct inheritance from Linné's time. Not only naturalists *ex professo* have taken part in the investigation of the flora and fauna of our country, but also physicians, clergymen, government officials and the general public, who have, ever since Linné's days, constantly and with zealous eagerness lent their aid to the augmentation of our store of knowledge in things pertaining to natural science.

By his travels, among the first which were undertaken for a purely scientific purpose, Linné has also given an example to the numerous explorers who since his time have gone out from northern lands — among those born in Finland we may mention Laxman the explorer of Siberia, Castrén the linguist, and Baron A. E. Nordenskiöld, the geologist, and discoverer of the Northeast passage — and to all those who, after Linné's time, have united the courage and energy of the pioneer with scientific thoroughness.

We geologists remember in especial that Linné — who had very correct ideas of the geological sequence among the silurian rocks of Sweden and the importance of fossils, and whose conception of the geological importance of the deluge was for his time unusually free from bias — can be reckoned among the early pioneers of geology and as a predecessor of the great naturalists who somewhat later, in Scotland and Saxony, laid the foundation-stones of scientific geology. He had a notion of the immense length of geological time, and expressed opinions which contained the germ of the actualistic doctrine that afterwards proved so fruitful for our science.

It has been the mission of the Anglo-Saxon nations to work out this doctrine and to build up on this basis the science of geology. When in our days we Northerners see without jealousy the hegemony in natural science pass over to the great nations which have continents for their field of research, we still remember with pride that it was at one time held by the little nation to which Linné belonged, and see in the festival with which your honored society celebrates the two hundredth anniversary of his birth a recognition that all scientific exploration which is carried on in an unprejudiced spirit of order and truth is a work in the spirit of Linné.

Remembering the bond which thus connects your great nation with the small countries of northern Europe, we wish especially to recall to you one of Linné's disciples, the explorer Pehr Kalm, professor of botany at the University of Åbo in Finland. He was very highly esteemed by his great teacher. In Linné's list of the naturalists of his time, in which each one was distinguished with a certain rank, Linné himself was general, and Kalm had the rank of major. Commissioned by the Royal Swedish Academy of Sciences, Kalm, as is well known, traveled far into North America, and afterwards published an uncommonly accurate and minute account of his observations, which was translated into several languages. He penetrated into what was then considered the Far West, to the Lake of Ontario; and it was through his letters to Benjamin Franklin, in which Kalm with his usual minuteness described the Falls of Niagara, that this great wonder of nature first became more generally known.

What a lapse of time has passed since that visit of the disciple of Linné to North America! — a time measured more properly by the wonderful development of civilization than by the number of years that have gone by. Over this vast continent, where then were forests and prairies, the abodes of the wild Indian, has the white man now built his homes, and it is strewn with schools in which the children learn to designate the plants and animals with the names given them by Linné. Everywhere there are universities in which the study of natural science is carried on with the aid of means and appliances which Linné never could have dreamed of. Where Kalm, at the mouth of the Hudson River, found a town which he says was then "about half as big again as Gothenburg in Sweden," lies now one of the greatest cities of the world; and in this city the two hundredth anniversary of Linné is now celebrated in a way that shows that his memory is as much honored there as in his fatherland.

What a proof of his greatness, what a guaranty that he will forever be regarded as one of the master-minds of mankind!

J. J. Sederholm.
Benj. Frosterus.

Senaat der Rijks-Universiteit te Leiden.

The Leiden University Senate has the honor to present its congratulations to the New York Academy of Sciences on the occasion of the commemoration festivities celebrating the two hundredth anniversary of the birth of Carl von Linné. The whole scientific world unites in grateful veneration of an admirable scholar, whose reputation is least of all lost in the land where he spent three of the most fruitful years of his life. Our Senate expresses its feelings of cordial sympathy with the way in which the New York Academy of Sciences intends to celebrate the anniversary of his birth by the erection of an architectural monument symbolizing the work of a man whose genius embraced the two realms of living nature.

For the Senate

W. Nolen, *Rector Magnificus.*
H. P. Wijsman, *Secretary.*

Professor A. A. W. Hubrecht, University of Utrecht.
(Honorary Member of the Academy.)

The great Swede whose birth — now two hundred years ago — will be commemorated all over the world on May 23, passed many years of his life in Holland. It is thus natural that many local reminiscences are connected with his name in different parts of this country. If we allow our thoughts to go back for more than a century and a half, we can imagine Linnæus roaming about on his botanical excursions over those same fields between 's Graveland and Hilversum where Hugo de Vries lately encountered an emigrant from the United States (*Œnothera lamarckiana*) that was to become a starting-point for new and important speculations about the species problem.

The foundations for an answer to that problem were laid in a quite masterly manner by Linnæus. In the latter half of the nineteenth century we have, however, been accustomed, after reading Darwin's works, to consider the problem as non-existing; species, apparently, being in slow and imperceptible continuity.

Hugo de Vries has again limited species between the occurrence of two mutations, each species thus being a real entity in time and in space. This does not prevent de Vries from being at the same time one of the stanchest disciples of Darwin, in whose steps he is treading.

Linnæus's species differ from de Vries's in that they are the primary network between the meshes of which de Vries has spun out the lacework of the mutation theory.

The new generations thus attempt to continue Linnæus's and Darwin's work, and unite in paying homage to the memory of the founder of the "Systema Naturæ."

L'Académie de Médecine de Paris.

L'Académie de Médecine de Paris est heureuse de répondre à l'invitation qu'elle a reçue de l'Académie des Sciences de New-York, à l'occasion du deuxième centenaire de la naissance de Linné. Elle s'associe cordialement aux hommages rendus à la mémoire de l'illustre naturaliste par les corps savants de la grande cité américaine.

Tout a été dit sur l'œuvre de Linné et sur la révolution qu'il a opérée dans les sciences naturelles. Au milieu de la confusion et de l'obscurité qui régnaient avant lui, il a su, le premier, dégager et rendre fécondes les idées générales éparses dans les écrits de ses devanciers; partout il a porté l'ordre, la clarté et des réformes heureuses.

Observateur incomparable, à l'amour de la vérité, il joignait une imagination vive, un esprit fertile et sagace, l'expression verbale pittoresque et le sentiment profond des choses de la nature. Ses écrits occupent depuis longtemps la première place dans l'estime des savants, et l'on se demande, en voyant leur prodigieuse étendue, ce qui doit le plus étonner, du nombre de ces ouvrages ou de l'importance de chacun d'eux.

Mais, de tous les titres de Linné à la reconnaissance de la postérité, le plus beau est sans contredit celui de fondateur de cette langue scientifique nouvelle, la nomenclature binaire, qui constitue le plus grand progrès accompli dans les sciences naturelles au dix-huitième siècle. A la prolixité confuse des descriptions antérieures, il substituait un langage net et précis, en introduisant l'usage de désigner les êtres par un nom de genre, qui les unit, et par un nom d'espèce, qui les distingue. La nomenclature linnéenne s'est étendue à toutes les branches de l'histoire naturelle; elle en a prodigieusement facilité l'étude en fournissant une langue commune aux savants de tous les pays.

Le système de classification établi par Linné n'a pas moins contribué aux progrès de la botanique pendant près d'un siècle. Dans ce cadre artificiel, les plantes nouvelles se rangeaient aisément d'après un petit nombre de caractères empruntés à la fleur et judicieusement choisis. Dès lors l'étude des végétaux devint accessible à la multitude, les recherches scientifiques se multiplièrent dans toutes les parties du globe avec une activité considérable.

Toutefois, l'esprit philosophique du grand naturaliste ne pouvait manquer de saisir toute l'importance d'une méthode plus parfaite, et, s'il ne lui a pas été donné de la réaliser lui-même, on peut dire du moins qu'il en a été le plus ardent promoteur et que nul, plus que lui, n'a contribué à l'avénement de la grande réforme opérée plus tard par Laurent de Jussieu.

Professeur de médecine, Linné s'est efforcé de diriger l'étude de la botanique vers les applications à l'art de guérir. Il a eu le mérite de formuler nettement le principe qui devait servir de guide à la recherche des propriétés médicamenteuses des plantes, principe fondé sur les analogies des caractères botaniques et des caractères chimiques des végétaux. Si les successeurs de Linné ont parfois exagéré la portée de la théorie, elle n'en a pas moins ouvert une voie féconde aux recherches ultérieures.

L'ancienne Société Royale de Médecine de Paris, dont notre Compagnie a recueilli l'héritage, a compté jadis l'illustre professeur d'Upsal au nombre de ses Associés étrangers. L'Académie de Médecine de Paris est donc particulièrement qualifiée pour célébrer avec vous l'anniversaire du grand naturaliste suédois. Elle remercie l'Académie des Sciences de New-York de l'avoir conviée à cette commémoration, qui lui permet d'exprimer ses sentiments d'admiration et de reconnaissance pour le savant dont l'œuvre géniale a projeté sur le monde une si vive et si puissante lumière que l'éclat n'en est pas encore affaibli.

ARMAND GAUTIER, *Le Président.*
JACCOUD, *Le Secrétaire perpétuel.*

Université de Lyon.

Le Conseil de l'Université de Lyon est heureux de s'associer moralement au deuxième centenaire de la naissance de l'illustre naturaliste Suédois Charles Linné. Il addresse à cette occasion l'hommage de son admiration profonde pour le créateur de la première classification scientifique des règnes animal et végétal; pour l'inventeur de la nomenclature binominale qui a introduit une si lumineuse clarté dans le chaos jusque là obscur de la nomenclature biologique; pour l'immortel auteur du "Systema Naturæ" qui est le premier inventaire universel des richesses du monde animé.

Il envoie en même temps à l'Académie des Sciences de New-York l'expression de sa gratitude la plus cordiale pour l'aimable pensée qu'elle a eue d'associer l'Université de Lyon à cette fête de la Science internationale.

T. JOUBIN, *Le Recteur,*
Président du Conseil de l'Université.

Société des Amis des Sciences Naturelles de Rouen.

La Société des Amis des Sciences naturelles de Rouen (France) a l'honneur d'exprimer à l'illustre Académie des Sciences de New York sa vive satisfaction de savoir qu'un pont de cette admirable ville sera dédié à l'immortel Linné, dont les travaux géniaux constituent la base de la taxinomie, et dont le nom sera perpétué à jamais par les innombrables espèces animales et végétales qu'il a décrites.

La Société des Amis des Sciences naturelles de Rouen prie l'illustre Académie des Sciences de New York d'agréer l'hommage de sa respectueuse admiration, joint à l'assurance de ses meilleurs sentiments de confraternité.

HENRI GADEAU DE KERVILLE, *President.*

Societé d'Histoire Naturelle de Toulouse.

ELOGE DE LINNÉ, APPRECIATIVE DE SON ŒUVRE.

"Tibi suaveo dædala tellus
Summittit flores." — LUCRÈCE, *De Natura Rerum.*

C'est à vous, divin naturaliste, que l'univers entier présente en ce jour ses plus belles fleurs.

Nous saluerons tout d'abord le savant qui d'un trait de son puissant génie, saisit la structure intime des végétal. Lui aussi a eu la gloire d'ouvrir un des sanctuaires de la nature et de s'initier le premier à quelques-uns de ses secrets.

"Effringere ut arcta
Naturæ primus poetarum claustra cupiret." — LUCRÈCE.

Avant Linné le végétal d'était qu'un vulgaire objet d'admiration, l'élément à la fois réjouissant et décoratif du paysage. Mais le génie du botaniste que nous fêtons eut y lire tout un monde nouveau, et de la comparaison de ce monde avec celui des animaux sut brillamment degager la natien de hiérarchie entre les deux règnes, entre le végétal et l'animal. Alors se dessina en quelque sorte le premier anneau, la trame primordiale qui devait bientôt amener l'esprit de l'homme à se représenter une chaîne complète des êtres. Reconnaissons donc en Linné un ancêtre de Darwin.

Mais le règne végétal s'est en quelque sorte animé sous le regard de ce scrutateur amoureux de la nature. Qu'est ce en effet pour Linné que cette riante parure que nous nous plaisons à appeler corolle de la fleur? Tout simplement le lit nuptial des organes sexuels, ceux qui reproduiront l'espèce. Et que seront, examinés attentivement, chacun de ces derniers organes, tant mâle que femelle, sinon un renduirent, une ébauche un "caneoas" de celui de l'animal, comme a fait si bien ressortir le physiologiste Bichat? C'est cette découverte qui constitue le trait original et saillant entre tous, le trait de génie, répétons le, de l'œuvre de Linné. Derrière l'homme de génie nous devons admirer le philosophe.

Aussitôt que Linné eut eue bien présente dans son esprit la continuité de la chaîne, disons mieux de l'échelle des êtres vivants avec leur lois generales communes aux deux règnes à la fois, il eut aussi toutes desporées d'une façon trés regulière les bases d'une classification des végétaux. Il les répartit en vingt quatre categories, basées toutes sur les rapports des organes mâles et des organes femelles dans une même fleur ou dans des fleurs séparées, les organes sont respectivement appelés les "maris et les femmes" par Linné. Signalons à titre de curiosité:

La classe xiv, Didynamie. — Deux puissances quatre maris dont deux plus grands et deux plus petits.

La classe xxi, Monœcie. — Une seule maison: les maris habitent avec les femmes dans des lits différents (dans la même maison).

La classe xxii, Diœcie. — Les maris habitent des domiciles et des lits divers.

La classe xxiii, Polygamie. — Plusieurs noces: les maris habitent dans des lits distincts avec des épouses légitimes et des concubines.

La classe xxiv, Cryptogamie. — Noces cachées, les noces sont celebrées clandestinement.

Cette théorie, toute géniale qu'elle était, n'était pas cependant destinée à subsister. Elle n'en demeurere pas moins comme le plus beau monument de l'âge d'or de la botanique. Aussi le chemin était frayé dans le domaine végétal: la notion de la classification allait devenir un chapitre important des études philosophiques, et, grâce à une plus complète connaissance de la nature, la philosophie elle même allait prendre un nouvel essor, agrandir, transforme son domaine, descendre des hauteurs métaphysiques à des données plus positives. Et cela jusques au jour où le progrès incessant des sciences naturelles viendrait introduire une nouvelle idée géniale, grâce à laquelle les deux règnes auraient des tendances à la confondu en un seul: par voie de progrès nous avons nommé cette évolution dont Linné avait jeté les premiers fondaments. Comme il était loin, quand il écrivait la Philosophia Botanica de pouvoir entrevoir seulement la grandeur future de l'édifice dont il jetait las assises! Quelle est enfin l'epithète qui convient à Linné au milieu de ce que l'on pourrait appeler le "chœur des botanistes?"

Un savant Suisse, Rueper, s'est plû à caracteriser chacun des grands historiens du règne végétal. Il nous représente le trés subtil Adanson. Le très ingénieux Bernard de Jussieu, les éminents Robert Brown et De Candolle, quant à Linné, il a sa place suréminente, c'est le divin Linné, divers Linnæus! Le divin Linné! nous lui maintiendrons ce sublime titre, puisque ce fut un des privilèges surhumains pour ainsi dire, doué des lumières tout à fait superieurs, qui sert ouvrir une des portes d'un sanctuaire de la nature, introduisent aussi à sa suite dans ce domaine reputé inaccessible jusques à lui toute une legion d'éminents travailleurs destinés a eu explorer les recours et à continuer son œuvre!

Le divin Linné! n'avait-il pas en effet comme profondément gravée dans tout son être l'empreinte de cette Divinité qu'il ne perdit jamais de vue? ne considerait il pas l'œuvre qu'il avait accompli dans la science comme le plus bel hommage qu'il fut capable de lui rendre quelques unes de ses pages redisent plusieurs fois le nom du Créateur de tous les êtres. Comme nous regrettons de n'avoir pu retrouver cette prière, si sublime dans sa brevité, dans laquelle il exprime à l'auteur de la nature sa reconnaissance eternelle pour la joie qu'il ressent de l'œuvre qu'il lui a permis d'accompli! Bornons nous à mentionner les invocations qui terminent un de ses chapitres:—

"O Jehovah, quam ampla sunt opera tua!
Quam ea omnia in sapientia fecisti!
Quam plena est terra possessione tua!"

Ce sont les propres accents de David, au psaume 103, mais sur un ton plus renforcé.

Saluons en terminant l'heureuse patrie de Linné, la Suede. La race des génies, si brillamment inaugurée par le botaniste dont nous fetons aujourd'hui l'anniversaire deux fois séculaire de la naissance, cette race disons nous, ne paraît pas volontaire s'épuiseren Scandinavie. Qu'il nous suffire de nommer un contemporain, le celèbre chimiste Arrhénius, qui semble lui aussi, par sa belle théorie des ions, avoir révolutionné à la fois le monde chimique et le monde électrique, preparant ainsi une nouvelle voie aux découvertes industrielles de l'avenir. L'œuvre de Linné était dans le règne végétal. Arrhénius a roula la tente dans un troisième règne, celui dont toute vie est exclué; les secrets qu'il croit en où arrachés à la nature sont d'un ordre encore plus intime et plus mystèrieux que ceux que lui avaient derobés le grand botaniste. Comme consequence des travaux de ces deux grands hommes, la science peut dire aujourd'hui avec plus de raison que le hero de Lucrèce: Il y a plus bien de mystérieuse dans la nature: nous avons triomphe de toutes les barrières, et nous avons conquis la notion du degré de puissance qu'a été delimité à chaque être et de la borne qu'il ne peut dépasser.

"Unde refert nobis victor quid ponit oreri,
Quid nequeat, finita potestas denique eusque
Quanam ut ratione atque alte terminus hœrens."

Lucrèce, *De Natura Rerum.*

H. de Lastée, *Bibliothécaire.*

Professor Charles Barrois, University of Lille.

(Honorary Member of the Academy.)

C'est un très doux sentiment pour les savants de la vieille Europe de vivre un jour en pleine communion d'idées avec les savants de la jeune Amérique, pour jeter le souvenir d'un maître commun, d'un bienfaiteur de la science. L'histoire, les nations, l'homme ont bien évolué depuis le jour de Linné; le respect dû a son nom demeure, et s'en va grandissant. Puisse son exemple faire des émules nombreux dans votre grand pays, qui de nos jours rend de si éminents services à la cause de la science.

Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, Halle A.S.

Der New York Academy of Sciences entbietet die Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher zu der Feier des 200-Geburtstages von KARL VON LINNÉ einen Gruss, da sie sich eines weiss mit derselben in dem Bestreben den grossen schwedischen Naturforscher zu ehren. War doch unsere Akademie die erste wissenschaftliche Körperschaft, welche bereits 1736 den jungen Linnæus in ihre Mitte aufnahm und ihm den glanzvollen Beinamen eines Dioskorides Secundus beilegte. Wohl auf keine anderen Geistesheroen kann das stolze Wort: Deus creavit, Linnæus disposuit auch nur annähernd angewendet werden. So unscheinbar die Linnæus borealis ist, umso grösser steht Linné als Naturforscher da. Aber nicht nur als Botaniker und Zoologe erwarb der Jubilar unsterblichen Ruhm, auch in der Medizin leistete er für die damalige Zeit in der Materia Medica wie der Diätetik Hervorragendes und war wohl derjenige, welcher in Schweden für die pathologische Anatomie als bahnbrechend anzusehen ist, da er die Leichensektionen daselbst einbürgerte.

Der New York Academy of Sciences gestatten wir uns anbei den Abdruck eines Aufsatzes zu überreichen, welcher zu Ehren von Karl von Linné in der Leopoldina soeben erschien.

A. WANGERIN, *Präsident.*
ROTH, *Bibliothekar.*

Geh. Rat Professor Dr. H. Rosenbusch, University, Heidelberg.
(Honorary Member of the Academy.)

. . . Leider ist es mir bei der Fülle von Arbeit, die vor mir liegt, nicht möglich, Ihrem Wünsche [for a document to be read at the Bicentenary] zu entsprechen, aber Sie dürfen überzeugt sein, dass meine Gedanken und Wünsche am 23 Mai bei Ihnen in New York sein werden. Möge Ihr Fest den schönsten Verlauf nehmen und ein freundlicher Stern über der schönen Brücke walten, die den Namen eines der bedeutsamsten Begründer der Naturwissenschaften tragen soll.

Ihre Nation gibt der ganzen Welt ein nachahmungswürdiges Beispiel, indem sie ein stolzes Werk der modernen Technik nach einem Forscher benennt, dessen ganzes Leben dem höchsten menschlichen Gute, der Wissenschaft, geweiht war.

Regia Societas Scientiarum Bohemica, Prague.

The Royal Bohemian Society of Sciences in Prague, fully appreciating the importance of celebrating the two hundredth anniversary of Carl von Linné's birth by the New York Academy of Sciences, is glad to join the sister institutions in honoring this great naturalist, whose efforts in the first splendid achievements and developments of biology are of perpetual value.

When, in the beginning of modern times, in the multitude of known and newly discovered organic forms, there was a complete chaos to be feared instead of an exact distinction of them, it was the genius of Linné which arranged the masses of raw material into the scientific edifice of a strictly logical system. Linné's epochal "Systema Naturæ" laid the foundation for all future systematics of animals and plants.

Introducing the descriptive method and terminology, establishing a clear definition of each species in its genus, order and class, Linné gained a firm basis for an exact deduction of organic forms. It was Linné who at the same time united the analytical and synthetical tendencies of his predecessors into an efficient discipline.

Linné's method has facilitated the knowledge of the flora and fauna of whole territories, and we have to thank this method that also in Bohemia very early efforts for a systematical analysis of the organic world have been brought to full efficiency.

The Royal Bohemian Society of Sciences, the oldest center of scientific efforts in Austria, has from the very beginning of her existence founded her work on Linné's teaching, and has in progress of time, with the increasing numbers of successful scientists amongst her members, continually contributed to the systematical knowledge of organic life in Bohemia. We need only point out the old classical systematicians of zoölogy and botany,— M. E. Bloch, Von Stein, K. P. Presl, Lad. Čelakovsky, and others who enriched the publications of the Royal Bohemian Society of Sciences in the spirit of Linné.

And the researches of modern times, so important for the study of organic life in the enormous mass of its zoölogical and botanical forms, though they are far advanced in their ideas and methods, still must always gratefully remember the invaluable deserts of the great Linné for the foundation and development of biology.

For the Royal Bohemian Society of Sciences:

K. Vrba, *President.*
Dr. V. E. Mourek, *General Secretary.*
F. Vejdovsky, *Secretary of the Class for Mathematical and Natural Sciences.*

La Société de Physique et d'Histoire Naturelle de Genève, Suisse.

La Société de Physique et d'Histoire naturelle de Genève s'associe de grand cœur à la manifestation que font les Sociétés Américaines pour célébrer le bi-centenaire de Linné.

Genève, plus que toute autre, s'y associe avec joie: ses naturalistes tels que les Vaucher, les de Candolle, les de Saussure ont toujours hautement apprécié l'œuvre du grand Suédois, et leurs descendants ne peuvent que suivre leurs traces et applaudir à tout ce qui pourra perpétuer la mémoire de ce savant.

Notre Société adresse donc des vœux chaleureux pour le succès de la manifestation américaine, qui sera digne de celui qui a laissé une trace si profonde dans les sciences naturelles.

A. Brun, *Président.*

Specula Vaticana, Rome.

The Specula Vaticana heartily joins in your celebration of the two hundredth anniversary of the birth of Carl von Linné.

The astronomers of the Specula recognize a close relation between their own realm and that of the distinguished Swedish naturalist, in that stars and flowers are called the " eyes of the heavens " and the "eyes of the field," which, with the eyes of the child, are numbered among the most precious gifts of the Creator.

We rejoice with you that Linné has unfolded to us the beauties and riches of the eyes of the field, which, no less than those of the heavens, show forth the glory of God.

JOHN G. HAGEN, S.J., *Director.*

Reale Osservatorio di Palermo, Italia.

Poichè in occasione del secondo centanario della nascita di Carlo Linneo, che cotesta Accademia celebrerà il 23 corrente, la S. V. Illma mi ha gentilmente invitato a contribuire un documento ufficiale apprerzante l'opera del Naturalista Svedese, io, non avendo una competenza sufficiente per dire cosa degna di un così eminente Scienrato in una ricorrenza così solenne, mi sono rivolto per aiuto al mio illustre collega Prof. A. Borzì, direttore del R. Giardino Botanico e Coloniale di Palermo, il quale mi ha risposto con la lettera che qui Le hascrivo.

"E'tanto difficile dire qualche cosa di nuovo su Carlo Linneo che io mi trovo imbarazzato a rispondere alla sua domanda. Da quasi due secoli tutte la vita di questo sommo Naturalista è stata indagata in ogni più minuta particolarità, tutte le sue opere studiate con tanta profondità di dottrina, che io non saprei che cosa dire. Certamente di Linneo si può affermare che nessun botanico o naturalista raggiunse a così alta fama come Lui: non v'è persona mediocremente colta che non rammenti il nome di Carlo Linneo, mentre di tanti e tanti altri insigni naturalisti il ricordo non ha vareato così vasti confini. Il più grande merito di Linneo, secondo me, non consiste rolamente nello avere riformato e piantato su basi incrollabili la sistematica vegetale, ma sopra tutto quello di aver tracciato le linee fondamentali della Botanica Scientifica moderna divinandone meravigliosamente i concetti. Basta leggere il piccolo libro intitolato " Philosophia botanica " per convincersene.

"Forse potrà far piarere all' Accademia de New York il comunicarle un documento inedito curiosissimo che interessa la storia del nostro Istituto Botanico a proposito di Carlo Linneo. Quando nel 1792 si fondò l'Orto Botanico di Palermo fu eretta una statua in onore del sommo botanico svedese. Lo scultore fu Vitale Zuccio, che la modellò in istucco il doppio del naturale. Questa statua fu copiata da un ritratto di Linneo, dal Linneo stesso giudicato il più somigliante e dovuto al pittore Roslins. Il Zuccio, scultore palermitano, non ebbe la occasione di vedere questa pittura, ma semplicemente una incisione eseguita dall' artista Bervic nel 1779. Importante però è il fatto che la prima statua eretta in onore di Linneo fu la nostra, mentre il primo ricordo marmoreo (un merzo busto) dell' insigne botanico, che si conosca, e quello che eresse il giardino delle piante di Parigi il 1790. La patria di Linneo ebbe al 1820 la prima statua dell' immortale suo figlio."

Io mi un pregio di mandare a Lei una fotografúa della statua di Linneo di cui ha partato il Prof. Borzì.

F. Angelitti, *Direttore.*

Real Academia de Ciencias Exactas, Físicas y Naturales de Madrid.

La Real Academia de Ciencias exactas, físicas y naturales de Madrid estima como honrosa distinción el convite, que esa ilustre Academia le dirige, para contribuir á la celebracion del segundo centenario del nacimiento de Carlos Linneo.

Gustosísima se asocia á las solemnidades con que se festeje la veneranda memoria del naturalista, que, antes y mejor que otro alguno, supo imprimir órden, método y sistema al estudio y conocimiento de los seres naturales, dotándo á la ciencia de una nomenclatura y de una noción de las especies, base de todas las descripciones y agrupaciones de los seres vivos, posteriormente aceptadas.

España se complace tanto más vivamente en la exaltación de la obra del sapientísimo maestro sueco, cuanto que por intermedio de un discipulo suyo estuvo con él en constante comunicación mientras vivió.

Fenga pues, la Academia de Ciencias de Nueva York por presente en espíritu á la Real Academia de Ciencias exactas, físicas y naturales de Madrid, en todos los actos, con que el 23 de Mayo glorifique á Linneo.

José Echegaray, *El Presidente.*
Francisco de P. Arrillaga, *El Secretario.*

Royal Cornwall Polytechnic Society, Falmouth, England.

To the members of the New York Academy of Sciences and assembled guests, on the occasion of the celebration of the bi-centenary of the birth of Carl Von Linné, the members of the Royal Cornwall Polytechnic Society (England) send greetings.

As the parent of all societies calling themselves by the name Polytechnic, and having from its birth, in 1832, consistently adhered to the purpose of its founders, viz., — the encouragement of science, as well as the fine and industrial arts,— the Royal Cornwall Polytechnic Society offers its congratulations to its fellow-workers in the domain of science in the great city of New York, on the practical and comprehensive character of the commemorative exercises which their enterprise and wisdom have projected for the interesting occasion falling on May 23 next. It trusts nothing will occur to prevent each function from realization in a manner befitting the memory of so great a benefactor to natural science, and fully sustaining the prestige of one of the foremost of the learned societies in America.

While leaving it to societies of wider renown to express the world's indebtedness and gratitude to Carl von Linné, who has been truly styled "the father of modern systematic natural history," and who was the founder of the now universally adopted binominal system of scientific nomenclature, the Royal Cornwall Polytechnic Society cannot, on this historic occasion, refrain from recording its own appreciation of the work accomplished by one who, though a distinguished son of Sweden, belongs, by virtue of his brilliant achievements, to every land and people.

The careful and far-reaching character of the investigations of Carl von Linné probably stand without parallel in the annals of science. Surrounded in early life by conditions which would have deterred most men, genius and a whole-hearted enthusiasm for the pursuit of knowledge in a direction where he was destined subsequently to hold a position which, after the lapse of two hundred years, is still unique, his clear insight, added to his almost incomparable faculty for dealing with vast accumulations of material, enabled him, after years of constant devotion to his self-imposed task, to evolve cosmos out of chaos. The foundation which he laid for the determination of genera and species was the soundest that science had been invited to adopt, and on it succeeding generations have reared a noble structure.

What the New York Academy of Sciences has been able to accomplish, what the Royal Cornwall Polytechnic Society has done for the encouragement of the many branches of natural science, what is being done by kindred societies all the world over, has been made possible through the new era which was ushered in by the publication of the numerous erudite works from the pen of him to whom all nations are now paying homage.

To-day we think of the student whose indomitable courage enabled him to triumph over difficulties of the most trying kind, and to fill his appointed niche in human affairs; of the *man* whose life was so devout that his first sight of an English furze-bush, arrayed in all its golden splendor, was to him fitting occasion for expressing gratitude to God; of the *distinguished scientist* on whom the world's greatest prizes had been freely showered, selecting one of the most unobtrusive of plants to perpetuate his own name. After two hundred years, Carl von Linné enters into full possession of his own well-earned estate, an estate fixed deep and indelibly in the heart and affections of every student of nature.

JOHN D. ENYS, *President.*
E. W. NEWTON, *Secretary.*

The Manchester Literary and Philosophical Society, Manchester, England.

The Manchester Literary and Philosophical Society willingly joins with the New York Academy of Sciences in its commemoration of the two hundredth anniversary of the birth of the illustrious Linnæus.

His profound insight into the affinities and disresemblances of organized beings; his vivid differentiation of natural groups; his pithy, crisp characterization of orders, genera and species; and his binomial principle of nomenclature, — all exercised a profoundly stimulating influence upon the progress of biological science.

Nor must the personal merits of the man pass unrecognized. His acknowledgment of the work of his predecessors, his self-sacrificing labors, the enthusiasm with which he inspired his students, and his remarkable humility — so fittingly commemorated in the *Linnæa borealis* — are qualities which provoke the admiration of naturalists, alike in the hemisphere in which he worked and in the hemisphere in which this commemoration is being held.

HAROLD B. DIXON, *President.*
FRANCIS JONES, FREDERICK WILLIAM GAMBLE, } *Honorary Secretaries.*

Professor James Geikie, University of Edinburgh.

(Honorary Member of the Academy.)

I deem it a high honor to be invited to place a little stone on the ever-increasing cairn raised by lovers of science all the world over in memory of Carl von Linné. The distinguished Swedish naturalist has made a name for himself that can never die. Admirable as an exact observer and careful collator of evidence, and no less admirable as a generalizer, he is an ensample to every sincere student of nature. Before this bright genius appeared, the study of natural science was in a more or less chaotic state. Doubtless much knowledge of living things had been acquired before his time, but hitherto that knowledge had not been systematized. It was reserved for Linné not only greatly to increase the stores of learning, but to indicate how it was possible to group and classify the multitudinous forms of life so as to show that all formed part of one grand harmonious whole. One can hardly exaggerate his influence upon the study of the natural sciences. His was one of those creative, fertile minds from which all who made his acquaintance, either personally or through his writings, were bound to catch inspiration. He must have had a most engaging personality, and was undoubtedly filled with enthusiasm. How otherwise could he have drawn annually to Upsala some fifteen hundred pupils from all parts of Europe? His "Systema Naturæ," "Genera Plantarum," "Critica Botanica," and other famous works, are unquestionably notable landmarks in the history of natural science. Science and their influence we can to some extent estimate; but who can estimate the profound influence he must have exerted on the many thousand pupils who listened to his prelections, and who carried his enthusiasm with them into every civilized country! Honored and admired in his own day, Carl von Linné will ever continue to be recognized as one of the foremost men of all time.

The Royal Society of Canada.

The President and Fellows of the Royal Society of Canada beg to offer their cordial thanks to the New York Academy of Sciences for its kind invitation to participate in the exercises commemorative of the two hundredth anniversary of the birth of Carl von Linné, and express their regret that they are unable to send a delegate to personally represent their Society on this most interesting occasion.

The Royal Society of Canada, which has just closed its Twenty-fifth Annual Meeting, shares with the New York Academy of Sciences and with kindred associations all over the world, in its high appreciation of the eminent services rendered to the natural sciences by the transcendent ability, judgment and foresight so remarkably displayed by the distinguished Swedish naturalist of the eighteenth century. To him is due in no small measure the modern system of scientific nomenclature, and by him were laid the foundations of the classification of animals and plants upon which biologists in all departments have since built their structures of scientific knowledge. It is therefore in the highest degree fitting that the name of so great a man as Linné, the precursor of a long line of eminent philosophers, should be honored in America in the manner that is now proposed, and that the beautiful bridge connecting the Botanical Gardens and the Zoölogical Park in New York should by its name perpetually remind the passer-by of the greatness that may be achieved by intellectual and scientific attainments. In an age that may be considered sordid in many of its occupations and aspirations, such a reminder is of great value, and may lead many to think of the man, and endeavor, in however humble a manner, to tread in his footsteps.

All honor to the name of Carl von Linné! May the torch which he kindled with the flame of natural science, which has illuminated the path of numberless followers during two hundred years, never be extinguished! May we all strive by our diligent work, by our enthusiasm, by our lofty aims and high hopes, to keep it alive and pass it on, ever growing more and more brilliant, to those who shall come after us!

WM. SAUNDERS, *President.*

The Entomological Society of Ontario.

The President and Officers of the Entomological Society of Ontario are pleased to have an opportunity of adding a few words, to the many which will be read at the commemorative exercises which are to be held on the 23d instant, in appreciation of the magnificent work which was done for the whole world of science by Carl von Linné, the founder of systematic natural history. It is, however, with deep regret that we find it impossible to send a delegate to take part personally in this celebration.

By entomologists and botanists especially, the name of Linné must always be held in reverence and respect, for to him is in large measure due the placing of these branches of natural history on a stable and permanent foundation. He was indeed the father of systematic biology; and the members of our Society feel that too much honor can never be bestowed upon the memory of so great a man. It is therefore a cause of much gratification that a lasting monument in the shape of a beautiful bridge crossing the Bronx River has been erected, which will be a constant reminder to all visiting the Botanical Garden and Zoölogical Park of the work which was done by this master mind.

JAMES FLETCHER, *President.*
CHARLES J. S. BETHUNE, *Secretary.*

Sociedad Cientifica "Antonio Alzate," Mexico, D.F.

By request of the Sociedad Cientifica "Antonio Alzate" of the City of Mexico, I have the honor to represent that distinguished Society as its delegate to the New York Academy of Sciences on the occasion of the exercises commemorative of the two hundredth anniversary of the birth of Linnæus.

The Society Antonio Alzate, which represents the scientific thought of the Republic of Mexico, is composed of men of high attainments, many of whom, through the important official publications of the Society and through other media, have made rich contributions to the sciences of botany, zoölogy, chemistry, astronomy and other branches of learning. These enlightened men are in full sympathy with the most advanced men of science in the United States.

The members of this important Society are fully imbued with the Linnæan spirit, and are animated by the same desire to emulate the great example of the master that inspires their New York brethren.

By the instructions of the Society Antonio Alzate I bring the friendly greetings and hearty sympathy of its members to the New York Academy of Sciences as it celebrates this interesting and notable anniversary.

George T. Stevens, *Delegate.*

The Museum of Comparative Zoölogy, Harvard University.

The Museum of Comparative Zoölogy in Harvard University accepts with pleasure the invitation of the Academy to participate in the exercises commemorative of Linnæus, and it has requested Mr. William Brewster, a member of its staff, to represent it upon that occasion.

Linnæus embraced the whole department of natural history in its widest sense. His conspicuous contributions to botany have much obscured the fact that every field of nature was investigated by him with productive results. Throughout the entire range of inorganic and organic nature he passed with steady step, introducing methods of study and systems of terminology which brought order out of confusion.

Recognizing the indebtedness which all natural science owes to Linnæus, our Museum joins in the tributes which at this time the whole world is paying to his name.

Charles W. Eliot, *President.*
Alexander Agassiz, *Secretary.*

The Boston Society of Natural History.

The Boston Society of Natural History, through its official representative, Mr. Joel Asaph Allen, sends its greetings and congratulations to the New York Academy of Sciences, and desires to share in the celebration of the two hundredth anniversary of the birth of Carl von Linné.

Upon the basis of the scientific achievements of the great Swedish naturalist, all subsequent work in botany and zoölogy has been built up. To his labors and to the system introduced by him, we owe the possibility of recording, and thereby mastering, the immense and bewildering flora and fauna of the world. Our debt to him can hardly be overestimated: therefore the Boston Society of Natural History is glad to add its tribute of admiration and gratitude, and begs to thank the Academy for the opportunity of participating in the present noteworthy celebration.

Charles Sedgwick Minot, *President.*

The Connecticut Academy of Arts and Sciences.

The Connecticut Academy of Arts and Sciences gratefully accepts the invitation of the New York Academy of Sciences to participate in the commemorative exercises to be held on the two hundredth anniversary of the birth of Linnæus.

The Academy appreciates the lasting influence which his work in botany and zoölogy has exercised on the development of these sciences throughout the whole world. Through his profound studies he was enabled to bring order out of the chaotic writings of his predecessors, to establish the science of taxonomy on a firm and satisfactory basis, and to prepare the way for a natural and logical classification of plants and animals.

The Academy has the honor to appoint Professor Alexander W. Evans as its authorized representative.

A. E. Verrill, *President.*
George F. Eaton, *Secretary.*

The American Journal of Science.

The editorial staff of the "American Journal of Science" — whose birth in 1818 was contemporaneous with the beginnings of natural science in this country, and which for nearly a century has kept pace with the growth of science, and ever striven to support and stimulate it — desires to express to you its profound appreciation of the debt we all owe to the great Swedish naturalist whose birth in 1707 you commemorate.

If science is classified knowledge, the highest credit belongs to him who brings scientific facts and observations into a rational system: in this work Linnæus stands pre-eminent. To his keen mind it was given not only to bring order among the genera and species of plants and animals, not only to build up a lasting system of nomenclature, but also to develop in these directions, as in the broader relations, a profound basis of classification which has had a lasting influence upon science in all its branches.

EDWARD S. DANA, *Editor-in-chief.*

The Torrey Botanical Club, New York City.

A clearly-stated conspectus of contents and an index so arranged that one may consult the contents with a minimum of labor are two crowning features of any volume. They reveal a systematic as well as a constructive intelligence on the part of the author, and mark the boundaries between chaos and clearness. It is with this feeling that botanists look back to Linnæus, not so much for the originality of his research as for his gift of order, by means of which the unclassified botanical observations of two centuries were reduced to a system. It matters not that this system perished almost in a generation; it served a purpose in its own day, and made progress possible to those who had previously been wandering over a boundless sea with neither stars nor sun to guide them. Linnæus is remembered, not because of his research, but because of his arrangement of existing knowledge in a usable form.

In spite of his blunders (for he was not free from them), in spite of his arbitrary substitutions of his own work for the clearer work of others, in spite of the fact that he emphasized system at the expense of the broader principles of comparison, and withal contributed to the fixing, for five generations, the dogma of constancy of specific characters,— botanists will always regard Linnæus as one of the truly great. He was the "father of botany," not even its elder brother. He was not the author of binomial nomenclature, for that originated before Linnæus was born; he was the first who was able to look at the existing knowledge of plant life with some degree of perspective, and he reduced that knowledge to a system, that botany might later become a science.

LUCIEN M. UNDERWOOD, *Committee.*

New York Entomological Society.

IN MEMORY OF CAROLUS LINNÆUS, 1707–1778.

The name of Linnæus, the illustrious naturalist who first pointed out the real utility of some system by which the great kingdoms of nature could be systematically arranged, is known to the whole civilized world.

Linnæus was not only a naturalist of most accurate observation, but of a philosophical mind, and upon this depended in a great degree the unparalleled influence which he exercised upon the progress of every branch of natural history.

If we consider the difficulties which beset his early scientific career, the limited number of collections of animals and plants at his command, we must admit that the merit which his contemporaries awarded him was very justly earned.

Among the important services which he rendered to science was the creation of a natural system of classification and the introduction of a more precise nomenclature, which in the main is followed to-day.

While quite young he received his first inspiration for natural history in his father's garden, which was planted with many rare shrubs and flowers. Those sparks which were kindled in the early part of his life at last burst into such a flame of intensity, that the marks are indelibly left upon the sciences.

Entomology owes much to the work of this great man.

In his "Systema Naturæ" (tenth edition), he divided the insects into seven orders, as follows: Coleoptera, Hemiptera, Lepidoptera, Neuroptera, Hymenoptera, Diptera and Aptera.

The modern orders Forficulidae and Orthoptera were placed with the Coleoptera; the order Thysanoptera, with the Hemiptera. The order Neuroptera included the modern orders Ephemerida, Plecoptera, Isoptera, Corrodentia, Platyptera, Neuroptera, Mecoptera, Trichoptera and Odonata. The order Aptera contained all the insects without wings or elytra, except the females of Mutillidæ, including also those arthropods which form to-day the classes of Arachnida and Myriapoda. Each order contained a small number of genera which were not arranged into families.

Of the many insects described by him, about three hundred species occur in the United States, most of which were originally described from Europe, and some from South America. Of the different orders represented, Linnæus described seven species of Neuroptera, four species of Odonata, twelve species of Orthoptera, twenty-seven species of Hemiptera, a hundred species of Coleoptera, fifty species of Diptera, twenty-eight species of Hymenoptera and sixty-six species of Lepidoptera.

The New York Entomological Society appreciates this opportunity of paying tribute to the memory of the man through whose wonderful far-sight and scientific attainment we are better able to understand the great system of nature.

C. W. LENG, *President.*
H. G. BARBER, *Secretary.*

INSECTS DESCRIBED BY LINNÆUS WHICH ARE KNOWN TO OCCUR IN NORTH AMERICA.[1]

Hymenoptera.

Rhodites rosæ
Rhyssa persuasoria
Chalcis minuta
Pteromalus puparum
Formica fusca
" rufa
Lasius niger
Odontomachus hæmatodes
Tetramorium cæspitum
Monomorium pharaonis
Sphærophthalma occidentalis
Pompilus tropicus
Chalybion cæruleum
Sphex ichneumonea
Sphex pennsylvanica
Oxybelus uniglumis
Monobia quadridens
Polistes canadensis
" carolinus
" annularis
Vespa crabro
" maculata
" rufa
" vulgaris
Cœlinxyz quadridentata
Bombus carolinus
" hortorum
Apis mellifera

Lepidoptera.

Danais plexippus
Heliconius charitonius
Agraulis vanillæ
Vanessa antiopa
Pyrameis atalanta
Victorina steneles
Anartia jatrophæ
Ageronia feronia
Diadema misippus
Calephelis cænius
Leptalis melite
Catapsilia eubule
" philea
Cosmosoma auge
Utetheisa ornatrix
Phragmatobia fuliginosa
Euplexia lucipara
Dyptergia scabriuscula
Pyriphila pyramidoides
" tragopoginis
Perodroma oculta
Scoliopterix libatrix
Plusia culta
Ophiderus materna
Erebus odora
Euproctis chrysorrhæa

[1] Contributed by the New York Entomological Society.

Papilio ajax
" philenor
" polydamus
" mackaon
" troilus
" turnus
" glaucus
Pamphila comma
Ællopus tantalus
" ixion
Triptogon lugubris
Chœrocampa tersa
Argeus labruscæ
Pachylia ficus
Pholus vitis
Pseudosphinx tetrio
Dilophonota ello
Phlegothontius carolina
Sphinx pinastri
Samia cecropia
Bombyx mori
Hydria undulata
Eustroma papulata
Rheumaptera hastata
" tristata
Philobia notata
Eramis defoliaria
Anagoga pulveraria
Zeuzera pyrina
Sesia culiciformis
" tipuliformis
Diaphamia hyalinata
Pyrausta octomaculata
Pyralis farinalis
Crambus puscuellus
Calleria mellonella
Ophomia sociella
Orneodes hexadactyla
Olethreutes hartmanniana
Carpopapsa pomonella

Coleoptera.

Cicindela carolina
" virginia
Elaphrus riparius
Blethisa multipunctata
Loricera cærulescens
Bembidium ustulatum
" 4-maculatum
Casnonia pennsylvanica
Eretes sticticus
Dytiscus marginalis
Hydrobius fuscipes
Sphæridium scarabæoides
Cercyon melanocephalum
" unipunctatum
Silpha americana
" opaca
Staphylinus erythropterus
Tachyporus chrysomelinus
Conosoma littoreum
Hippodamia 13-punctata
Coccinella trifasciata
" sanguinea
Adalia bipunctata
Harmonia 14–guttata
Chilocorus cacti
Ptinus fur
Ernobius mollis
Sitodrepa panicea
Phanæus carnifex
Aphodius fossor
" erraticus
" fimetarius
" granarius
Trox scaber
Polyphylla occidentalis
Pelidnota punctata
Dynastes tityus
Cotinis nitida
Euphoria inda
Mallodon melanopus
Prionus imbricornis
Hylotrupes bajulus
Achryson surinamum
Tragidion coquus
Leptura sexmaculata
Lagochirus araneiformis
Crioceris asparagi
" 12-punctatus
Adoxus obscurus
" vitis

Hyperaspidius trimaculatus
Silvanus surinamensis
Typhœa fumata
Dermestes lardarius
Attagenus pellio
Anthrenus scrophulariæ
" musæorum
Hister bimaculatus
Carpophilus hemipterus
Epuræa æstiva
Nitidula bipustulata
" rufipes
Omosita colon
Latridius minutus
Tenebriodes mauritanica
Peltis ferruginea
Cyphon padi
Alaus oculatus
Corymbites tesselatus
" cruciatus
Ellychnia corrusca
Photinus pyralis
Buprestis aurulenta
Lamphrohiza splendida
Necrobiaviolacea
Prasocuris Phellandrii
Chrysomela philadelphica
Gastroidea polygoni
Lina lapponica
Gonioctena pallida
Phyllodecta vulgatissima
Trirhabda tomentossa
Crepidodera rufipes
" Helxines
" Modeeri
Bruchus pisorum
" chinensis
Blaps mortisaga
Unis ceramboides
Tenebrio molitor
Nacerdes melanura
Brachyderus incanus
Otiorhynchus ovatus
Elleschus bipunctatus
Cionus scrophulariæ
Cryptorhynchus lapathi
Rhinoncus pericarpius
Brenthus anchorago
Rhynchophorus palmarum
Calandra oryzæ

Hemiptera.

Pachycoris fabricii
Euthyrhynchus floridanus
Mormidea ypsilon
Euschistus ictericus
Nezara vividula
Edessa arabs
Leptoglossus phyllopus
" balteatus
Ligyrocoris sylvestris
Emblethis arenarius
Largus succinctus
Dysdercus andreæ
Leptopterna dolobrata
Lygus pratensis
Capsus ater
Monalocoris filicis
Halticus apterus
Acanthia lectularia
Coriscus ferus
Arilus cristatus
Heza acantharis
Zelus longipes
Reduvius personatus
Salda littoralis
" saltatoria
Corixa striata
Lygus pabulinus

Diptera.

Trichocera regelationis
Xiphura atrata
Chironomus pedellus
" plumosus
Eristalis tenax
Syritta pipiens
Gastrophilus hæmorrhoidalis
" nasalis

Orthocladius barbicornis
Cricotopus tremulus
Tanypus monilis
Culex pipiens
Scatapse notata
Simulius reptans
Hermetia illucens
Sargus cuprarius
Microchrysa polita
Tabanus mexicanus
Anthrax moris
Bombylius major
Scenoppinus fenestralis
Laphira gilva
Erax æstuans
Leucozona lucorum
Lasiophthicus pyrastri
Syrphus ribesii
Sphærophoria scripta
Sericomyia lappona
Doliosyrphus nemorum
Œstrus oris
Œdemagena tarandri
Melanophora roralis
Cynomyia mortuorum
Calliphora vomitaria
Lucilia xæsor
Pyrellia cadaverina
Musca domestica
Stomoxys calcitrans
Hamalomyia canicularis
Anthomyia pluvialis
" radicum
Scatophaga stercoraria
Tetanocera umbrarum
Scaptera nibrans
Themira patris
Piophila casei
Scyphella flava
Hippobosca equina
Ornithomyia avicularia
Melaphagus ovinus

Orthoptera.

Forficula auricularia
Labia minor
Blatta germanica
Stylopyga orientalis
Periplaneta americana
Pycnoscelus surinamensis
Stagmomatis carolina
Achurum brevicornis
Dissosteira carolina
Cyrtophyllus perspicillatus
Conocephalus triops
Gryllus domesticus

Odonata.

Trithemis umbrata
Tramea carolina
Libellula quadrimaculata
Æschna juncea

Corredontia.

Clothilla pulsatoria
Cæcilius pedicularis
Psocus sexpunctatus

Platyptera.

Chauliodes pectinicornis
Corydalus cornutus

Trichoptera.

Limnophilus rhombicus
" griseus
Leptocerus niger

The Staten Island Association of Arts and Sciences.

It has been said by Taine that "every book and every man may be reviewed in five pages, and those five pages in five lines." On this occasion, however, we are not asked to review the life or the books of the man in whose honor we are assembled, but to testify as briefly as may be to our appreciation of his work and what this work has meant to his posterity. Such a task is different from that which the reviewer is ordinarily called upon to perform; and to do it justice in words, within a reviewer's recognized limitations, would be impossible in connection with the name of Linnæus. Fortunately, however, words are not necessary, and indeed are superfluous, where this appreciation is so clearly demonstrated in the fact that we accept the principles which he formulated, and pursue the methods which were his, in all of our scientific activities. By merely recognizing and calling attention to this fact, we show our respect for the man and what he has wrought far better than by even the most earnest and sincere attempt to express our sentiments in words.

Consciously or unconsciously the influence of Linnæus is felt by all modern scientific workers. System, or rather the ability to systematize, is the key to progress in all lines of human endeavor; and science in particular owes its present commanding position to those who have recognized and applied the principles of Linnæus in their work, and who have accepted and applied his rules for the nomenclature of natural objects.

Linnæus was pre-eminently a systematist, and it was this habit of mind, more than anything else, which raised him above his contemporaries in science. Without his masterly ability to co-ordinate and arrange his work in logical sequence and coherent groupings, his great powers of observation would have lacked completeness. This ability was the special characteristic which enabled him to revolutionize the scientific work of his age and to influence so profoundly all that has followed.

To Linnæus may well be applied the words of Bourget: "In life everything is unique, and nothing happens more than once."

ARTHUR HOLLICK, *Delegate.*

New York State Museum.

Linné's contributions to systematic biology are brilliantly exemplified by one of his species of fossil brachiopods, the *Anomites reticularis.* No organism which ever appeared in the long history of the earth has had a career so noteworthy for the stability of its specific characters. It made its début in the Midsilurian era, and thence onward it survived through the long ages of the Devonian and into the Carboniferous, without at any time departing from the specific type.

Anomites reticularis stands as the ideal of conservatism, the very shibboleth of heredity, Nature's ultimate expression of stability in the organic world. Its life was the longest that ever fell to the lot of organic species; its period beheld the rise and fall of many another race; an endless procession of creations saluted it and passed on, as we to-day, after two hundred years, salute the great Swede, and pass on to join the multitude.

JOHN M. CLARKE, *Director.*

The Buffalo Society of Natural Sciences.

The Buffalo Society of Natural Sciences, in expressing its thanks to your honorable Society, and its appreciation of its privilege in being permitted by your courteous invitation to share in your celebration of the two hundredth anniversary of the birth of Carl von Linné, desires to add its tribute of praise to the memory of that great reformer in the work of natural science.

The world must ever be grateful to Linnæus for the wonderful knowledge, born of close and accurate observation, and for the clear vision and admirable judgment which enabled him to index the book of Nature, to substitute order for confusion, and, by the judicious simplicity of the laws laid down by him in his methods of classification, to convert, what before his time had been chaotic, into the orderly ways that characterize the modern systematic study of botany and biology.

To him and to his work we turn as the starting-point for these scientific studies which since his day have been so nobly developed by those who have been his successors.

Though his system may have been superseded by the philosophical conclusion of other famous workers in botanical science during the past two centuries, the revolution which he wrought in that great department of nature study, the lucidity and simplicity of the reforms in method which he first proposed, have crowned him as one of the greatest leaders known to the annals of science, and as such we honor and revere his memory.

We ask you to accept our felicitations on this interesting occasion.

T. GUILFORD SMITH, *President.*
CARLOS E. CUMMINGS, *Secretary.*

The American Philosophical Society.

The American Philosophical Society held at Philadelphia for Promoting Useful Knowledge sends cordial greetings to the New York Academy of Sciences on the occasion of the celebration of the two hundredth anniversary of the birth of Carolus Linnæus.

Out of the mechanical and inorganic systems of ancient and mediæval times this great Swedish naturalist constructed an organized system, which, assisted by the binomial nomenclature, established order and system in the natural sciences. This system has guided clearly the mind of man in the classification of natural objects, and has made the name of its author immortal.

In the year 1770 The American Philosophical Society, in recognition of the valuable services Carolus Linnæus rendered to science, elected him to its membership, and now, a hundred and thirty-seven years later, this Society takes pleasure in uniting with the New York Academy of Sciences in doing honor to his memory.

Signed and sealed on behalf of The American Philosophical Society held at Philadelphia for Promoting Useful Knowledge.

EDGAR F. SMITH, *President.*
J. MINIS HAYS, *Secretary.*

The National Academy of Sciences, Washington, D.C.

I am directed by President IRA REMSEN of the National Academy of Sciences to convey the greetings and congratulations of the National Academy on this occasion of the celebration of the two hundredth anniversary of the birth of Linnæus. I desire to present a brief appreciation of Linnæus from the standpoint of comparative anatomy and classification of the mammalia.

The period of Linnæus was that of his active scientific life, between 1730 and 1795. Linnæus did not introduce the term "Mammalia" until the tenth edition of the "Systema" (1758). In following the suggestions of Ray, Bernard de Jussieu, and, it is also claimed, of Blumenbach, he separated the hairy quadrupeds, the manatees and whales, as a single class, noting among the distinctive characters the position of the mammæ and the hairy covering. His education as a physician qualified him to define the class through the internal anatomical characters,— the heart, the lungs, the sense organs,— as well as through external characters. In arranging the mammals he sought for natural groupings, and endeavored to find the hidden bonds of structural affinity as indicated by comparative anatomy, although he did not recognize that the real basis of affinity is to be found in kinship of evolution from similar ancestral forms.

His scientific independence and genius were indicated especially by his inclusion of man with the apes and monkeys in the order Primates. It was a mark of genius that Linnæus felt the force of the anatomical likeness of man to his lower relatives and that he had the courage to definitely ally him with them from a strictly zoölogical view-point. This is the very starting-point of all modern philosophy, that man is linked by ties of blood kinship to the whole organic world.

That Linnæus's system is based in part on adaptive resemblances or analogies, rather than on structural affinities or homologies, is not surprising, because it is only recently that naturalists have been able to distinguish analogies from homologies.

HENRY FAIRFIELD OSBORN, *Delegate.*

The Smithsonian Institution of Washington, D.C.

The Smithsonian Institution, uniting with the New York Academy of Sciences in its appreciation of Carl von Linné, cordially accepts its invitation to participate in exercises commemorative of the two hundredth anniversary of the birth of the great Swedish naturalist.

The Smithsonian Institution, in response to the invitation to take part in the Academy's celebration of the bicentenary by an appreciative record of the work of von Linné, needs only to recall the great impulse which he gave to natural science by his industry and methods, and the facility for expression of facts by his binomial system of nomenclature. But the philosophic generalization which was recorded in the name of Mammalia may be especially recalled as the greatest morphological triumph of the Linnæan era.

CHAS. D. WALCOTT, *Secretary.*

The Biological Society of Washington, Washington, D.C.

The Biological Society of Washington acknowledges with pleasure the invitation of the New York Academy of Sciences to take part in its celebration of the two hundredth anniversary of the birth of Carl von Linné, and is glad to unite in paying fitting tribute to the memory of the man who is justly regarded as the father of the biological sciences.

It is, in fact, scarcely possible to overestimate the influence his work and personality had in shaping the future of botany and zoölogy; and coming generations of biologists will continue to rejoice, as we now do, that he laid the foundations of their science so deep and so broad.

The vocabulary of superlatives to praise his genius has long since been exhausted; but we who daily and hourly profit by the laws he enunciated may well pause in our work to exult because, two hundred years ago, Sweden gave to the world a light that will continue to shed luster upon her name so long as the biological sciences exist.

LEONHARD STEJNEGER, *President.*
WILFRED H. OSGOOD, *Secretary.*

The Indiana Academy of Sciences, Indianapolis, Ind.

The criterion by which a man's greatness is judged is his work. If this gains recognition from his contemporaries, he is successful; if his name lives to be honored by succeeding generations, his career has been more than successful, he has achieved fame; but, if he leaves behind him some piece of work or the record of some discovery from which his successors reckon time, his is a distinction which comes to few men, and to which none dare aspire. Such is the record of Linnæus. He was a recognized leader among his contemporaries; his co-ordination of the chaos which then existed in the natural sciences gave him fame; and the successful application of the binomial system of nomenclature to animals and plants made his works the point from which the taxonomist measures time. Nor is the homage the expression of the whim of a group of hero-worshipers. To-day the system of Linnæus is discarded by taxonomists, and much of his work is forgotten; but as long as systematic botany and zoölogy have their devotees among men of science, so long will his name be remembered and his fame endure as the one who first brought the binomial system of nomenclature into general use.

GUY WEST WILSON, *for the Academy.*

The Colorado Scientific Society, Denver, Colo.

The Colorado Scientific Society, the oldest and largest scientific association of the Rocky Mountain region, sends greeting to its elder sister in the metropolis of America, and extends congratulations on the successful completion of the memorial in honor of the world's greatest botanist. How great must be the power of the savant whose influence can extend over such great gulfs of space and time as those which separate the sage of Upsala from the naturalists of the Rocky Mountains, the lands of the midnight sun from the dome of the North American Continent, the dawn of the eighteenth from that of the twentieth century!

In common with the rest of the scientific world, we are greatly indebted to him who initiated the modern system of a concise and descriptive nomenclature, to him who found "biology a chaos, and left it a cosmos," and to him who made it possible for finite minds to grasp the thoughts of the Infinite in the world of life.

Colorado is especially indebted to Linnæus from the fact that, owing to the general similarity of our Alpine flora to the plants of the Scandinavian Alps, a large portion of our mountain plants was originally described by the father of botany, and so well classified and described, that the notoriety-seeking, hair-splitting species-makers do not venture to meddle with the work of the master hand.

We are proud of the fact that on the snowy summits of our higher peaks grows in abundance the tiny pink-tipped flower which the innate modesty of the true savant led him to select from all the wealth of the floral world to perpetuate his name in coming generations.

G. L. CANNON, *President.*

PUBLICATIONS

OF THE

NEW YORK ACADEMY OF SCIENCES

[Lyceum of Natural History, 1818–1876]

The publications of the Academy consists of two series, viz.:

(1) The **Annals** (Octavo series), established in 1823, contain the scientific contributions and reports of researches, together with the records of meetings and similar matter.

A volume of the Annals will in general coincide with the calendar year and will be distributed in parts. The price of the current issues is one dollar per part or three dollars per volume. Authors' reprints are issued as soon as the separate papers are printed, the dates appearing above the title of each paper.

(2) The **Memoirs** (quarto series), established in 1895, are issued at irregular intervals. It is intended that each volume shall be devoted to monographs relating to some particular department of Science. Volume 1 is devoted to Astronomical Memoirs, Volume II, to Zoölogical Memoirs, etc. The price is one dollar per part, as issued.

All publications will be sent free to Fellows and Active Members. The Annals will be sent to Honorary and Corresponding Members desiring them.

Publication of the **Transactions** of the Academy was discontinued with the issue of Volume XVI, 1898, and merged in the Annals.

Subscriptions and inquiries concerning current and back numbers of any of the publications of the Academy should be addressed to

The Librarian,
New York Academy of Sciences,
care of
American Museum of Natural History,
New York City.

CONTENTS OF VOL. XVIII, PART I.

VOL. XVIII PART II

ANNALS

OF THE

NEW YORK ACADEMY OF SCIENCES

EDITOR

Edmund Otis Hovey

NEW YORK

PUBLISHED BY THE ACADEMY

1908

NEW YORK ACADEMY OF SCIENCES.

OFFICERS, 1908.

President — CHARLES F. COX, Grand Central Station.
Recording Secretary — E. O. HOVEY, American Museum.
Corresponding Secretary — H. E. CRAMPTON, Barnard College.
Treasurer — EMERSON McMILLIN, 40 Wall Street.
Librarian — RALPH W. TOWER, American Museum.
Editor — EDMUND OTIS HOVEY, American Museum.

SECTION OF GEOLOGY AND MINERALOGY.

Chairman — A. W. GRABAU, Columbia University.
Secretary — C. P. BERKEY, Columbia University.

SECTION OF BIOLOGY.

Chairman — FRANK M. CHAPMAN, American Museum.
Secretary — ROY W. MINER, American Museum.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

Chairman — ADOLF MEYER, Ward's Island.
Secretary — R. S. WOODWORTH, Columbia University.

Sessions of 1908.

The Academy will meet on Monday evenings at 8:15 o'clock from October to May, inclusive, in the American Museum of Natural History, **77th Street and Central Park, West.**

Annals, N. Y. Acad. Sci., Vol. XVIII, Part II, May, 1908.

[Annals N.Y. Acad. Sci., Vol. XVIII, No. 2, Part II, pp. 91–127. January, 1908.]

NEW SPECIES AND GENERA OF THE LEPIDOPTEROUS FAMILY NOCTUIDÆ FOR 1907. PART II.[1]

By John B. Smith, Sc.D.

No branch of zoölogy has profited more by the explorations and collections made during the past decade than entomology. Not only have new species been found in localities collected over for the first time, but, as the result of more thorough investigation of the fauna of older regions, we have learned that mere resemblance to species of other faunal regions does not mean necessarily specific identity. With more abundant material, our conception of the limits of species became more accurate, and definition became possible.

In the Canadian northwest a quite distinct noctuid fauna is becoming gradually known, and in the southwestern portion of our own territory the canyons are yielding not only specific but also generic types heretofore unknown.

For some time past, material has accumulated gradually in my collection which could not be referred satisfactorily to known or described species,— sometimes in single examples only, sometimes in small series,— and this has increased gradually to such an extent as to demand a general clearing-up, although descriptive work of this kind is perhaps the least attractive to the true student.

Viridemas nov. gen.

Head retracted, small; front with an upright, blade-like corneous process, which reaches to the end of the short, rough vestiture, and does not modify the general impression of a flat head. Palpi very short and weak, not extending beyond the edge of the front. Tongue weak, not functional. Eyes large, round, naked, not fringed with lashes. Antennæ of normal length; those of the male with the segments marked and the projecting angles set with short bristle-tufts, those of the female simple. Thorax short, quadrate; collar round, flat; patagia well marked,

[1] Part I of the descriptive papers for 1907 is in the Transactions of the American Entomological Society, Vol. XXXIII, pp. 125–143, where twenty-nine species are described. In the present paper forty-seven species are characterized and four new generic terms are proposed.

The types are in most instances in the author's collection at Rutgers College, New Brunswick: a few of them are at the Museum of the Brooklyn Institute of Arts and Sciences.

a little uplifted; vestiture scaly with an admixture of flattened hair, forming, posteriorly, a large mass, which is scarcely a definite tuft. Legs short, middle and hind pairs sub-equal in length; tibiæ unarmed, not spinulate, in the male clothed with a mass of rough scales and hair. Abdomen stout, well exceeding the secondaries; in the female, stout, sub-equal and sub-cylindrical, obtusely terminated, with a prominent little tuft on the third dorsal segment. Primaries trigonate, rather broad; apex well marked; outer margin arquate, oblique; hind angle rounded; venation normal; accessory cell present, giving rise to 7, 8 + 9 and 10 from its end. Secondaries proportionate, with vein 5 obsolescent.

Viridemas galena nov. sp.

Ground-color ashen gray, powdery. Front with an admixture of brown scales. Collar with an obscure median line and an admixture of bluish-green scales. Patagia with disk clothed with green scales, and with a blackish sub-marginal line. Posterior scale-mass bronze-brown. Abdomen dark gray, the posterior margins narrowly light gray. Primaries with all the usual maculation traceable, but obscured by the powdering of dark scales. Basal space green-powdered, and on this the short, single, black basal line is fairly defined. T.a. line black, single, upright, a little irregular. T.p. line single, black, slender, discontinuous, a little lunulate, well exserted over the cell and almost as much incurved below, followed in the sub-median interspace by a conspicuous greenish-white blotch, which is the most obvious feature in the maculation. There is a broken, black median line, which extends along the inner margin of the reniform, and below it to the margin. S.t. line whitish, diffuse, powdery, discontinuous, partly defined inwardly by black scales, which give the line a jagged appearance. A series of black terminal lunules is followed by a pale line at base of fringes. Claviform a broad, black-ringed loop, extending about one-third across the cell and as broad as long. Orbicular large, round, gray, ringed by black scales, a little darker centered. Reniform large, gray, not defined above or below. Secondaries gray, with a dark, lunate terminal line. Beneath, gray, powdery, with a broad, diffuse exterior line and a lunate discal spot, which tends to become obscure on the primaries.

Expands 1.16–1.32 in. = 29–33 mm.

Habitat: Huachuca Mountains, Arizona, VII, 30; Palmerly, Cochise County, Arizona, VII.

Two males and one female, in fair condition. The males are purchased specimens from my own collection, the female is from the collection of the Brooklyn Institute. A perfect, fresh specimen will show undoubtedly a considerably greater admixture of green, and, on the other hand, in old specimens the green tends to become dull and to mingle with the gray base so as to become inconspicuous except under a lens.

Meleneta nov. gen.

Eyes hairy, without overhanging lashes. Head moderate or rather small, applied very closely to the thorax; front very flat, quadrate, clothed with short, divergent, hairy vestiture. Palpi very short, straight, extending scarcely beyond the frontal margin; second joint with long hair below; third joint as long as second; cylindrical, truncate. Tongue functional, well developed. Antennæ of male thickened, the joints marked by impressed rings, without vestiture of any kind. Thorax quadrate, rather small; collar round, not produced; patagia well defined; vestiture coarse hair, not forming obvious tufts. Legs rather short; tibiæ clothed with dense, long, coarse hair, not armed or spinulated Abdomen with long tufts of fine hair laterally at base, and with small, indefinite dorsal tuftings. Primaries trigonate; costa arched; apex marked; outer margin arquate, decidedly oblique; hind angle obtusely rounded: veins 7 to 10 out of the end of the elongate accessory cell; 7 and 10 from the lower and upper angle respectively; 8 and 9 on a stalk from the middle, between the two. Secondaries with vein 5 as strong as the others, out of the cross-vein not far removed from 4.

This is a genus related to *Raphia*, with similar wing and body structure; differing in the antennæ, character of vestiture, and absence of the characteristic tuftings. Only males are at hand, unfortunately, and the above characterization is drawn from that sex alone.

Meleneta antennata nov. sp.

Deep bluish gray, the markings black or blackish. Head with vertex black; collar black-tipped; edges of patagia and dorsum black-edged. Antennæ deep chrome-yellow. Primaries with the normal marking well defined. Basal line black, geminate, included space gray, and with a gray patch just outside. T.a. line geminate, outer portion most obvious, almost upright, accompanied by a paler gray shade. T.p. line less definitely marked, geminate, the inner portion reduced to scattered black scales, the outer portion more continuous, but diffuse and irregularly defined, with an even outcurve over the cell and almost straight below. Median shade blackish, diffuse, darkening the space between the ordinary spots. S.t. line very irregular, pale, preceded by a black shading, which is best marked on the costa and below vein 2. There is a narrow, black terminal line, and the fringes are concolorous. There is no obvious claviform, but there is a little jog in the t.a. line where it should be, and beyond is a rusty brown patch that extends to the median shade. Orbicular small, round, with a distinct black ring and an equally distinct black central dot. Reniform rather large, oblique, narrow, centrally a little constricted, narrowly black-ringed, gray with a white central line. Secondaries white, with a blackish terminal line which extends from the apex halfway to the inner angle. Beneath, primaries blackish, costal and outer margin with white powderings; secondaries white, costal margin with black powderings, a blackish terminal line from apex halfway to the inner angle.

Expands 1.25–1.40 in. = 31–35 mm.

Habitat: Huachuca Mountains, Arizona, VII, 30; Palmerly, Cochise County, Arizona, VIII.

Two males, in good condition; one of them a purchased specimen, the collector unknown; the other from the collection of the Brooklyn Institute, taken by Mr. Carl Schæffer. The species is quite characteristic, and I am sure that I have seen it in another collection.

Acronycta othello nov. sp.

Ground-color whitish ash-gray with sooty black shades and markings. Head, vertex black except at sides. Collar mostly black or sooty. Disk of thorax and margins of patagia black or sooty. Abdomen smoky gray above, whitish below; basal tuftings black or sooty; edges of segments narrowly white. Primaries with a broad basal space rather evenly washed with thin blackish over a bluish-gray base. T.a. line geminate, black, moderately outcurved and oblique, and with outcurves in the interspaces. T.p. line geminate, black; outer line most distinct, denticulate, with well-marked outward teeth on the veins: as a whole, well curved over cell and deeply drawn in below. There is no obvious s.t. line. The outer part of the median space above median vein is filled with blackish, and below this vein the entire space is sooty black, but not contrasting or intense. The outer part of the wing is gray, the veins blackish-lined, and a sooty black streak from t.p. line to hind angle just below vein 2. The fringes are cut with sooty brown on the interspaces. Orbicular a small black circle which may be obscured by a shading from the t.a. line. Reniform moderate or small, lunate, incomplete, obscured by the median shade. Secondaries in the male white, in the female washed with smoky gray. Beneath, whitish, powdery, the primaries darker (darker in the female than in the male); secondaries with a small, blackish discal spot. Legs smoky, annulate, with white at the joints.

Expands 1.75 in. = 44 mm.

Habitat: San Diego, Cal., Sept. 15.

One male and one female, in good condition; from Mr. Frank A. Merrick. The species is allied to *perdita*, but is obviously distinct by the absence of basal streaks and by the soft gray and black shadings.

Acronycta lepetita nov. sp.

Ground-color pale bluish gray with an olivaceous shading. Palpi black at sides, a black dot at base of antennæ. Primaries with black basal streak extending to the t.a. line; a slight spur inferiorly at about the middle, a longer narrow branch on the upper edge, which reaches the t.a. line. A slender black streak crosses the t.p. line in the sub-median interspace, and extends to the outer margin. The basal line is indicated by an olivaceous costal spot. T.a. line geminate, olivaceous gray, very oblique, so as to reach the inner margin almost at middle. T.p. line geminate, outer line black, included space whiter than ground, somewhat squarely exserted over the cell and only moderately incurved below. S.t. space beyond the t.p. line is more olivaceous shaded, and this is best marked on the costa and over the black streak above anal angle. A series of terminal black points on the veins. Median shade obvious on costa, oblique over the reniform, which it darkens, and then lost. Orbicular oval, oblique, concolorous, narrowly outlined by black scales. It may or may not touch the reniform; but, when it does, the junction forms an obvious, curved black mark. Reniform large, broadly lunate, somewhat irregular, a little dusky, incompletely outlined by blackish scales. Secondaries smoky, paler at base, the fringes whitish. Beneath, whitish, the primaries smoky on disk; both wings with discal marks and more or less obvious extra-median lines.

Expands 1.05–1.10 in. = 26–28 mm.

Habitat: Esper Ranch, Brownsville, Tex.

One male and one female, in good condition; from the collection of the Brooklyn Institute of Arts and Sciences. The species is allied to *vinnula* and *paupercula*, but is smaller than either and much more delicately marked. Comparatively, also, the primaries of the new species are shorter and broader.

Noctua larga nov. sp.

Head and collar bright rusty brown, the head darker in shade. Thorax brown with a more or less marked rusty tinge. Primaries gray-brown with a reddish tinge, varying in the specimens. All the lines single, punctiform. Basal line marked only on costa and in the cell. T.a. line with black venular spots and a scattering of black scales that marks the line across the costal region. T.p. line even, marked by distinct black dots on the veins, in course parallel to the outer margin. S.t. line wanting. A series of black, inter-spatial terminal dots. Claviform vaguely indicated by scattered black scales. Orbicular indicated by a few black scales, or altogether wanting. Reniform marked by a black dot and a variable number of black scales; not complete, or even so outlined as to make out a definite form, in any case. Secondaries pale at base, outwardly dusky, darker throughout in the female. Beneath, primaries smoky, secondaries whitish, both darker in the female.

Expands 1.80–2.10 in. = 45–52 mm.

Habitat: Palmerly, Cochise County, Arizona, August; Huachuca Mountains, Arizona, June 16.

Three males and one female, in good condition; from the Museum of the Brooklyn Institute. The specimens were taken by Mr. Carl Schæffer, who says they were commonly found under shelter, much as our *clandestina* are sometimes found in large numbers. There are other rubbed examples in the Museum collection; but all seem to be very much alike. The large size and simple markings, allied to those of *clandestina*, distinguish the species.

Rhizagrotis acclivis Morr., Ann. Lyc. Nat. Hist., N.Y., XI, 93, **Agrotis**, 1875; **reclivis** Dyar, Jour. N.Y. Ent. Soc., XV, 106, **Rhizagrotis**, 1907.

Mr. Morrison's specimen came from New York and the type is in the Tepper Collection. About the same time, Dr. Harvey described *Agrotis opaca*, from Texas, and in 1890 I recorded my belief that the two gentlemen had named the same species. I had, then and later, examples from Texas, Arizona and Colorado, and, as the type of maculation and structure was unusual for the eastern fauna, I questioned whether the locality of the specimen in the Tepper Collection might not be erroneous. An examination of Dr. Harvey's type in the British Museum confirmed my belief; and in my Catalogue of 1903 (Bull. 44, U.S. Nat. Mus., 79) I cited the two names as referring to the same species, and gave the New York locality with an "(?)." Until 1907 I did not see another eastern example, though I had a number from southwestern localities. In a miscellaneous lot received from Dr. Dyar for determination, there was an example which I named *acclivis*, and to which I appended the note quoted by Dr. Dyar: "The first authentic specimen I have seen from this region. It indicates that the New York locality which I questioned in my Catalogue may have been correct, or it may indicate two very similar species which I have not had material enough to discriminate."

Dr. Dyar did have material to discriminate, and he gives the differences between the eastern and the southwestern forms; but in giving a name he re-describes the eastern form that served Morrison as a type, and therefore creates a synonym merely. I assume that Dr. Dyar is correct in determining that there are two species, though I have not been able to verify that point; but, if this is so, it simply means that Dr. Harvey's name must be restored to the list and that the southwestern specimens now labeled *acclivis* Morr. in collections must be re-labeled *opaca* Harvey.

Euxoa cocklei nov. sp.

Head, thorax and primaries dull brown, varying from chocolate to smoky, and more or less irrorated with black. Collar with a more or less marked black median line. Disk of thorax and patagia with a sparse admixture of yellow scales. Primaries with all the maculation traceable, and usually well written. Basal line geminate, black, included space yellowish. T.a. line geminate, included space yellow, the edgings black; upright to median vein outcurved in the space below and outwardly bent below vein 1. T.p. line geminate, inner portion lunulate, not well marked, outer portion hardly distinct; the included space yellowish, variably marked and not always continuous; in course moderately outcurved over the cell and then parallel with outer margin. S.t. line a little irregular, broken, yellowish, sometimes reduced to scattered yellow scales. A series of dusky terminal lunules, which are rarely distinct. There is a tendency to a darkening below the median vein, between the basal and t.a. line, and in one example there is a distinct black line. Claviform moderate, black-bordered. Orbicular round or oval, moderate in size, with a narrow black edging within which is a ring of whitish scales. Reniform moderate in size, kidney-shaped, edged with black scales, then with an inner (more or less incomplete) border of yellowish; the spot sometimes darker inferiorly. Secondaries smoky yellowish, almost uniform, with an obscure dusky lunule. Beneath, dull smoky; secondaries more yellowish and powdery; all wings with an outer shade band and discal mark, less evident on primaries.

Expands 1.15–1.35 in. = 29–34 mm.

Habitat: Kaslo, B.C., July 27.

Two males and five females; from Dr. James Fletcher, collected by Mr. J. W. Cockle, after whom the species is named. All the examples are in good condition and no two are alike. The two males are smaller than all the females, although the larger of the two is almost as large as the smallest female. So the males are also darker and less distinctly marked, the ornamentation in one case, indeed, being scarcely traceable. In all the females all the markings are at least traceable, and in one case every feature is complete, and, in addition, the s.t. space is a little paler than the rest of the wing. The type of maculation is similar to *insulsa,* but there is no darkening of the cell and the wings are also too powdery. There are no strong positive characters, and in Hampson's Tables it falls between *submolesta* and *procellaris,* neither of them American species.

Euxoa criddlei nov. sp.

Head, thorax and primaries mahogany-brown; the head and thorax darker, without markings; primaries with all the transverse maculation lost, except the s.t. line, which is traceable by a line of pale scales edging the darker, more blackish terminal space. No trace of claviform. Orbicular faintly indicated by a blackish powdering. Reniform faintly outlined by scattered pale scales inferiorly filled with blackish. Secondaries dull yellowish becoming smoky at outer margin, with a dark discal lunule. Beneath, smoky, powdery; primaries darker; all wings with a discal lunule. Abdomen dull smoky.

Expands 1.40–1.50 in. = 35–37 mm.

Habitat: Aweme, Manitoba, Aug. 24, 25, Sept. 4.

One male and two females, in good condition; from Dr. James Fletcher, collected by Mr. Criddle, after whom the species is named. This is a very simply marked form, and in fact, at first sight there appear to be no markings at all, so feebly are they indicated. In wing form the species is like *pastoralis,* with which it will be most naturally associated in the list. In Hampson's Tables the species would fall in next to *stigmatilis* Sm., to which the new species has but a slight resemblance.

Euxoa quinta nov. sp.

Head, thorax and primaries dull ashen gray, the entire surface with uniformly placed brown irrorations, which are quite conspicuous under the glass, and give a soft shading to the insect. Transverse maculation, except s.t. line, brown or blackish, broken, more or less lost. S.t. line pale, rather conspicuously relieved by a smoky preceding shade. Basal line marked by a geminate spot on costa and sometimes by a dot on median vein. T.a. line geminate, outer line best marked, evenly oblique, with small outcurves in the interspaces; always broken. T.p. line geminate, only a little bent over the reniform, parallel to outer margin; outer line a series of venular points; inner tending to become diffuse. A broad, diffuse, obscure median smoky shade. S.t. line irregular, complete or nearly so, emphasized by white scales. A series of small black terminal dots and a narrow line at base of fringes. Orbicular moderate, round or oval, incompletely marked by whitish scales. Reniform moderate, kidney-shaped, outlined by a vague yellowish ring, inferiorly black-filled. Secondaries smoky fuscous, more yellowish at base, with a dark discal lunule and pale fringes. Abdomen pale ashen gray. Beneath, primaries smoky with a powdery pale-gray border, an extra-median line marked on costa, and an obscure discal spot; secondaries pale gray, powdery, with a conspicuous black discal line and an incomplete extra-median band, beyond which the marginal area is blackish.

Expands 1.35–1.42 in. = 34–36 mm.

Habitat: High River, Alberta (Mr. Thomas Baird); Kaslo, B.C., June 1, 30, July 7, 10 (Mr. J. W. Cockle).

Three males and two females, all in good condition; received from Dr. James Fletcher. The examples are all very much alike, a slight difference in the amount of dark filling in the reniform and in the completeness of the transverse lines being all the variation noted. The species belongs with the *bostoniensis* series, but differs from all those previously known to me, in the dark secondaries of both sexes. It recalls *scandens* at first sight, but is much darker than that species throughout.

Euxoa capota nov. sp.

Head dark brown in front, vertex reddish gray, a black line dividing the two. Collar reddish at base, tip velvety black; a white line between the two. Disk of thorax reddish gray. Primaries brown; median space very dark purplish brown, almost black; costal region to t.p. line whitish; the ordinary spots of the brown ground-color. A black basal shade margins the costal pale area inferiorly. T.a. line geminate, black, obsolete on costa, very distinct below it and with an inward curve at the middle of its course. T.p. line geminate, black, the outer line less distinct, almost straight from the costa to end of cell and then with a very small incurve. S.t. line pale, only a little irregular, chiefly defined by the slightly darker terminal area against the s.t. space, which is the lightest part of the wing. Claviform narrowly outlined in black, incomplete, concolorous. Space between the ordinary spots black-filled. Orbicular, U-shaped, open to the costal pale area. Reniform large, incompletely outlined by dark and pale scales, lunate rather than kidney-shaped. Secondaries smoky brown, with a small, darker discal lunule. Beneath, reddish gray, powdery, with a common outer line and a discal lunule on all wings.

Expands 1.15–1.30 in. = 29–32 mm.

Habitat: Palmerly, Cochise County, Arizona, July and August.

Eight examples, mostly in good condition, all very much alike and all females. The reference to *Euxoa* is in the sense in which that genus is used by Hampson. The frontal structure in this species is as in *Chorizagrotis*, but the body is not depressed. As there are no males, the antennal structure of that sex cannot be used as a guide, and the generic reference must be provisional. The species is altogether unlike any other form known to me from our fauna, and the peculiar course of the median lines should serve as a means of recognition.

Ufeus electra nov. sp.

Ground-color dull chocolate-brown. Head and thorax with dark hair intermingled. Primaries so densely set with long black hair as to give the whole a blackish appearance. A black basal streak in the sub-median interspace extends almost to the middle of the wing. Another streak extends, with little interruption, through the cell and beyond it to the outer margin. T.a. line lost. T.p. line outwardly bent from costa, obscure, blackish, with small outward extensions on the veins. A series of black inter-spatial marks at base of fringes, becoming longer toward the apex. Secondaries dull yellowish, smoky, with an overlay of black hair; a distinct discal lunule and a well-marked extra-median shade line. Beneath, reddish gray, powdery, darker at the margins on primaries; secondaries with an obvious extra-median line and a distinct discal lunule.

Expands 1.55–1.65 in. = 39–41 mm.

Habitat: Oregon.

Two female examples, without date or name of sender. Evidently they are electric-light captures, and more or less defective; but their difference from the allied forms is obvious. The species is nearest to *plicatus* in type of maculation, and it is quite probable that in some specimens, traces of the discal spots will occur.

Ufeus hulstii nov. sp.

Ground-color rather light red-brown. Head and thorax without markings. Primaries with fine black hair, the veins a little darker. T.a. line distinct, single, blackish, outwardly oblique, with three distinct outward angulations,— one on the sub-costa, one below the median and the other on vein 1. T.p. line single, black, followed by a slightly paler shade, evenly and moderately outcurved, with short outward spurs on the veins. A series of small black terminal dots. Fringes cut with yellowish. Secondaries silky gray with a reddish tinge. Beneath, very pale pinkish gray, immaculate.

Expands 1.38–1.42 in. = 34–35 mm.

Habitat: Black Hills, Wyo.; Stockton, Utah, July 22.

Two male examples. One of them is from the Hulst Collection, without abdomen, but else in good condition; the other is from Mr. Thomas Spalding and in good shape. This differs from the other described species, all of which are represented in my collection by the distinct and rather even red-brown, and the well-marked median lines. It is perhaps nearest to *satyricus* in type of maculation, but differs obviously in color, in the absence of all trace of ordinary spots, and in the immaculate under side.

Mamestra leomegra nov. sp.

Ground-color blue-gray shaded with smoky, powdered and ornamented with black. Head with a black line across front. Collar with a black line across middle, dividing the smoky lower from the ashen upper portion. Thorax mottled with blue-gray, smoky, white and black, forming no distinct markings. Primaries with all the maculation obvious, but so obscured and mottled that scarcely any of it is clear-cut and distinct; the narrow yellowish s.t. line with the prominent black preceding shades forming the most conspicuous feature of the wing. Basal line geminate, black, broken, the whitish included space broad and most obvious; a pair of curved black marks just below the median vein. T.a. line geminate, blackish, oblique, outcurved in the interspaces; included space broad, pale. T.p. line geminate, lunulate, a little irregular, broadly exserted over the cell and a little incurved below; included space narrower and not so pale as in t.a. line. There is an obscure, diffuse, smoky median shade, which darkens the outer part of the median space. S.t. line forms a small W on veins 3 and 4, where the preceding black shading is less conspicuous than it is above and below. A series of conspicuous black terminal lunules. Claviform small, concolorous, black-margined. Orbicular, of good size, broadly and irregularly ovate, oblique, black-margined, a little lighter than the ground, with a smoky center. Reniform large, lunate, black-edged, outwardly with a margin of white scales within the black, center smoky, inclosing a curved gray streak. Secondaries blackish, the outer margin narrowly gray. Beneath, gray, powdery; both wings with a conspicuous black discal mark and a more or less evident extra-median line. The primaries have a narrow whitish outer border, and in the female this is obvious on the secondaries as well.

Expands 1.90–2.00 in. = 47–50 mm.

Habitat: Grand Lake, N.F., Aug. 28.

Three males and one female, of which only one female is in really good condition. The specimens were caught at light by Mr. Owen Bryant, packed dry in cotton, and sent me through Mr. C. W. Johnson of the Boston Society of Natural History. The species is obviously related to *imbrifera*, but is larger and darker throughout, and distinctly more blue-gray in color. The W of the s.t. line, while small, is distinct. The antennæ of the male have the joints only a little marked, with little tufts of fine bristles and longer single ciliæ. The tuftings appear to be as in *imbrifera*, but less developed.

Mamestra pallicauda nov. sp.

Head and thorax dark brown; abdomen gray, the dorsal tuft at base brown. Primaries red-brown tending to gray, with black powderings and transverse lines. Basal line geminate, black, distinct; included space with pale scales; outcurved in the interspaces, reaching to the sub-median vein. T.a. line geminate, black, inner portion tending to become lost; outcurved in the interspaces, a little outcurved as a whole; below vein 1 the included space is white. T.p. line single, black, irregular, incurved in the interspaces, scarcely clears the reniform; a white lunule follows that part below the sub-median vein. The median space is very narrow; and the median shade, which is blackish, runs close to the inner border of the reniform across cell, and then close to the t.p. line below it. S.t. line irregular, marked partly by blackish shadings and spots, and partly by the darker terminal space. A black terminal line broken by whitish points on the veins, the veins themselves more or less black-marked. Three white points in costa between t.p. and s.t. lines. Orbicular obscure, traceable as an indefinite paler brown blotch. Reniform small, oblique, incompletely outlined, a series of three white dots along the outer edge and a fourth at the lower inner angle. Secondaries smoky, the veins darker, fringes tipped with white. Beneath, smoky gray, powdery, with a smoky extra-median shade and a small dark discal lunule. Tip of abdomen of female obtuse, with a mass of white fluffy hair arranged so as to form a compact mass.

Expands 1.24 in. = 31 mm.

Habitat: Palmerly, Cochise County, Arizona, July; Huachuca Mountains, Arizona, July 12.

Two female examples, one of them, belonging to the Brooklyn Institute, in perfect condition; the other, from my own collection, somewhat rubbed. This is altogether unlike any other species known to me, and eventually must be removed from *Mamestra,* to which I have referred it tentatively in the absence of a male. It belongs to *Hadena* as limited by Hampson, and has only a basal tuft on the dorsum of the abdomen; but it agrees with none of the species that he places in that genus. The cylindrical, squarely truncate abdomen, with its dense tuft of white fluffy hair, is characteristic, and may indicate some unusual character in the male as well.

Miodera nov. gen.

Eyes moderate in size, round, hairy. Front protuberant, roughened, obtuse, without processes or plates. Tongue fully developed. Palpi small, oblique, not reaching to the middle of the front. Antennæ of male lengthily bipectinated, the branches decreasing in length toward the tip, the last few joints merely serrate. Thorax quadrate, heavily clothed with scaly vestiture, forming an obscure anterior and somewhat more obvious posterior tuft; patagia well marked. Vestiture of under side dense, somewhat hairy, loose. Legs short and not especially stout, though the heavy vestiture makes them appear so; anterior tibiæ and tarsi without special armature; the terminal claws, however, unusually long. Abdomen with a loose tuft at base, otherwise dorsum untufted. Primaries short, broad, trigonate, the apices well marked.

Differs from *Mamestra* chiefly in the very stout body, lengthily pectinated antennæ and protuberant roughened front. I cannot identify it with any of the genera of Hampson's monographic work.

Miodera stigmata nov. sp.

Head, thorax and primaries deep dark brown. Head with a scant admixture of gray and black scales. Collar with a blackish transverse line. Thoracic disk with an admixture of gray scales, varying in the examples; patagia with a black sub-margin. Primaries with smoky and blackish shadings variably mixed with gray, and with a sprinkling of yellow scales that gives a richness of color to the wings. Basal line black, geminate, interrupted on the sub-costa. A short black basal dash that just reaches the t.a. line. T.a. line geminate, black, the included space sometimes lightened by yellow scales, in course outwardly oblique, with three moderate outcurves. T.p. line geminate, black, abruptly bent out below costa, then almost parallel with outer margin; the inner line lunulate and usually, at least, traceable across the wing, the outer more even and usually lost below the cell. S.t. line more or less yellow, variably defined by darker preceding or following shadings, with a well-defined W on veins 3 and 4. A lunate black terminal line followed by yellow venular points at the base of the long interlined fringes. Claviform a small but conspicuous black loop. Orbicular round or nearly so, moderate in size, concolorous, ringed with yellow scales. Reniform large, upright, a little constricted at middle and expanded below, inferiorly black-filled, the upper half paler, and edged with yellow scales. Between the spots the cell is darker or even blackish. Secondaries smoky yellowish, with a discal lunule, a somewhat waved extra-median line and a distinct blackish terminal line. Beneath, gray, powdery, with a narrow, distinct extra-median black shade line crossing both wings. All wings with a discal spot and a lunate marginal line. Abdomen like secondaries in color.

Expands 1.04–1.14 in. = 26–28 mm.

Habitat: Witch Creek, Cal., Jan. 12–Feb. 3.

Ten males, in good or fair condition. This is a well-marked and rather pretty species somewhat resembling *Mamestra ectypa*, and it does not appear to vary to any considerable extent.

Tæniocampa macona nov. sp.

Ground-color of head, thorax and primaries, creamy to luteous gray. Head and thorax without maculation. Primaries more or less powdered with black atoms, and veins tend to become pale. Basal line geminate, broken, usually marked by black spots on costa and median vein. T.a. line outwardly oblique, even, of the ground-color or paler, marked on both sides by black scales so as to define the entire line in the best case, but so irregularly in others that it may become entirely lost beyond the costal area. T.p. line concolorous or a little paler, almost parallel with outer margin, preceded by black scales or lunules, so variable that the line may be either completely defined, or almost lost. A black median shade extends obliquely from costa across the reniform, forms an angle at its lower margin, and extends obliquely inward to the middle of the inner margin. This shade is usually distinct, and when it is obscure the median lines are best defined. S.t. line concolorous or a little paler, a little irregular, defined by a preceding black powdering, which may extend across the wing or may be confined to the costal region. A series of black terminal dots in the interspaces. Orbicular concolorous, usually lost, sometimes defined by a slightly paler ring, then large, ovate, joining the reniform inferiorly. Reniform large, oblique, broadly oval, pale-ringed, always darker and usually contrasting, filled with black powdering. Secondaries whitish with a reddish tinge, a small dark discal spot, a punctiform, obscure extra-median line, and a series of dark terminal lunules. Beneath, with a reddish tinge, coarsely black powdered; primaries with blackish orbicular and reniform and a broken exterior line; secondaries with dark discal spot and punctiform extra-median line.

Expands 1.36–1.50 in. = 34–37 mm.

Habitat: Witch Creek, Cal., Jan. 30, Feb. 1–14.

Two males and two females, varying greatly, as indicated in the description. At first sight the species suggests *flaviannula;* but the male antennæ are not pectinated. They are bristle-tufted, and therefore the species belongs with *alia*. Sir George Hampson refers these species to *Monima* Hbn.

Tæniocampa bostura nov. sp.

Head, thorax and primaries dull luteous brown with smoky powderings, which give the insect a sordid appearance. Primaries with all the markings present, but not relieved or distinct. Basal line geminate, blackish, complete, included space of the ground-color. T.a. line geminate, outwardly oblique, with small outcurves in the interspaces, outer portion well marked, included space of the ground-color. T.p. line with a moderate outcurve over cell and an almost even incurve below it, the inner portion obscurely lunulate, the outer punctiform. A very obscure median shade through the outer portion of the median space. S.t. line yellowish, narrow, only a little irregular, preceded by a continuous blackish shade, which darkens the outer half of the s.t. space. A continuous, slightly waved yellow line at the base of the fringes. Orbicular not traceable in the specimen. Reniform large, oblique, a little constricted, blackish-filled, obscurely outlined by yellowish scales. Secondaries dull whitish at base darkening to a smoky outer margin, the fringes more yellowish. Beneath, reddish gray, powdery. All wings with a distinct extra-median line and a small discal spot.

Expands 1.30 in. = 32 mm.

Habitat: Kaslo, B.C.

One male, in good condition; from Dr. James Fletcher. The species is allied to *rufula* and *indra,* but is more sordid and powdery in appearance than either, while the course of the lines is quite different. The thoracic vestiture is thicker and the patagia are much better defined than in the allied forms. It is Dr. Fletcher's No. 168.

Tæniocampa fringata nov. sp.

Rusty red-brown darkening to brown-gray. Lower part of front and palpi crimson. Antennæ bright red with a white dot at base. Collar and thorax tending to become hoary through gray-tipped hair. Primaries tending to an overlay or powdering of bluish-gray scales, and with a vague irrorate appearance, the maculation never conspicuous and sometimes scarcely traceable. Basal line geminate, gray-filled, rarely evident. T. a. line geminate, a little darker than the ground, sometimes with gray filling, a very little oblique, and slightly outcurved in the interspaces. S.t. line brown, geminate, evenly outcurved over the cell and a little incurved below; included space concolorous; followed on each vein by a short blackish line which is interrupted by a pale dot, so that there is the appearance of a double dotted line, which is easily mistaken for the t.p. line. S.t. line pale, obscure, a little irregular, defined by a slightly darker preceding narrow shade line. A vague median shade line is traceable below the reniform, parallel to the t.p. line. Claviform barely traceable in one example. Orbicular dusky, oblique, elliptical, with narrow yellowish outline, obvious in most specimens. Reniform large, upright, a little constricted, dusky, narrowly ringed with yellow, obvious in all specimens. Secondaries smoky fuscous with carmine fringes. Beneath, gray with a crimson tinge, powdery. Both wings with a discal spot and outer line, which are best marked on secondaries, but always at least traceable on primaries. The tarsi tend to become narrowly white-ringed.

Expands 1.24–1.34 in. = 31–33 mm.

Habitat: Monterey County, California, March; Santa Cruz Mountains, California.

Five males and two females, all save one in good condition. This is an ally of *præses* and *saleppa*, and yet more closely of *transparens*. It is referable to the *Perigrapha* of Hampson, and has the ridged crest of the species that stand as *Stretchia* in our Catalogue. Except in the ground-color, there is very little variation among the specimens at hand.

Stretchia erythrolita Grt.

Until recently this species has been represented in my collection by a single male example labeled by Mr. Grote, and agreeing well with his description and type. In 1906 I received two examples from Pasadena, taken in March and April, which indicated quite a range of variation, but which nevertheless were very similar to the typical form. Recently I received from San Diego County a series of upwards of thirty examples, taken in early February, no two of which were alike, the extremes being so far apart that probably I should have considered them distinct, had I received single specimens only of each. In color they vary all the way from uniform mouse-gray to uniform smoky black, with scarcely a trace of maculation. The s.t. line is most frequently present and the tendency is to a pale terminal space, the extreme of this type being a glossy black primary with a contrasting gray terminal space. Then the black breaks up at base and the wing becomes mottled in every possible intermediate form. In the pale examples, the reniform tends to become relieved, especially in the males, and in the extremes this is ringed with yellow, and filled with dark brown. The orbicular is rarely present, but may be as conspicuous as the reniform, though in only one case is it as well defined.

I have no information as to the habits of the insect; but it is quite obvious that it may at times be much more common than the number of specimens in collections indicates.

Himella rectiflava nov. sp.

Of the usual powdery luteous ground-color, the markings obscure, except for the conspicuous yellow s.t. line and the scarcely less defined dusky median shade line. Head and thorax with scattered black powderings only. Primaries, basal line traceable by the pale included shade and the slightly more dense powderings at its borders. T.a. line geminate, smoky, included space not paler, with a very regular and even outcurve from costa to inner margin. T.p. line geminate, tending to become punctiform, the veins blackish beyond the line and so interrupted as to give the appearance of geminate dark points; outwardly bent over cell, with the angle on vein 7, below which the line runs evenly oblique to the inner margin. Median shade distinct, blackish, a little diffuse, outwardly bent from costa to bottom of reniform, then evenly oblique to the inner margin. S.t. line conspicuous, yellowish, preceded by a distinct, even, continuous, narrow brown shade, the following terminal space darker than the rest of wing. A yellowish crenulated terminal line, from the points of which pale lines extend across the fringes. No obvious claviform. Orbicular round, with narrow smoky ring, of ground-color, but not powdery. Reniform upright, oblong with rounded corners, concolorous, defined by a narrow dusky line within which there is a paler ring. Secondaries fuscous, paler at base, fringes more luteous. Beneath, reddish gray, powdery. Both wings with an extra-median line; secondaries also with a discal spot.

Expands 1.10 in. = 27 mm.

Habitat: Huachuca Mountains, Arizona, July 30.

One male specimen, in good condition as to wings, somewhat defective as to antennæ, etc. The specimen was received in paper in a purchased lot, and the collector is unknown. It belongs to *Eriopyga* of the Hampson Catalogue, in the series in which the males have ciliated antennæ and no other conspicuous secondary sexual characters.

Orthodes keela nov. sp.

Head, thorax and primaries red-brown; head with a paler, more yellowish shading. Secondaries and abdomen smoky. Primaries with all the normal markings traceable, but none of them distinct or well written. Basal line geminate, smoky, obscure, included space with a few yellowish scales. T.a. line geminate, smoky, obliquely outcurved, with small outcurves in the interspaces, some pale scales in the included space over the costal region, the line tending to become obscure below the middle. T.p. line geminate, blackish, only a little bent over cell, then almost evenly parallel with outer margin; inner portion more or less lunulate; outer, punctiform below costal region. An outwardly curved smoky median shade. S.t. line marked by scattered yellow scales and by a continuous, narrow, blackish preceding shade, only a little irregular in course. A broken, yellowish terminal line. Orbicular small, obscurely outlined by yellowish scattered scales. Reniform small, narrow, oblique, a little constricted, outlined and partly filled by yellow scales, with a blackish superior dot and a dark inferior filling. Secondaries uniformly smoky with a bronze luster, the fringes more yellowish. Beneath, primaries with disk smoky, lustrous, the margins yellowish with reddish powderings; secondaries yellowish with reddish powderings, with a smoky broken outer band and a smoky discal lunule.

Expands 1.07–1.15 in. = 27–29 mm.

Habitat: Palmerly, Cochise County, Arizona, August.

One male and one female, in good condition; from the collection of the Brooklyn Institute of Arts and Sciences. The male is the smaller of the two, more deeply colored and less distinctly marked. The species is an ally of *vecors*, and ranges next to it in Hampson's Catalogue, under *Eriopyga*. It is narrower winged, however, much more uniformly tinted, with more even median lines and a different s.t. line. In wing-form it is nearer to *imora* Strck., which is darker lustrous, and has the maculation reduced to a small gray reniform.

Faronta nov. gen.

Eyes hairy, large, round, globose, not overhung by long cilia. Tongue fully developed. Front roughened, slightly protuberant, without processes or excisions. Palpi straight; terminal joint very short, poorly developed, not projecting much beyond front; the second joint with short vestiture. Antennæ in male, ciliated; in female, simple. Thorax convex, rounded; vestiture hairy, forming no tufts, rather smoothly laid. Legs moderate in length, strong, without spines or other unusual armature on tibiæ or tarsi; tibiæ in the male more thickly clothed with hair, but forming no obvious tufts. Abdomen smoothly clothed, without tufts or fringes of any kind, stout, extending well beyond the hind angle of secondaries. Primaries elongate, narrow, sub-lanceolate, the apex not acutely drawn out, margin gently rounded, venation normal. Secondaries proportionate.

Differs from *Leucania* in the stout convex thorax and long stout abdomen, as well as the narrow elongate wings. From *Neleucania* it differs in the more robust build throughout, in the more closely appressed vestiture and the rounded margin and apex of primaries. From *Meliana* it differs in the stouter form, less pointed wings, and comparatively simple antennæ of the male. The roughened front may not be peculiar, in the absence of plates or processes.

Faronta aleada nov. sp.

Head, thorax and abdomen uniform creamy white or grayish tending to yellowish, the head usually most intense in color. Primaries with the disk a faint leaden gray, costa and internal margin creamy white, median vein pale, and dividing into pale rays on veins 3 and 4. In the apical region the veins are a little dark marked. No lines or dark spots on the wing. Secondaries white in both sexes. Beneath, white; primaries with a tinge of yellow, which is better marked at the margins.

Expands 1.30–1.42 in. = 32–35 mm.

Habitat: Brazos, Tex.

One male and three females, all in good condition; from the collection of the Brooklyn Institute of Arts and Sciences. The species is entirely unlike any other of our leucaniids, and agrees with nothing described by Hampson from the adjoining faunal region. The tendency is for the leaden gray disk to become rubbed so as to give a uniform creamy appearance.

Anarta Ochs.

The species of this genus are not well represented usually in American collections, and my own material has been for two years or more eked out by a collection loaned me by Mr. Philip Laurent of Philadelphia. This was mostly purchased from Staudinger, and contained a fair series of the circum-polar species, including those listed as common to the American and European faunas.

Sir George Hampson's revision of the species drops out several of our listed names, and adds others, so that I found it desirable to rearrange my material, and did so with very interesting results.

Three series are recognized: —

I. Antennæ of male strongly serrate and fasciculate; fore wings very narrow.

II. Antennæ of male minutely serrate and fasciculate.

III. Antennæ of male ciliated.

The first of these series contains only a single species, and is not represented in our fauna.

The series in which the male antennæ are minutely serrate and fasciculate, or bristle-tufted, is divided as follows: —

Hind wings white.
  Primaries with s.t. line angled inward in discal fold . . *staudingeri*
  Primaries with s.t. line not so angled.
  Primaries with prominent series of dentate black marks before s.t. line . . . . *richardsoni*
  Primaries without such marks before s. t. line . . *quadrilunata*
Hind wings yellowish . . . . *leucocycla*
Hind wings uniformly suffused with fuscous.
  Primaries with the stigmata not filled with blue-gray . *etacta*
  Primaries with the stigmata filled with blue-gray . . *membrosa*

Staudingeri has not appeared heretofore in our Catalogue; but I found, on comparing the figure and descriptions carefully, that I had two males, one from Labrador and one from "British Columbia," which were apparently the same, and which agreed with the characters given for the species.

Of *quadrilunata* I have a pair from Colorado, which are properly determined. An example from Laggan may indicate a new form.

Of *richardsonii* I supposed I had a long series; but I found, to my surprise, that only one nice pair from Labrador answered all the requirements of Hampson's definition. My Greenland examples received through Staudinger did not answer at all. The White Mountain examples, which stand under *richardsoni* in our collections, had the s.t. line of *staudingeri;* and the long suite of specimens from Newfoundland represented yet another form. They are distinctly yellow-winged, but will not do for *leucocycla* at all. The species marked *schœnherri* in my collection, and to which name *leucocycla* has been cited heretofore as a synonym, was neither one nor the other.

Using the same characters used by Hampson, in a somewhat different form, I differentiate the species now before me as follows: —

S.t. line of primaries angulate and dentate.
  Secondaries white or nearly so.
    Ordinary spots of primaries white-marked, median line white-shaded . . . . *staudingeri*
    No white on primaries, all the pale markings bluish gray . . . . *hampa*
  Secondaries decidedly yellow.
    Ground-color blue-gray, terminal space contrastingly blue-gray . . . . *flanda*
S.t. line of primaries even, or scarcely irregular.
  Secondaries white, primaries contrastingly black and white marked.

T.a. line oblique, outcurved in the interspaces . . . *richardsoni*
T.a. line angulated on the median vein, then rigidly oblique to inner margin . . . . *lanuginosa*

Secondaries pale yellowish, primaries smoky brown, not contrasting.
S.t. line distinct, with preceding dusky shades or spots *squara*
S.t. line partly obliterate, preceding shades on costa only . . . . *quadrilunata*

Etacta and *membrosa* are left out of consideration here.

Hampa and *flanda* are allies of *staudingeri*, but are larger and darker. *Flanda* has decidedly yellow secondaries, and that is its chief superficial difference from *hampa*. I might have deemed it racial or varietal, were it not accompanied by a decided difference in the eyes; those of *flanda* being distinctly larger, and decidedly more rounded.

Squara is based on Greenland examples of *schœnherri*, from which it differs by the distinctly yellowish secondaries and the totally different type of transverse lines. I am, of course, assuming that all the names cited by Hampson to *richardsoni* are really identical with the form to which he has applied that name.

The third series, in which the male antennæ are ciliated only, is separated by Hampson as follows:—

Hind wings bright yellow.
Fore wings with the ground-color deep red . . . . *myrtilli*
Fore wings with the ground-color blackish.
Fore wings with the reniform white-filled . . . . *cordigera*
Fore wings with reniform not white-filled . . . . *mimuli*
Hind wings yellowish, tinged with brown . . . . . *impingens*
Hind wings uniform brown . . . . *phæa*
Hind wings white, more or less suffused above with fuscous.
Fore wings broad, triangular.
Reniform without whitish annuli . . . . *melanopa*
Reniform with whitish annuli . . . . *mimula*
Fore wings narrow, elongate.
Fore wings pale olive-gray . . . . *mausi*
Fore wings fuscous . . . . *zemblica*

Myrtilli Linn. is in our collections as *acadiensis* Beth., and is listed from Canada northward. It occurs also in the mountains of Colorado, and I have never been sure that there was only a single species represented. I have compared the Colorado examples recently with German specimens, and am by no means certain that the two are identical. The resemblance is very close, however, and my material is not sufficient to induce me to dispute the union.

Cordigera Thumb. is a very sharply-marked species, and I have in my collection examples from Colorado, Labrador and Germany, which are practically alike.

Mimuli Behr. is a Californian species unknown to Hampson, and not represented in my collection. The type has been destroyed in the San Francisco fire.

Impingens Wlk. — with *curta* Morr., *nivaria* Grt. and *perpura* Morr. as synonyms — is a purely American species, which differs quite markedly from the preceding species in general habitus, and comes nearer to *Scotogramma* in wing-form. I have it from Colorado only; but it is also recorded from British Columbia.

Phæa Hampson is a new species to our fauna, and quite a close ally, in appearance, to the preceding. It comes from Victoria Land, Cambridge Bay, and is not represented in my collection.

Melanopa Thunb., re-described by Packard as *nigrolunata*, is another sharply-defined form which is very widely distributed. It occurs in the United States from Mount Washington northward, and extends along the Rocky Mountain chains into New Mexico. My examples are from Colorado and Labrador, without very much difference between them.

Mimula Grt. is from New Mexico, and the type is in the Snow Collection. Professor Snow was good enough to send it to me for examination nearly fifteen years ago, and since that time I have not seen another example, so far as I know.

Laerta Smith was not known to Hampson when he wrote, and differs from *melanopa* in the more sordid fuscous color throughout and by the much reduced whitish area of secondaries. From *mimula* it differs in the ordinary spots, the reniform not being ringed with pale scales. This really resembles *A. kelloggi* Hy. Edw. very much; but Hampson places that species in *Sympistes* with naked, reniform eyes, while in *laerta* they are distinctly hairy.

Mausi Hampson is from E. Turkestan, and the only species in the series that is not American or circum-polar.

Zemblica Hampson is from Nova Zembla, and is a narrow-winged ally of *mausi*. While not really American, it is not unlikely that the species will be found in Alaska, and so should be looked for.

The other species referred to this genus I have commented upon in the N.Y. Ent. Soc. Jour., 1907, Vol. XV, p. 151, and have there stated the disposition made of them.

I still have in my collection a few examples that do not fit into any of the described species; but they are not sufficiently well marked, nor in sufficient number, to warrant me in describing them at present.

Anarta hampa nov. sp.

Ground-color dull smoky fuscous with black and gray maculation. Patagia with sub-marginal black line and gray disk, dorsum posteriorly mottled with gray. Basal line black, outwardly shaded with gray, with two moderate angulations. T.a. line black preceded by a gray shading, a little oblique outwardly, irregularly outcurved. T.p. line denticulate, black followed by a narrow gray shading, moderately outcurved and only a little incurved in its course. S.t. line gray or yellowish, marked by the evenly dark s.t. space, drawn in on veins 2 and 5, outcurved between and on each side. A series of black terminal lunules. The fringes dusky, cut with yellowish. A vague median shade in the paler examples. Claviform small, but distinctly outlined. Orbicular small, round or oval, more or less gray-marked. Reniform small, narrow, upright, with narrow pale ring, a little constricted centrally. Secondaries very pale straw-color, almost white, smoky at base and along inner margin, with a distinct discal mark, a narrow, almost crenulated outer line, and a broad blackish outer margin; fringes white. Beneath, whitish, more or less shaded with blackish, with a black discal spot, an extra-median blackish line, and a blackish outer margin on all wings. Primaries with fringes checkered, black and white; secondaries with fringes white.

Expands 1.10–1.20 in. = 28–30 mm.

Habitat: White Mountains, New Hampshire.

Two males and one female, all in good condition. One of the males came originally from Mrs. Slosson; the others have no indication of their source, and none have a date label. Mossy yellow scales are in the median space in cell and sub-median interspace, and along the line of the s.t. line, beyond it.

Anarta flanda nov. sp.

Head and thorax gray to blackish, mixed with black scales; collar gray-tipped; patagia with black sub-marginal line, disk posteriorly black-spotted. Abdomen smoky, with a yellowish tinge in the male. Primaries gray marked with black, and sometimes so much black-powdered that only the lines and terminal space are of the gray base. Basal line geminate, black, included space gray, with two distinct outward angulations in its short course. T.a. line geminate, black, included space gray, outwardly oblique and very irregular. T.p. line lunulate, black, denticulate on the veins, the accompanying gray shade narrow, moderately outcurved over the cell, and then almost parallel with outer margin. S.t. line irregularly and variably dentate, sharply defined by the contrast between the black or blackish s.t. space and the gray terminal area. A series of small black terminal lunules between which the long dark fringes are cut with yellowish. In lighter examples a distinct median shade line extends from costa outwardly between the ordinary spots, and then, from an obtuse angle, inwardly oblique to the inner margin. Orbicular round or oval, small or moderate in size, usually gray. Reniform, moderate, upright, centrally constricted, usually obscure, rarely paler in part. In the median space there is usually a more or less obvious powdering of mossy yellow scales at the outer portion of the cell and in the sub-median interspace. Secondaries dull yellow, smoky at base and along inner margin, in the female with a dark discal lunule, a narrow blackish extra-median line and a broad blackish outer border; fringes yellow; beneath, yellow. Primaries paler, outer border blackish with a black discal spot. Secondaries with a black discal spot, an incomplete extra-median line and a narrow blackish border.

Expands 1.00–1.16 in. = 25–29 mm.

Habitat: Newfoundland (Mr. Owen Bryant).

Over fifty examples, taken at light, and sent unpinned in layers of cotton. There are few antennæ, and legs are at a premium; but many of the specimens are otherwise in good condition, and the series is excellent to determine the constancy of the type. They range from almost ash-gray with black transverse lines to almost black with gray lines, the terminal space being always contrasting, and relieving the irregular s.t. line. The secondaries tend to become suffused, and examples of both sexes are almost uniformly washed with black. The mossy yellowish shading is a decidedly variable quantity.

Anarta squara nov. sp.

Head, thorax and abdomen blackish, the vestiture of head and thorax more yellowish, somewhat intermixed with white. Primaries dull smoky brown, more or less gray, and black-powdered. Basal line distinct, single, black, rather diffuse. T.a. line black, single, diffuse, almost upright to vein 1, and then outwardly bent to inner margin. The space between basal and t.a. line may be gray-powdered. T.p. line more or less lunulate, evenly outcurved over cell and scarcely drawn in below it, accompanied outwardly by paler lunules and a more or less traceable defining-line. S.t. line even, pale, preceded by blackish or dark spots or shadings. A series of black or dark terminal lunules. The dark fringes narrowly pale cut. Orbicular large, irregular, oblique, incomplete, concolorous, or paler. Reniform large, upright, centrally constricted, incomplete, more or less marked with pale. Secondaries dull yellowish, smoky along inner margin, with a broad blackish outer marginal band and a blackish discal lunule. Beneath, all wings whitish to a broad black marginal band, and all with a distinct black discal spot.

Expands 1.30–1.38 in. = 32–34 mm.

Habitat: Greenland.

Two males and one female. The female is more uniform in color, and has no white shadings. One male is much like this, but the median space is darker, the lines are better marked, and the paler shadings are more obvious. The other male has the basal and terminal spaces and the ordinary spots mottled with gray in which mossy yellow scales are intermixed. A somewhat defective female from Colorado may be referable here.

Luperina innota nov. sp.

Ground-color a reddish rusty luteous. Head and thorax concolorous, somewhat deeper in reddish than primaries. Primaries with median space more reddish and darker than basal and extra-median areas. Basal line barely indicated on costa. T.a. line single, brown, barely relieved, outcurved in the sub-median interspace. T.p. line single, brown, barely relieved, with little outward points on the veins, evenly outcurved over the cell and almost evenly oblique below it. S.t. line marked near costa by a brown shade in the s.t. space, thence lost, or barely marked by a slightly darker preceding shade. Claviform long, narrow, extending nearly to t.p. line, but so slightly relieved in outline as to be readily overlooked. Orbicular round, moderate in size, a little paler, else not defined. Reniform moderate, broadly lunate, a little paler than its surroundings. Secondaries pale, transparent yellowish with a smoky tinge. Beneath, yellowish; secondaries paler, primaries tinged with smoky in the male.

Expands 1.36–1.45 in. = 34–36 mm.

Habitat: Yellowstone Park, Wyoming, July 8; Arangie, Idaho.

One male and one female in good condition, and two poor males, which are probably the same; from Colorado localities. The type of maculation is not unlike that of *passer;* but the faded, rusty, washed-out appearance is more like the orthosiids of the *citima* type. A male example is in the British Museum, and I owe acknowledgments to Sir George F. Hampson for comparing it with the Museum material.

Hadena (Luperina) birnata nov. sp.

Head and thorax dark purplish brown, vertex of head and tip of collar with yellowish hair admixed. Primaries light brown; the upper half to t.p. line, a quadrate patch in s.t. space on costa, and terminal space (save apex), dark brown with a blackish shade or powdering. Basal line obscurely marked as a pale spot on costa. T.a. line vaguely traceable by a paler shade across the dark portion of wing, altogether lost below that. T.p. line obvious throughout its course, but hardly well defined: on the costa it is obviously geminate, and makes a rather abrupt even bend over the cell, well defined by the difference between the dark median and pale s.t. space; below vein 2 the difference between the spaces is slight, and the line is defined by a narrow line of darker brown scales. S.t. line marked chiefly by the contrast between s.t. and terminal spaces, the darker shades extending inward opposite the cell and in the sub-median interspaces. A series of small black terminal lunules. Fringes cut with yellowish. Claviform absent, or barely marked by a few black scales. Orbicular obscure, vaguely black-edged, irregular, of moderate size. Reniform moderate in size, broadly lunate, discolored, lighter than the rest of the wing, not completely outlined nor well defined, inferiorly, and at the branching at the end of the median, marked with black scales. Secondaries even dull yellowish or smoky. Beneath, yellowish gray, powdery; disk of primaries darker; secondaries, costal area and a discal spot darker.

Expands 1.12–1.32 in. = 28–33 mm.

Habitat: Newfoundland.

Three male examples, one of them almost perfect, a second fair, and a third more or less oily, yet with maculation in good condition. This is a close ally of *L. passer* Gn., and I thought, at first, a small, local race; but in the long series of *passer* in my collection, covering from the Atlantic to the Pacific, and the Rocky Mountain region into the mountains of Canada and Manitoba, there are certain features that occur always, in spite of differences in size, and variations in color and markings. In the almost total absence of claviform, in the form, marking and outline of reniform, and in the course of the s.t. line, the new species differs most markedly from *passer*, as well as in the smaller size. A defective example from St. John, N.B., will probably prove referable here.

It might be added that I have an example of true *passer* from Grand Lake, N.F., as small as *birnata,* but quite characteristic in other respects.

Xylophasia illustra nov. sp.

Ground-color sooty black, dull. Head and thorax concolorous. Primaries with all except the s.t. line lost. The latter is marked by white scales, but is broken and fragmentary: so far as it shows, it is irregular, indicating a small W-mark, and partly preceded by velvety black scales forming an irregular, vague preceding shade. A yellowish line at the base of the fringes, emphasized by larger dots at the ends of the veins. The reniform is vaguely indicated by paler scales. Abdomen dusty gray, the dorsal tuftings well marked. Secondaries yellowish gray with a darker line at the base of the paler fringes. Beneath, smoky gray; primaries darker with terminal space paler; secondaries paler, more powdery, with a moderate discal spot.

Expands 1.52 in. = 28 mm.

Habitat: High River, Alberta.

A single good male, taken by Mr. Thomas Baird and sent me by Dr. Fletcher. The species resembles *sputatrix* and *plutonia* in the dark color; but this color is dull, not glossy, and the secondaries have no trace of yellow or brown.

Xylophasia miniota nov. sp.

Ground-color dull, smoky fuscous without strong contrasts of any kind. Front of head and collar, inferiorly, more yellowish; front with a black transverse line; collar with a black line dividing the lower pale from the upper darker portion; disk of thorax mottled with black scales. Primaries dull with black powdering, all the maculation present, but not contrasting. A short black streak at base, reaching to the basal line, which is geminate, blackish, included space a little paler. T.a. line geminate, blackish, included space concolorous, outwardly oblique, with a little irregular outcurve. T.p. line geminate, the inner portion black, more or less lunulate and irregular, the outer obscure, brown, even, partly lost: as a whole, somewhat irregularly outcurved over cell and decidedly incurved below it. S.t. line narrow whitish, irregular, with a distinct W, preceded by sagittate black marks and shades which tend to become lost, and sometimes outwardly emphasized by black scales. A series of black terminal lunules, beyond which the fringes are cut with yellow. Claviform short, broad, outlined by blackish scales, concolorous. Orbicular of good size, irregularly oval, oblique, incompletely outlined, not so powdery, and sometimes a little paler. Reniform large, broad kidney-shaped, outlined in black, outwardly relieved by a pale blotch which has somewhat the appearance of a small reniform stuck in the upper outer corner of a very large one. Secondaries pale dirty yellowish, outwardly smoky, with a more or less obvious outer line and discal spot, darker in the female. Beneath, smoky, powdery; secondaries paler; all wings with a more or less well-marked extra-median line and a small dusky discal spot.

Expands 1.36–1.62 in. = 34–41 mm.

Habitat: Manitoba; Miniota, May 5, 11, 22; Cartwright, May 24.

Three males and six females, mostly in fair condition, are under examination, two of them belonging to Mr. Heath, the others received through H. H. Brehme. The species is in some respects intermediate between *versuta* and *runata,* and is characterized principally by having no very strong characters. There is quite a variation in the distinctness of the sagittate marks preceding the s.t. line, one example from Cartwright having the entire series fully defined, while in other examples they are almost entirely absent.

Hadena ferida nov. sp.

Ground-color dull rusty brown with black powderings. Head with a dusky frontal line. Collar with two narrow blackish lines. Thoracic disk and patagia more or less marked with dark brown or black scales. Primaries with all the normal maculation present, but not constrasting, and more or less obscured by black powderings. Basal line geminate, black, broken, angulated. T.a. line geminate, black, the inner part less marked, outwardly oblique, somewhat curved, with an obtuse angle just below the middle. T.p. line geminate, inner portion somewhat lunulate, outer more even and less distinct, followed by a series of pale venular points; outwardly bent over cell, then oblique, nearly parallel to the outer margin, except for an incurve in the sub-median interspace. S.t. line yellowish, broken, almost punctiform in some examples, a distinct though broken W on veins 3 and 4. A series of black terminal lunules, between which the fringes are cut with yellow. There is a somewhat obscure, diffuse median shade, which is more obvious on the costa and again below the claviform, where the entire median space is somewhat darkened. Claviform pointed, large, extending across the median space, the lower margin forming an obvious black bar, the upper margin less conspicuous and sometimes incomplete. Orbicular very large, oblique, irregularly ovate, incompletely outlined by black scales, a little paler than ground, with a dusky central dot, spot or line. Reniform large, irregular, the upper and lower margins extending beyond the cell, and not defined, more or less marked with yellowish scales, and tending to central lines. Secondaries smoky, paler at base, with a dark terminal line at the base of the yellowish fringes. Beneath, gray to smoky, powdery, with a more or less marked extra-median line and discal spot on all wings.

Expands 1.32–1.52 in. = 33–38 mm.

Habitat: Newfoundland.

Four female examples, in good to fair condition except for legs and antennæ. The thoracic crests are well marked, the anterior divided centrally; abdominal tufts distinct, those on 3d and 4th segments even conspicuous. The species has no very close allies in our lists, but is perhaps nearest to *miniota*, with which, nevertheless, it can hardly be closely compared.

Hadena susquesa nov. sp.

Head a dull rusty luteous. Collar luteous gray inferiorly, leaden or ash-gray at tip. Thorax with gray and black mottlings and lines over a rusty luteous base; the disk of patagia luteous. Primaries rather bright reddish luteous, with rusty brown markings and ash-gray shadings. Median lines obscure. T.a. line traceable chiefly by the difference in shade between the luteous basal space and more gray-shaded median space, also by dusky venular marks which are not connected. T.p. line indicated on costa, lost over the cell, but traceable again below vein 4, and there parallel with outer margin. There is no obvious s.t. line. A series of inter-spatial blackish terminal lunules tend to unite into a shaded line below vein 4. A narrow yellow line at base of fringes, which are narrowly cut with yellow beyond the veins. There is a rusty brown streak at base below the median vein. Claviform large, concolorous, outlined in rusty brown, extending almost across the median space: beyond it the interspace is yellowish to the outer margin. Orbicular round or nearly so, brown-ringed, then with a yellow annulus, gray-centered. Reniform large, upright, a little constricted, gray-filled, rather obscurely outlined in brown and yellow, a conspicuous yellowish shade beyond it toward apex. The veins tend to become blackish marked; and, beyond the t.p. line, veins 3 and 4 are whitish-bordered to the outer margin, giving them a white-rayed appearance. Secondaries dull smoky brown with a darker discal spot and a blackish line at base of the white-tipped fringes. Beneath, yellow-gray, more or less mottled and powdery, with variably distinct outer line and discal spot.

Expands 1.20 in. = 30 mm.

Habitat: Claremont, Cal. (Carl Baker); San Diego, Cal. (Frank Merrick).

Two male examples, in good condition, neither with date of capture. The example from Mr. Baker has been in my collection a long time awaiting a mate; the example from Mr. Merrick is just received, and, while it is not exactly a mate, it is at least a duplicate that shows the species to be a good one, and not discolored, as I had suspected. The peculiar reddish luteous ground, the gray shading, and the tendency to a strigate type of maculation, give the species a superficial resemblance to *Morrisonia*, and more especially to *mucens;* but it is really allied to *Hadena fumosa*, and has the excision below the apex of the secondaries well marked.

Orthosia dusca nov. sp.

Has the general appearance of *euroa*, but is smaller, darker, with more diffuse maculation and with shorter, broader primaries. I have a series of ten eastern *curoa* ranging in locality from New York to Kittery Point, Me., and a series of over forty specimens from various points in Manitoba and British Columbia, and the latter are uniformly different in the points just mentioned. In the females the difference is much more marked, as a rule, than in the males; for in the female *curoa* the primaries are usually distinctly rectangular or even a little pointed at tip, the median shade is distinct and well defined, and all the maculation is neatly written: in *dusca*, on the other hand, the primaries are quite as stumpy in the female as in the male, the median shade is diffuse, often indistinct, and usually all the markings are obscure and mottled.

Expands 1.–1.12 in. = 25–28 mm.

Habitat: Cartwright, Miniota and Winnipeg, Manitoba, August and September; Kaslo, B.C.

Cucullia phila nov. sp.

Head, thorax and primaries bluish gray. Head with two obscure blackish transverse lines. Thorax with disk brownish, the patagia obscurely sub-margined with brown or blackish. Primaries tending to brownish along the costal region, a distinct rusty shade in the cell where the ordinary spots are vaguely indicated. A distinct white, diffuse blotch in the sub-median interspace before the curved black mark representing the t.p. line. T.a. line traceable, single, slender, black, with long outward teeth, that in the sub-median interspace reaching almost to the middle of the wing. T.p. line vaguely indicated, except in the sub-median interspace, where it forms a black incurve, and over vein 1, where it is bent outwardly and is accompanied by a white band. An obscure black basal streak into the s.m. tooth of t.a. line. An oblique black streak extends from the curve of the t.p. line to the margin just below vein 2. The veins are black-marked, and beyond them the brown fringes are cut with gray. There is a narrow, black, broken terminal line. Secondaries white to the middle, then darkening gradually to a deep smoky brown outer border, the fringes white. Beneath, primaries glossy smoky brown; secondaries as above, but the dusky outer border is narrower. Abdomen grayish white, the dorsal tuftings brown.

Expands 1.50–1.60 in. = 37–40 mm.

Habitat: Philadelphia, Pa.; Maryland.

Two males and two females. The two males and one female are from Mr. Frederick Weigand of Philadelphia, and are bred specimens. The Maryland example is old, and has been left unnamed for years, because I had no record of its source, and I doubted a new eastern species so rare that only one example should occur in collections. It is more sordid in appearance than the bred examples, and has a brownish shading throughout the primaries, which obscures the white blotch in the median space.

The species is allied to *speyeri*, but is smaller and darker throughout, with comparatively broader primaries.

The larva, an inflated specimen of which is sent by Mr. Weigand, has the head black, clypeal sutures and an inferior lateral spot yellow; a broad orange dorsal line bordered by a broad black band which cuts into and vertically divides a yellow lateral line; a broad orange sub-lateral line inferiorly edged by a broken black line. Feet yellow, black-ringed at base. Ventral surface yellow, marked with a broken black line toward the sides. The margins of the first thoracic segment are yellow above, and the posterior margin of the dorsal hump on segment 12 is also yellow.

The larvæ were taken in fall, "feeding on the perennial or New England Aster," in Fairmount Park. Adults emerged the spring following, date not quoted.

Copicucullia mala nov. sp.

Head, thorax and primaries whitish gray. Head with front mixed with brownish; collar with obscure brownish transverse lines. Thorax with brown scales intermingled, but no definite maculation. Primaries with transverse maculation lost, and ordinary spots not traceable. T.a. line marked by an oblique costal brown streak. On the inner margin is a black streak, which extends from near base to about the middle of the wing. A narrow black line extends from base, through submedian interspace, to middle, where it dilates, and forms a streak which is dislocated at half its course, and reaches the outer margin below vein 2. Veins blackish-marked; costal region a little darker; an obscure dusky shade extends inwardly from outer margin below apex toward the middle of inner margin; but it is interrupted before the sub-medial black streak, and practically lost in the ground-color. Secondaries smoky, a little paler at base, the fringes white. Beneath, very pale whitish gray; the primaries a little darker.

Expands 1.30 in. = 32 mm.

Habitat: Witch Creek, Cal., Aug. 12.

A single male, in fair condition. This resembles *eulepis* Grt., but is smaller. The t.p. line is completely lost, and there is no black marking below vein 4 on the outer margin. There are other, minor differences; but those named above are most obvious.

Plagiomimicus dollii nov. sp.

Ground-color a luteous yellow overlaid and shaded by pale chocolate-brown, the lines luteous golden brown, and a golden brown tinge also reflected from the primaries. Head and thorax uniform brown; abdomen paler, more yellowish. Primaries with t.a., median and t.p. lines single, sub-parallel, each with a strong outward acute angle. In the t.a. line this angle is near the middle; in the median line it is on vein 5, opposite the lower angle of the cell; in the t.p. line it is above vein 6; and at the point of angulation an oblique dusky shade continues to the apex seeming at first a continuation of the line. The s.t. line is marked by this oblique shade near costa, but below only by the difference between the luteous terminal area (which is the palest portion of the wing) and the slightly darker, very narrow s.t. space. A golden brown, continuous, even, terminal line at the base of the yellowish brown fringes. The ordinary spots are large, concolorous. Orbicular round or nearly so, inconspicuously ringed with darker brown. Reniform broad, a little constricted, incompletely defined in brown. Secondaries yellow with a golden luster, smoky toward base within a dusky extra-median line. A faint dusky lunule and a distinct brown line at base of fringes. Beneath, golden yellowish, with a dusky median shade line on both wings.

Expands 1.12–1.35 in. = 28–34 mm.

Habitat: Palmerly, Cochise County, Arizona, August.

Two male and two female examples, all in good condition; from the collection of the Brooklyn Institute. I cannot identify this with any of the described species from Central America, and it is quite different from those of our own species thus far described. The frontal protuberance is umbilicate, the depression roughened.

Schinia espea nov. sp.

Head and thorax creamy with a reddish tinge; abdomen whitish. Primaries very pale creamy with a greenish tint, the shading olivaceous. Basal area whitish to the t.a. line, which is very oblique inwardly and a little arquate, extending from beyond basal third of costa to within basal third of inner margin. The line is outwardly shaded with olivaceous, which is darkest and broadest inferiorly, so as to slightly obscure the entire median space, the costal area being lightest, and fading out to the t.p. line. T.p. line from costa just within apex inwardly oblique, evenly bi-sinuate, to the outer third of inner margin. S.t. space very narrow, especially on costal margin, olivaceous, marking, by its contrast with the pale terminal space, an even but not at all defined s.t. line just about parallel to the outer margin. Fringes olivaceous. Secondaries white, sub-transparent, with a moderate blackish outer border. Beneath, white; primaries with smoky clouds over the costal area and s.t. space.

Expands .96 in. = 24 mm.

Habitat: Miaco, Florida, September.

One rather poor female out of a purchased lot, collector unknown. The species is an ally of *biundulata* on the characters used by Hampson; but the course of the median lines is utterly unlike that of any other species known to me.

Pseudacontia cansa nov. sp.

Head and thorax a mottling of white and glossy gray scales, more white on the head than on thorax, and more white in the male than in the female. Abdomen gray, segments narrowly white-ringed. Primaries smooth glossy gray, the median lines forming broad, rather even white bands in the female, becoming more diffuse inwardly in the male. S.t. line whitish, very irregular, tending to become lost medially, a little emphasized by brown preceding scales in some specimens; a patch of golden brown scales at the apex. A series of black terminal dots, fringes obscurely cut with pale. Orbicular a small black dot. Reniform a small black crescent at the inner edge of the white band forming the t.p. line. Secondaries smoky gray with a diffuse whitish median band, more distinct in the male, in which a dusky lunate discal mark is more or less obvious. Beneath, primaries smoky at base, becoming paler outwardly until they are white before a distinct broad, defined blackish s.t. band, beyond which the wing is again pale. There is a small black discal lunule. Secondaries whitish, with a narrow extra-basal dark band, a broader, blackish subterminal band, and a black discal lunate mark.

Expands .94 -.98 in. = 23.5-24.5 mm.

Habitat: Hamilton County, Kansas, 3500 feet (Professor F. H. Snow).

One male and two females, in fair condition. I have been inclined to regard these as forms of *crustaria* Morr.; but the receipt of quite a series of the latter shows them to be distinct. The vestiture is smoother throughout, and, while the maculation is almost the same, there is none of the bright coloring or sharp contrast of the older species. The armature of the fore tibia is also somewhat different, forming distinct outer and inner claws, instead of a long inner claw with a marked outer angle of the flat corneous tip.

Pseudacontia louisa nov. sp.

Head and thorax rich yellow-brown mottled with creamy white and black scales; abdomen yellowish. Primaries creamy yellowish white marked and mottled with brown and black. Basal space brown-powdered, so that the pale ground is only just discernible; the basal line geminate, blackish, included space of the ground-color. T.a. line a broad band of the basal creamy tint, the anterior margin formed by the limits of the dusky base, the posterior a black scale line edging the brown median space; the line irregular, with a larger outcurve between veins 1 and 2, and a sharp inward tooth on vein 1. The median space is narrow, brown-powdered, with the round black reniform (which is annulate with yellow) forming a conspicuous feature, the outer margin formed by an edging of black scales, of which the small lunate orbicular forms part and the irregular inner part of the t.p. line forms the remainder. Beyond this the wing is creamy to the brown terminal space, the s.t. space appearing bluish from the dark band of under side, the edges of which are a little marked by brown scales on the upper surface. S.t. line not defined, the terminal space narrow, and irregularly brown-powdered. A series of distinct black terminal lunules at the base of the long, brown, pale interlined fringes. Secondaries blackish, with a broad yellowish white median band in which is a large blackish discal lunate mark. Beneath, primaries mottled, blackish and yellow; a distinct, extra-median, broad outer band forming the most conspicuous feature. Secondaries pale yellowish, with a large blackish discal mark and a narrow, broken, irregular sub-terminal blackish band. A broken dark terminal line on all wings.

Expands 1.10 in. = 27 mm.

Habitat: Sabine Parish, La. (G. Coverdale).

A single male has been in my collection a long time awaiting a mate, and is now described because there seems no present hope of more material from the same region. It was a papered example, and the body is transversely flattened out of all shape; but the primaries are perfect and the maculation is clean and well defined. It is larger than *crustaria* with a similar type of maculation; but in this the pale ground predominates, and the dusky s.t. space and more or less well-defined s.t. line are eliminated altogether. The anterior legs are wanting in the type, and the generic reference is therefore made upon the basis of the general resemblance to *crustaria.*

Annaphila miona nov. sp.

Head and thorax bronze-brown with black and metallic-blue scales intermingled, forming no obvious ornamentation. Abdomen deep orange with narrow black dorsum, the edges of the segments narrowly orange. Primaries brown, mottled with black and metallic blue scales, the latter most obvious beyond the reniform and along the upper course of the s.t. line. Basal line traceable by black scales. T.a. line geminate, black, more or less broken, included space a little paler than ground, outwardly oblique and with a distinct outward tooth in the sub-median interspace. Median line black, quite obvious, outwardly oblique and a little outcurved. T.p. line, consisting of a very even brown band, very regularly bent over the cell, and an inner, broken, very irregular blackish line forming the outer border of the median space, and this is inwardly toothed on vein 2. The outer part of the wing is black at apex, shading to brown at anal angle; and through the black portion the s.t. line is very irregularly marked out by brilliant blue scales: below the middle the line becomes more even•and pale. Fringes brown with a black interline, beyond which they are checkered with black. Orbicular not obvious in the specimens. Reniform large, irregularly lunate, pale brown, ringed with white, with a whitish patch above it to costa, and outwardly three lobe-like extensions of the t.p. line filled with blue scales. Secondaries deep orange with a broad, even, black margin and a very faint basal line of blackish scales. No discal spot. Beneath, orange; primaries with a broad outer border, narrowing toward the angle, interrupted by a series of orange spots, and a broad median band from inner margin to center, where it breaks, and sends spurs toward costa and outer margin; secondaries with a broad black outer band in which a series of orange spots is traceable.

Expands .80 in. = 20 mm.

Habitat: Plumas County, California, June.

Two females, in good condition save for lack of antennæ. At first sight the orange of secondaries seems unbroken, except for the broad, solid, black outer band, and this forms a characteristic of the species. The faint blackish basal line becomes obvious enough when attention is drawn to it; but there is no black shading at the extreme base of the wing.

Annaphila variegata nov. sp.

Head and thorax bronzed brown mottled with blue and white scales, the latter tending to form a white tip to the collar. Abdomen orange, dorsum blackish, the segments narrowly orange-ringed. Primaries with basal area grayish brown to t.a. line; the median space, except reniform, darker, more or less blue-powdered; reniform, and obliquely below to the inner angle, white or very pale orange-yellowish merging outwardly into a dusky terminal and apical shade in which a black-edged s.t. line is prominent to the middle: the line itself consists of scattered white scales forming a white mark on costa, and beyond it are blue scales. Basal line dark chocolate-brown. T.a. line geminate, black or blackish, forming a sharp outward tooth in the sub-median interspace, and almost or quite meeting an inward tooth of the median shade; black scales connecting the two when they do not actually meet. Median shade line black, very irregular, keeping close to the t.p. line so far as that is defined below the reniform. T.p. line discontinuous, brown, and partly defined by the s.t. space from costa over cell, broken opposite the lower angle of the reniform, where a loop-like extension of the dark median space forms the lower angle of that spot, then black, with an inward angle on vein 2. Orbicular very obscure, round, concolorous, traceable by an outline of black scales. Reniform a large white or faintly orange blotch, inwardly and inferiorly defined, upwardly extending to costa, and outwardly merging into the s.t. space. There is a series of black terminal spots which tends to become sagittate above the pale area. There is a pale line at the base of the long fringes, which are brown with a black interline, and outwardly checkered gray and brown. Secondaries orange-yellow, varying in depth; the males paler, with a broad black outer band having an irregular inner margin, a more or less continuous narrow sub-basal band, and a black spot on the inner margin above the anal angle. Beneath, orange; primaries with a broad outwardly oblique black band, a black sub-marginal band which is broad from costa to the middle, where it touches the inner margin and is then very narrow and linear, and a black outer border, which is separated from the black fringes by a very narrow orange line; secondaries with a broken black inner line, a fragmentary median line indicated by two spots near inner and one on costal margin, a very irregular outer band more or less connected with the narrow black outer margin.

Expands .88–.95 in. = 22–24 mm.

Habitat: Placer County, California, 2500 feet.

Five males and five females, in good condition and all very much alike. The males are uniformly a little smaller and less intensely colored, with the inner black band on secondaries more generally broken. There is no black discal spot on secondaries, and the maculation of the primaries is more like the yellow-winged forms than any other of the orange-winged species, except *miona.*

Erastria puncticosta nov. sp.

Ground-color very pale ashen with a smoky gray powdering and overlay. Head and collar dark chocolate-brown, but varying toward the ground. Primaries with large brown costal spots at the inception of the basal, t.a. and t.p. lines, and beyond the latter a series of alternate brown and pale marks to the apex. The basal line does not extend much below the costal spot. T.a. line single, narrow, broken, irregular, inwardly oblique. T.p. line single, broken, very irregular, outwardly bent over cell, and partly obsolete at that point. S.t. line pale, very irregular, preceded by a dusky shading, which may be emphasized by still darker, more sagittate spots. A series of black terminal lunules, beyond which the fringes are cut with pale. There is no obvious orbicular. Reniform a narrow black line or lunule, which may or may not be margined outwardly with whitish. Secondaries uniformly smoky brown. Beneath, smoky, varying in tint; the primaries always darker, with the white costal dots of upper side reproduced; the secondaries more whitish, tending to a dusky outer margin.

Expands .60–.66 in. = 15–16.5 mm.

Habitat: New Brighton, Pa., July 22–Aug. 11.

Nine examples, all males and mostly in good condition. The species at first sight resembles the deltoid species of *Megachyta* by the prominent brown costal spots. There is little variation in the examples before me, except in the amount of the dusky overlay. In the best examples this extends from just beyond the base to the outer margin, becoming gradually more intense, so that the pale s.t. line stands out clearly in contrast; in the poorest examples the dusky tint remains over the terminal area only, and the s.t. line loses in relative distinctness. The abdomen is smoothly scaled, with a small dorsal scale-tuft at base in the better specimens. Beneath, the legs are dusky and the tarsi narrowly pale-ringed.

The species seems to be not uncommon at New Brighton, but I have none at present from other sources.

Erastria humerata nov. sp.

Head and collar chocolate-brown; thorax and ground-color of primaries gray with an overlay of yellowish pale brown scales. Primaries with median space filled by a blackish-brown shading and a sub-quadrate patch of the same color on costa in s.t. space. Basal line brown, extending to median vein, and from it, to base of wing, is a dark chocolate-brown spot, which looks like the extension of the collar. T.a. line dark brown, irregular, a little inwardly oblique, outwardly diffuse, preceded by a whitish line or shade. T.p. line blackish, broken, irregular, abruptly and squarely exserted over the cell. This outward exsertion of the paler ground occurs beyond the linear black reniform, so that at first sight the t.p. line seems to cross the wing with only a slight outward curve. Outwardly the t.p. line is bordered by pale scales. S.t. line pale, very irregular, forming a broad inward angle opposite the cell, and an almost equal outward angle between veins 3 and 4. As a whole, the s.t. space is a little smoky, darkening to the large brown costal patch. Terminal space usually paler and a little more brown than the rest of the wing. A series of distinct black terminal lunules, beyond which the dusky fringes are cut with yellowish. Orbicular wanting. Reniform black, linear, upright. A series of three white dots on costa between t.p. and s.t. lines. Secondaries uniform smoky. Beneath, smoky; primaries darker, with the costal dots of upper side intensified and a larger one at inception of t.p. line; secondaries paler, with a large discal spot.

Expands .58–.64 in. = 14.5–16 mm.

Habitat: New Brighton, Pa., July 11–31.

Eight examples, in good to fair condition, all males; from Mr. H. D. Merrick. As in *puncticosta*, the antennæ have the joints distinctly marked and feebly serrate, with obvious ciliæ but no distinct tufts. There is also a small scale-tuft at the base of the abdomen, which is rubbed in most specimens. There is little or no variation except such as is due to the condition of the specimens, producing more or less contrast between the median and the outwardly adjoining areas.

Erastria immuna nov. sp.

Deep purplish brown or blackish over a pale base, the maculation black. Wherever the purplish overlay has been marred, the whitish base becomes more or less evident. Primaries with basal line black, obvious on costa, and emphasized by whitish scales outwardly. T.a. line black, single, velvety, a little outcurved in the interspaces, and on the whole a little inwardly oblique. Median shade black, nearly upright, a little diffuse, and beyond it the wing tends to a little mottling. T.p. line black, single, more or less lunulate, irregularly outcurved over the cell and inwardly bent below it, emphasized by a few pale scales. S.t. line irregular, broken, pale, chiefly marked by a black preceding shade which is sharply defined on the line, but becomes diffuse inwardly. A series of black terminal lunules which may be emphasized by pale scales. A series of four white costal dots before apex. Fringes cut with pale opposite the cell. Orbicular wanting in the specimens. Reniform a creamy white lunule. Secondaries even, smoky gray. Abdomen smoky gray with a conspicuous black basal tuft on dorsum. Beneath, gray, powdery; primaries darker, with a paler terminal space; secondaries more whitish, with a small discal spot and a tendency to an exterior line.

Expands .80 in. = 20 mm.

Habitat: New Brighton, Pa., July 21, 28.

Two males, in fair condition; from Mr. H. D. Merrick. The species is similar to *muscosula* in size and wing-form, but is much darker throughout, and darker than any of the other species known to me. Of the two examples before me, the one taken July 21 is almost uniformly purplish black with the pale reniform and the small whitish costal dots conspicuous; the specimen taken on the 28th has the outer half of the wing distinctly pale-flecked, and this seems to be due to the removal of some of the surface scales. The species is therefore apt to be apparently variable, the more so as the black markings are composed of somewhat elevated scales.

Thalpochares fractilinea nov. sp.

Head, thorax and primaries pale, creamy yellowish, the latter washed and shaded with luteous. Basal line wanting, or marked only by black dots on costa and sub-costa. T.a. line a series of black dots which are sometimes connected by a brownish line, in course a little inwardly oblique. T.p. line black, broken, squarely exserted over the cell, followed by a more or less obvious pale shading. S.t. line pale, very even, outwardly diffuse, preceded by a darker shading in which there may be some black scales. A series of distinct black terminal lunules and a pale line at base of fringes. A somewhat obscure median shade darkens the outer portion of median space. Orbicular wanting. Reniform a small black, somewhat lunate mark. A series of four pale costal spots from t.p. to s.t. line. Secondaries uniformly smoky. Beneath, primaries dusky, with the costal spots of upper surface obscurely reproduced; secondaries paler, without obvious maculation.

Expands .48 –.52 in. = 12–13 mm.

Habitat: New Brighton, Pa., June 12, July 29, Aug. 3, 9, 12, 14, 26.

Five males, one female, and two specimens in which the sex is indeterminable, owing to their defective condition; from Mr. H. D. Merrick. The species is narrower-winged and has longer palpi than the other American forms referred to this genus, and this may not be the best place for it. The primaries lack the accessory cell in the two specimens examined, and this determined the generic reference.

Homopyralis bigallis nov. sp.

Of the usual red-brown overlying a dull luteous, which becomes apparent when the specimen is flown? Maculation black. More or less black powdering, which usually darkens the basal space and may obscure the outer half of median space of primaries. Head and thorax marked with black and purplish intermingled scales. Primaries with t.a. line black, geminate, outcurved below median vein, inner part of line not distinct from dusky basal space. T.p. line geminate, inner portion lunulate, more or less broken, rather squarely exserted over cell; outer portion incomplete, in part reduced to a series of pale venular dots. A pair of waved black shade lines through the outer portion of median space. S.t. line pale, irregular, variably defined, preceded by a quadrate blackish patch on costal area. A series of black marginal followed by smaller, yellow terminal dots. Orbicular a small, round, solid black spot. Reniform a large, solid black quadrate or oblong spot. Secondaries with the maculation of primaries continued across the disk, but as a whole nearer to the base than on primaries. There is a tendency to a purplish shading through the outer part of the wings. Beneath, smoky luteous; both wings with a curved extra-median line, a crenulated terminal line, a more diffuse sub-basal line, and an obscure discal lunule.

Expands 1.15–1.40 in. = 29–35 mm.

Habitat: Hot Springs, New Mexico, 7000 ft., September; Yavapai County, Arizona, Aug. 8; Huachuca Mountains, Arizona, July 30; Palmerly, Arizona, without date.

Four males and two females, in fair condition. The markings are more clearly defined and the lines are better separated than in the allied species. Superficially the larger size will at once make it recognizable.

Epizeuxis intensalis nov. sp.

Head, thorax and primaries deep, rich, lustrous smoky brown; on the head and thorax uniform, on the primaries overlying a pale, glossy luteous which appears through in places, and gives the wing a mottled appearance. T.a. line upright, with three equal outward teeth or angles only a little darker than the ground, and usually best marked by the preceding pale shade, which is variably complete and always diffuse. T.p. line sharply denticulate, with long outward teeth on all veins, only a little outcurved over cell and incurved below, best marked by the well-defined pale line which follows the obscure darker line. S.t. line very irregular, forming three main outward lobes and three long inward angles, the first outward lobe beginning at costa and extending to the inward tooth opposite middle of cell; the second lobe begins at the latter point, and extends to the inward angulations on veins 1 and 2; the third outward lobe is only partial, and extends to the inner margin. The terminal space is always paler than the rest of the wing, often mottled, and sometimes contrastingly so. There is no obvious median shade. A distinct black terminal line, narrowly interrupted on the veins. Fringes smoky, narrowly cut with yellow. Orbicular a small round dot of the yellow ground-color. Reniform moderate in size, somewhat lunate, consisting of a dark crescent set in a larger spot of the pale ground-color. Secondaries whitish, with a yellowish or smoky suffusion, darker outwardly. There is a dusky median line followed by a pale shading, a pale sub-marginal line, and a distinct brown terminal line. Beneath, yellow, very sharply marked with a common black median line, a much fainter and variably evident s.t. line, and obscure discal spots.

Expands 1.10–1.40 in. = 28–37 mm.

Habitat: Yavapai County, Arizona, July and August (Hutson); Southern Arizona, June 15–30 (Poling); Southern California (Poling).

Six males and one female, in fair or good condition. This species resembles *cobeta* Barnes at first sight, but differs from all others in the genus by the distinctly annulate reniform, the contrasting terminal space, and the sharply-marked under side. The secondaries also are paler than in any other of the allied forms, so that we have a fairly well-defined species in an aggregation of decidedly variable forms.

Epizeuxis partitalis nov. sp.

Head and thorax glossy brown with a smoky tinge, abdomen somewhat paler. Primaries glossy brown; basal area a broad diffuse median shade, and all beyond the t.p. line smoky blackish. T.a. line nearly upright, with three moderate outcurves in the interspaces. T.p. line blackish, well-defined, denticulate, followed by a less distinct paler line, moderately outcurved and drawn in only a little in the submedian interspace. S.t. line pale, irregular, incomplete. A black, somewhat lunate terminal line. Fringes pale brown, obscurely cut with darker brown. Orbicular not marked in the specimens before me. Reniform a small, upright dark bar preceded by a paler shading. Secondaries smoky, darker outwardly, almost whitish at base. There is a blackish median, a whitish sub-terminal, and a blackish terminal line; the fringes pale dull yellowish. Beneath, powdery yellowish basally, smoky or blackish beyond the middle; all wings with a small discal spot; primaries with diffuse median shade, with obvious t.p. and pale s.t. line; secondaries reproducing more clearly the maculation of upper surface.

Expands 1.24–1.32 in. = 31–33 mm.

Habitat: Yavapai County, Arizona, July 24 (Hutson).

One male and one female. Differs from the allied species in the paler median space crossed by an obvious median shade. The secondaries are as dark as in *lubricalis;* and as a whole it is very markedly distinct from *intensalis,* which was collected in the same locality.

[ANNALS N.Y. ACAD. SCI., Vol. XVIII, No. 3, Part II, pp. 129–146. 4 April, 1908.]

ON DETERMINATION OF MINERAL CONSTITUTION THROUGH RECASTING OF ANALYSES.[1]

BY ALEXIS A. JULIEN, PH. D.

INTRODUCTION.

The recognition of the aggregate character of rock constitution, even in varieties of aphanitic texture, has led the analyst in recent years to rearrange the determined chemical components of a rock in the form and proportion of its existing mineral constituents. The now well-known advantages of this practice, in the bearing of its results on the true character and probable origin of a rock, are bringing about a complete revolution in petrographical science. The day of the representation of the material of a rock by a mere report of its chemical analysis has now passed.

The early mineralogists were accustomed frequently to transpose analyses of a mineral substance into the proximate mineral constituents known at that time, such as calcareous minerals and ores into various carbonates and oxides. With the silicate minerals however the increasing list of known minerals soon became burdened with an indefinite series of hypothetical compounds, proposed by Rammelsberg, Tschermak, Knop and their successors. The difficulty and uncertainty attending the use of these, in interpretation of chemical analyses, have perhaps served to discourage the continuance of the ancient method; so that at present the discussion of the chemical composition of a mineral generally ceases with presentation of its analysis, accompanied by oxygen ratios and a formula.

A chemical analysis alone, particularly of a complex compound, such as a silicate, rarely conveys — even to the eye of an expert mineralogist— much more than a vague guess or estimate of the distinctive character of the combination. A glance, for example, over an analysis of a chlorite, separately presented, would hardly enable him to assign it with any certainty to the page-full of selected but widely varying analyses of penninite or to those of clinochlore or to those of prochlorite comprised in every treatise

[1] Presented to the Academy at the meeting on 6 January, 1908.

on mineralogy, now seriously offered to us in illustration of the fixed theoretical composition of each of those minerals.

Nor is the certainty increased in very many cases by deduction of the actual ratios existing between the components included in the chemical analysis of a supposedly pure mineral. A chemical formula merely marks a possible relationship and may be but a blind and even misleading guide. The extraction of a formula is not confined to an independent mineral and is not a certificate of homogeneity. Whatever the figures of an analysis obtained from a pinch of soil or clay or from a fragment of brick, it would go hard with any analyst if he could not devise therefrom some skeleton of a formula. Yet these spectral shapes hover over all the early history of mineral analysis, and their existence is often brought forward as the chief, generally as the sufficient evidence to justify promulgation of new mineral names or supposed new reactions in mineral genesis.

It is obvious that the initial process in the calculation of a formula, *i. e.*, division of the percentage of each component by its molecular weight, is one that tends to reduction of the comparative proportion of the minor components, and thus to minimize and conceal the lack of homogeneity in a substance subjected to analysis. An investigation of mineral material therefore which ends with the presentation of the bulk analysis, even with an annexed calculation of oxygen or molecular ratios and formula of the crude aggregate, is surely incomplete.

Constitution of Crystallized Minerals.

The prevailing method of the analytical chemist, just discussed, seems to have been founded upon two exaggerated views concerning the constitution of crystallized minerals:

1. The assumption of their practical homogeneity and purity, an error which has crowded the literature of the science with hordes of discordant analyses and a series of poorly described and uncertain species.

The revelations of the microscope, particularly by means of polarized light, have long since established that a mineral, however well crystallized, often even when limpid and free from visible enclosures, may be but an aggregate, with one constituent in predominance in selected specimens, enveloping a number of others. In the same association or vein, particularly in vicinity of the matrix or vein-wall, phases of intermixture with increasing amounts of the minor constituents commonly pass into less perfectly crystallized forms of the first predominant unit, and often into earthy or massive aggregates in which one or another of the associates rises into greater or prevailing proportion. Familiar examples of these transitions are found in the endless variations of intermixture of quartz, even within its crystals, with hyalite, iron-oxides, rutile, chlorite, etc.; the inter-inclosure, intergrowth and inter-twinning of the feldspars in aggregates of the most complex constitution, and the similar mutual envelopments of the metallic sulphides.

The possibility of even "ideal purity" of a mineral has been based largely on results of examination of material selected for chemical analysis. The precautions usually taken to insure freedom from impurities are probably shown fairly in those long ago described by Doelter.[1] The fragments were first examined by the naked eye and then under a hand lens. A thin section was prepared and inspected. Splinters and cleavage-plates in different directions were then spread on a glass slide and examined by transmitted light under a low magnifying power of the microscope. By these means, it was believed, the visible purity of the material was insured, or, if impurities could still be detected but not removed, they were identified and allowance made for their amount in the reduction of the analytical figures.

In the light of present knowledge all these precautions appear insufficient to insure purity. From the subtle revelations of existing intergrowths now obtained through polarized light — the absolute concealment of all foreign inclosures within subtranslucent and opaque specimens — and, in every case, the escape of microscopic inclosures from observation, whatever their abundance, whose minute dimensions fall below the resolving power of the microscopic lens — the natural conclusion follows that the most effective detection of inclosures must be sought through study of the relationships of the chemical components of the mineral.

2. The usual mode of application of purely hypothetical compounds in rearrangement of components.

Without questioning the propriety of their consideration in reconstruction of an analysis, little seems to be gained toward real explanation of lacking relationships, by excessive resort to imagined compounds, like $Mg\ Fe_2'''\ SiO_6$, $Fe_2\ Fe_4'''\ Si_2\ O_{12}$, and others, in pyroxene, which have never been discovered in nature, in isomorphous interlocking with others, like $CaMg\ Si_2O_6$, whose co-existence as actual minerals is proved by optical behavior. In such cases, a conviction of the extent of dissemination of existing minerals as inclosures will lead rather to more persistent search for the latter, and, I think, more satisfactory solution of difficult problems constantly presented in recasting analyses.

An analysis then is not the end, but it is only a step toward the discovery of the existing mineral constitution. As the chemical composition of an

[1] Min. u. petr. Mitth., I, 49, 67, 373. 1878.

established mineral species is fixed, the possible object of analysis of a specimen identified by other means may be two-fold: determination of any replacements of components in the chief mineral; and demonstration of the constitution of other minerals which may be intermixed in the aggregate. The latter may be of great importance in elucidation of genetic history and relationships of the chief mineral.

Several methods have already been devised and applied toward quantitative determination of the elements of such intergrowths or aggregates: such as the graphic methods for measurement of their respective areas in a microscopic field, by means of drawing or photography; that of separation of the elements in a crushed aggregate by suspension in a dense liquid; that of separation of ferruginous minerals from a pulverized aggregate by means of an electromagnet; that of separate chemical analysis of the portions of an aggregate soluble and insoluble in an acid; and that of comparison of the simplified bulk analysis with a series of hypothetical chemical compounds. The first two methods are inapplicable to aggregates whose granulation is microscopic; the next two are limited and imperfect, through dependence upon a single character, and the last is subject to the errors usual to excessive reliance upon hypothesis rather than upon data of observation.

A more simple and effective method, in many cases, is that shown in the practice of the early mineralogists. Within every chemical analysis of a mineral substance lies the Key to its constitution. For its completion a re-arrangement or recasting is needed to determine the existing minerals as combinations of stated components. This can be carried out where the data are fairly complete, sometimes with great ease, and the results tend toward solution of long mooted problems and elucidation of the character of admittedly doubtful mineral species. Modern examples of a return to this earlier practice have been offered in late studies of certain varieties of pyrites, feldspars, spodumene and, more recently, jade.

Recast Analyses of Minerals.

A few simple illustrations, taken from a series of calculations now at hand, will suffice to show the ease of the long-neglected method and the value of its results. In connection with each analysis, as published, my estimate of the approximate mineral constitution is appended. In conformity to the description of the mineral, the alumina has been assumed, in these particular examples, as the basis for calculation of the amount either of a chlorite or of an aluminum hydrosilicate, using the theoretical composition which may correspond to the accepted formula of each mineral.

The following is presented as a good example, on the one hand, of the deceptive appearance which may be assumed by a chemical analysis, and, on the other, of the corrective evidence supplied by optical examination of the same specimen.

"Marmolitic antigorite."

From New Idria, California. Pale apple-green. Analysis by G. F. Becker, who states: "In pure serpentine 40.42 per cent. of magnesia corresponds to 41.52 per cent. of silica. It appears therefore that this mineral is in fact a serpentine comparatively free from impurities. When reduced to the proper thinness it was found that the material was far from homogeneous. A portion as seen under the microscope appeared absolutely colorless by transmitted light, while the remainder was of yellowish and brownish tints, in spots almost opaque, although by reflected light this position retained the pale apple-green color of the hand specimen....clouded by the presence of extremely microcrystalline particles" (Mon. U. S. Geol. Surv., XIII, 1888, 110).

Hypothetical constituents	Silica	Alumina	Ferrous oxide	Nickel oxide	Magnesia	Water	Totals
	41.54%	2.48%	1.37%	0.04%	40.42%	14.18%	100.03%
Antigorite	31.19				31.20	9.31	71.70
Deweylite	5.86				5.20	3.51	14.57
Prochlorite	3.37	2.48	1.37		4.02	1.35	12.59
Connarite	0.03			0.04		0.01	0.08
Hyalite	1.09						1.09

"Antigorite."

From Antigorio, Piedmont. Analysis by Kenngott.

Hypothetical constituents	Silica	Alumina	Ferrous oxide	Magnesia	Water	Totals
	41.20%	2.90%	6.53%	36.71%	12.52%	99.86
Antigorite	31.73			31.74	9.46	72.93
Deweylite	2.48			2.20	1.49	6.17
Prochlorite	3.95	2.90	6.53	2.77	1.57	17.72
Hyalite	3.04					3.04

This is but one of a long series of determined mixtures of crystalline antigorite with the minerals above stated and with others in the widest variation. They appear to me to afford no ground for the hypothesis of definite isomorphous mixtures of two minerals, antigorite and amesite, from one extreme of a regular series to the other, as claimed by Tschermak, but to indicate the irregular mixtures of several minerals in commonly associated development.

"Deweylite."

An unusual variety of the mineral from the United States, whose high content of silica has never been explained. G. = 2,096. Analysis by Thomson.

Hypothetical constituents	Silica	Alumina	Ferrous oxide	Magnesia	Water	Totals
	50.70%	3.55%	1.70%	23.65%	20.60%	100.20
Deweylite	28.55		1.70	23.65	17.11	71.01
Halloysite	4.18	3.55			1.88	9.61
Hyalite	17.97				1.61	19.58

"Bowenite."

From Cumberland, Rhode Island. The reported formula: 2(MgO. CaO)$_2$. $SiO_2 + 3H_2O$ (Dana). Analysis by Bowen.

Hypothetical constituents	Silica	Alumina	Ferric oxide	Lime	Magnesia	Water	Totals
	44.69%	0.56%	1.75%	4.25%	34.63%	13.42%	99.30
Diopside (residual)	9.18			4.25	3.05		16.48
Antigorite	20.51				20.52	6.12	47.15
Deweylite	10.84				9.63	6.51	26.98
Limonite			1.60			0.26	1.86
Chalcedony	2.78						2.78
Penninite	1.38	0.56	0.15		1.43	0.53	4.05

"Thermophyllite."

From Hopansuo, Finland. Average of three analyses by Arppe, Hermann and Northcote, with the formulas: (RO. $3R_2O_3$) $2SiO_3$ + 2HO and (MgO. HO) + MgO. SiO_3.

Hypothetical constituents	Silica	Alumina	Ferric oxide	Ferrous oxide	Magnesia	Potassa	Soda	Water	Totals
	41.93%	4.04%	0.66%	1.40%	37.29%	1.06%	1.54%	11.62%	99.54%
Phlogopite (residual)	11.79	4.04	0.66		8.85	1.06	1.54	2.72	30.66
Antigorite	29.82			1.40	28.44			8.90	68.56
Hyalite	0.32								0.32

"Celadonite."

An apple-green mineral, insoluble in acids, from Scotland. Average of four analyses by Heddle.

It is stated: "*Comp.* — A silicate of iron, magnesium and potassium, formula doubtful" (Dana).

Hypothetical constituents	Silica	Alumina	Ferric oxide	Ferrous oxide	Lime	Magnesia	Potassa	Water	Totals
	54.84%	3.52%	12.64%	4.90%	0.89%	6.65%	7.00%	9.62%	100.06
Biotite	26.91	3.52	12.12	4.90	0.89	6.65	7.00	2.77	64.76
Limonite			0.52					0.09	0.61
Hyalite	27.93							6.76	34.69

"Houghite."

From Rossie, New York. Analysis by S. W. Johnson. "A hydrotalcite derived from the alteration of spinel" (Dana).

This was originally considered to consist essentially of variable mixtures of $3H_2O$. Al_2O_3 and MgO. H_2O (Kenngott).

Hypothetical constituents	Silica	Alumina	Magnesia	Insoluble	Carbonic acid	Water (by difference)	Totals
	3.02%	19.74%	36.29%	8.27%	8.46%	24.22%	100.00%
Spinel (residual)				8.27			8.27
Spinel (dissolved)		10.84	4.22				15.06
Hydrotalcite		8.90	20.77			23.32	52.99
Magnesite			7.69		8.46		16.15
Antigorite	3.02		3.02			0.90	6.94
Periclase			0.59				0.59

Constitution of Micro-aggregates.

Those substances in particular which are apparently amorphous seem to have led to the greatest misapprehension and error, which may now be removed by similar treatment of their analyses. In the absence of outward crystalline form they present two alternatives: they may be considered as possibly either truly colloidal and optically isotropic, like obsidian; or as microcrystalline but mostly homogeneous aggregates. In either case the so-called "impurities" must be present. In the micro-aggregates, even though one mineral may predominate, it is always safe to presume that admixture with other minerals does occur in varying but notable proportions. In this respect it matters nothing whether an aggregate be macroscopic, with constituents visible to the naked eye, or microscopic or even ultra-microscopic; the limitations of our vision or optical instruments have no bearing in any way on the settlement of homogeneity and of the question of intermixture.

It is true that in descriptions of minerals many micro-aggregates have been cautiously assigned to subsidiary lists or groups, under such headings as "Chloritic minerals more or less imperfectly defined," "Magnesian silicates allied to serpentine but of somewhat doubtful character," and "Appendix to hydrous silicates." Yet the same pages are crowded with the names of impure aggregates, figuring as minerals, mainly because amorphous and somewhat uniform in color and other characters, particularly if this conclusion has been buttressed by construction of chemical ratios or formulas from the analyses.

Micro-aggregates are likely to comprise a larger number and proportion of chemical components and of their combinations than those found in crystals. The proposed solution of their constitution does not consist merely of a calculation of the possible mineral combinations of a certain number of chemical components; that process might be almost endless. It is restricted to a careful discrimination of the probable proximate compounds, *i. e.*, simpler existing minerals, consistent with the physical and optical characteristics possessed by the micro-aggregate. Furthermore, when the associations of this aggregate and the probable conditions attending its formation are known, the identification of the constituent minerals may be facilitated by restriction to the class of minerals developed in certain vein or gangue formations or in a particular metamorphic zone: for example, the constituents of the "diabantite" mixture to the series of minerals developed in the belt of weathering and there only.

In a study of the hydrous silicates, almost completed, to which this paper is a partial introduction, I have prepared a tabulated list to indicate the possible mineral combinations which may logically be sought for in micro-aggregates of this particular class. Taking for present examples in illustration of these views the micro-aggregates of magnesian hydrosilicates of the belt of weathering or decay — one of the groups of amorphous mixtures of the most difficult resolution — the following are some of the chief indices for detection of the combinations in which the more common components may occur.

Silica in three forms: *a*) colloidal and soluble, in combination with a large proportion of water, *e. g.*, disilicic monohydrate, $H_2Si_2O_5$, containing 13.05 per cent. of water, or trisilicic dihydrate, $H_4Si_3O_8$, containing 16.67 per cent. of water; *b*) hyalite or opal, containing 2 to 13 per cent. of water and insoluble, and (*c*) this, passing through various intermixtures, as semi-opal, chalcedony, etc., into anhydrous and insoluble crystalline quartz.

Alumina: a) where silica is scanty, as one of the two aluminum hydrates (bauxite, gibbsite); *b*) with silica abundant, as a residual remnant of an aluminous mineral (pyroxene, mica, feldspar, etc.) or as one of eight aluminum hydrosilicates (allophane, halloysite, talcosite, etc., but perhaps not kaolinite); *c*) in presence of alkaline and earthy bases, as a newly formed chlorite or zeolite (a restricted list, prochlorite, stilbite, natrolite, etc.).

Ferric oxide: a) with silica scanty, as anhydrous oxide (hematite, but never magnetite), or as one of the four ferric hydrates (limonite, limnite, turgite, göthite); *b*) with silica abundant, as one of the three ferric hydrosilicates (hisingerite, chloropal, anthosiderite), or as an aluminum-ferric hydrosilicate (?).

Ferrous oxide: a) commonly in replacement of magnesia, sometimes as siderite or other carbonate; *b*) with silica abundant, as one of the two ferrous hydrosilicates (ekmanite, chloropheite of Forchhammer); or (*c*) as the aluminum-ferrous hydrosilicate (aphrosiderite).

Manganese oxide: a) as manganous oxide (manganosite), sesquioxide (manganite) or dioxide (pyrolusite); *b*) as hydrate (pyrochroite) and carbonate (in wad, rhodochrosite, etc.); *c*) with silica abundant, as manganese hydrosilicate (bementite).

Lime: *a*) as a residual remnant of one of the calcareous silicates (augite, diopside, tremolite, anorthite, etc.); *b*) as carbonate (calcite) or calcium-magnesium carbonate (dolomite, ankerite); *c*) with silica abundant, as one of the newly formed calcium hydrosilicates (gyrolite, okenite, xonotlite), or as aluminum-calcium hydrosilicate, (sloanite ?).

Magnesia: *a*) with silica scanty, as oxide (periclase), hydrate (brucite), ferro-magnesium hydrate (pyroaurite), aluminum-magnesium hydrate (hydrotalcite), magnesium carbonate (magnesite, breunerite, mesitite) or hydrocarbonate (hydromagnesite, hydrogiobertite, etc.); *b*) with silica abundant, as one of two of the magnesium hydrosilicates (deweylite, sepiolite) or as aluminum-magnesium hydrosilicate (pyrosclerite).

Alkalies: with alumina and ferrous oxide (as a chlorite); with lime, as a hydrosilicate (certain zeolites).

It should here be noted that in a study of micro-aggregates of a different origin, *e. g.*, from development within a lower zone of metamorphism, a quite different series of constituent minerals would need to be considered. The preparation of any such series, in the present incomplete knowledge of the conditions of origin of mineral species, would require careful investigation of associations, relationships and all other evidence at hand. One conclusion from such study will be remarked in the series above given: that many minerals, the occurrence of which in distinct and crystallized specimens has been set down by the mineralogist as uncommon or even very rare (*e. g.*, brucite, periclase, deweylite, gyrolite, anthosiderite, etc.), may yet be shown to occur abundantly, in dissemination through rock formations and mineral aggregates in obscure or entirely invisible forms.

In calculation of mineral constitution from the analyses of such micro-aggregates, the chemical formulas of the constituent minerals, so far as they have been determined with certainty, may be accepted and used as absolute, and as far preferable in most cases to any actual analysis of a mineral, on account of the universal intermixture of impurities in the latter, even in the best crystallized and apparently purest specimen.

The facts show, in my opinion, that all mineral substances have a definite composition and character, that none are intermediate or transitional, that even from decay or other mode of dissociation of a complex mineral compound only independent minerals of simpler but exact composition are derived. If this be true, we shall have little need of resort here to hypothetical chemical compounds but may perhaps rely entirely on determined formulas for all calculations of mineral constitution.

It has been already intimated that one result of loose and vague misapprehension of the essential and non-essential chemical components of a crystallized mineral, or of the predominant mineral in a micro-aggregate, appears to have been that the limitations in the laws of replacement in the composition of a mineral have not always been clearly recognized; inclosures have been mistaken for replacements. For example, in the two basic magnesium hydrosilicates, deweylite and antigorite, magnesia may be replaced by ferrous oxide, by manganous oxide, and probably by lime, but never by metallic oxides.

Recast Analyses of Micro-aggregates.

A few examples of micro-aggregates, taken from my notes on minerals of the magnesian hydrosilicate group, are presented below. They have been selected to illustrate a variety of mineral constituents, identified in these mixtures by this simple method, in contrast with the chemical formulas on which the present acceptance of these mixtures as possible or certainly independent minerals has been largely founded.

Fibrous "diabantachronnyn."

From Gräfenwart, Voigtland. Analysis by Liebe, with the formula — $RO.SiO_2 + Mg(OH)_2$.

Hypothetical constituents	Silica	Alumina	Ferrous oxide	Magnesia	Water	Totals
	31.56%	12.08%	21.61%	22.44%	11.78%	99.47
Prochlorite	16.43	12.08	16.86	9.38	6.56	61.31
Chrysotile	15.13		4.75	10.39	4.51	34.78
Nemalite				2.38	0.71	3.29
Periclase				0.29		0.29

In this calculation the alumina content is taken as the basis for estimating the chlorite (or very likely a mixture of chlorites); the remainder of silica for that of chrysotile, distinguished by Liebe under the microscope; the remainder of the water for that of the fibrous magnesium hydrate, which, as has been pointed out in a previous paper,[1] has not been hitherto discriminated from chrysotile in optical mineralogy.

[1] Annals N. Y. Acad. Sci., XVI, 410–411. 1906.

The following is an example of a mere mixture of apparent complexity of composition, but of comparative ease in determination of mineral constitution.

Blackish green "delessite."

From Thüringer Wald. Analysis by Pufahl, with the deduced formula $R_7 (R_2)_2 Si_5 O_{23} + 7$ aq.

Hypothetical constituents	Silica	Titanic acid	Alumina	Ferric oxide	Ferrous oxide	Manganous oxide	Lime	Magnesia	Potassa	Soda	Phosphoric anhydride	Sulphuric acid	Carbonic acid	Water	Totals
	28.79%	0.18%	16.74%	4.83%	18.30%	0.31%	0.98%	16.62%	0.28%	0.24%	0.08%	0.26%	0.35%	12.25%	100.21
Prochlorite	18.12		13.32		18.30	.31		10.32						7.23	67.60
Deweylite	5.79							5.14						3.47	14.40
Picro-thomsonite	3.99		3.42				0.23	1.16	0.28	0.24				1.50	10.82
Hematite-ocher				4.83											4.83
Calcite							0.45						0.35		.80
Gypsum							0.18					0.26		0.12	.56
Apatite							0.12				0.08				.20
Rutile		0.18													.18
Hyalite	0.89														.89
Variation														+.07	

"Diabantite."

From Farmington Hills, Connecticut. Mean of two analyses by G. W. Hawes; "A unisilicate of the pyrosclerite group, with the formula, $(\frac{2}{3}\dot{R}_3 + \frac{1}{3}\ddot{\ddot{A}}l)\ \ddot{S}i_3 + 3\ \dot{H}$." Dana states that the figures "correspond to the formula $R_{12}\ (R_2)_2\ Si_9\ O_{36} + 9$ aq., which is near to that of pyrosclerite," and also:

"*Comp.*— $H_{18}\ (Fe, Mg)_{12}\ Al_4\ Si_9\ O_{45}$ or

$12\ (Fe, Mg)O.2Al_2O_3.\ 9\ Si\ O_3.\ 9\ H_2O$."

In my calculation of the mineral constitution I have applied to pyroxene, perhaps unwisely, the actual analysis of that mineral by Hawes from an outcrop of diabase in the same region. It is apparent that "diabantite" is not identical with "diabantachronnyn," nor is it at all likely that any two specimens of either mixture are ever identical.

Hypothetical constituents	Silica	Alumina	Ferric oxide	Ferrous oxide	Manganous oxide	Lime	Magnesia	Soda	Water	Totals
	33.46%	10.96%	2.56%	24.72%	0.39%	0.92%	16.52%	0.29%	9.96%	99.78
Pyroxene (residual)	3.49	0.24		0.72	0.39	0.92	0.65	0.29	0.08	6.78
Enstatite (residual)	6.27						4.18			10.45
Prochlorite	14.63	10.72		14.96			8.32		5.82	54.45
Ekmanite	5.69			9.04					1.60	16.33
Deweylite	3.38						3.01		2.03	8.42
Limonite			2.56						0.43	2.99
Periclase							0.36			0.36

"Jollyte."

From Bodenmais, Bavaria. Analysis by von Kobell.

Formula: $(\frac{1}{3}\dot{R}^3 + \frac{2}{3}\ddot{\ddot{A}}l)^2\ \ddot{S}i^3 + 4\ \dot{H}$; it "resembles a hisingerite in which the iron is replaced by alumina" (Dana).

Hypothetical constituents	Silica	Alumina	Ferrous oxide	Magnesia	Water	Totals
	35.55%	27.77%	16.67%	6.66%	13.18%	99.83
Chloritoid	14.09	23.77	16.67		4.17	58.70
Deweylite	7.50			6.66	4.49	18.65
Allophane	2.34	4.00			3.51	9.85
Colloid silica	11.62				1.01	12.63

"Saponite."

From Kinneff, etc., Scotland. Average of thirteen analyses by Heddle. "A hydrous silicate of magnesium and aluminum, but the material is amorphous and probably always impure" (Dana).

Hypothetical constituents	Silica	Alumina	Ferric oxide	Ferrous oxide	Lime	Magnesia	Water	Totals
	40.63%	7.18%	7.96%	2.38%	2.14%	21.43%	21.76%	99.48
Pyrosclerite	18.87	7.18		2.38	2.14	12.26	5.68	48.51
Deweylite	10.33					9.17	6.19	25.69
Limonite			3.96				.67	4.63
Colloid silica	11.43						9.22	20.65

"Pilolite."

Mountain cork or leather, from Scotland. Average of seven analyses by Heddle, with the formula: $4MgO. Al_2O_3. 10 SiO_2. 15H_2O$.

Hypothetical constituents	Silica	Alumina	Ferric oxide	Ferrous oxide	Manganous oxide	Lime	Magnesia	Water	Water at 100° C.	Totals
	51.92%	8.48%	0.89%	2.45%	1.41%	0.98%	9.92%	14.75%	8.74%	99.54
Deweylite	11.17						9.92	6.70		27.79
Halloysite	10.00	8.48						4.50		22.98
Ekmanite	3.04			2.45	1.41	0.98		0.86		8.74
Chloropal	1.00		0.89					0.50		2.39
Colloid silica	26.71							2.19	8.74	37.64

"Aphrodite."

From Långban, Sweden. Analysis by Delesse, with the formula: $MgO. SiO_2. H_2O$. "A soft earthy mineral near sepiolite.... Perhaps $H_6Mg_4 Si_4. O_{15}$ but of doubtful homogeneity" (Dana).

Hypothetical constituents	Silica	Alumina	Magnesia	Water	Totals
	53.50%	0.90%	28.60%	16.40%	99.40
Deweylite	21.14		18.79	12.69	52.62
Antigorite	9.79		9.81	2.92	22.52
Allophane	.53	.90		.79	2.22
Hyalite	22.04				22.04

"Picrofluite."

From Lupikko, Finland. Analysis by Galindo, with the formula: $4RO. 3SiO_2 + 2CaF_2 + 3H_2O$. It has also been described as "a serpentine intimately impregnated with fluorite" (Arppe), and as "probably a mixture of fluorite with a magnesian silicate" (Dana). Neither the formula nor these explanations account for the high percentage of magnesia nor for the excess of lime (6.4 per cent) beyond that required in the possible amount of fluorite. The deficiency in the total may be due only to incomplete determination of fluorine.

Hypothetical constituents	Silica	Ferrous oxide	Manganous oxide	Lime	Calcium	Magnesia	Water	Fluorine	Totals
	29.00%	1.54%	0.78%	22.72%	(11.66%)	28.79%	8.97%	11.16%	98.30
Fluorite				(16.32 =)	11.66			11.16	22.82
Wollastonite	6.85			6.40					13.25
Antigorite	22.15	1.54	0.78			19.84	6.61		50.92
Brucite						5.26	2.36		7.62
Periclase						3.69			3.69

"Webskyite."

From Amelose, Hesse. Mean of two analyses by Websky, with formulas: $H_6R_4Si_3O_{13} + 6$ aq. and $H_2(Mg, Fe) SiO_4 + 2$ aq.

Hypothetical constituents	Silica	Alumina	Ferric oxide	Ferrous oxide	Magnesia	Water	Totals
	35.85%	0.24%	10.32%	3.04%	19.68%	31.53%	100.66
Ferro-deweylite	24.98			2.70	19.49	14.97	62.14
Limonite			10.32			1.73	12.05
Prochlorite	0.33	0.24		0.34	0.19	0.14	1.24
Colloid silica	10.54					14.69	25.23

In this however the descriptive data are not sufficient to determine the exact condition of the alumina (as bauxite? or as a hydrosilicate?).

"Genthite."

From Texas, Pennsylvania, etc. Analysis by Genth, from which it has been pronounced "a gymnite, with part of the magnesium replaced by nickel: $2NiO. 2MgO. 3SiO_2. 6H_2O$," or $H_{12}\ Mg_2\ Ni_2Si_3\ O_{16}$.

Hypothetical constituents	Silica	Ferrous oxide	Nickel oxide	Lime	Magnesia	Water	Totals
	35.36%	0.24%	30.64%	0.26%	14.60%	19.09%	100.19
Connarite	24.51		30.64			7.38	62.53
Deweylite	10.85	0.24		0.26	9.13	6.50	26.98
Brucite					5.47	2.46	7.93
Water						2.75	2.75

"Xylotile" (Mountain-wood).

From Schneeberg, Tyrol. Average of three analyses by Hauer, after exclusion of water lost at 100° C. Probably an altered chrysotile (Kenngott).

"A very ferruginous chrysotile, of which part of the iron has been oxydized by secondary processes" (Lacroix).

According to Liebe, it has been probably derived from alteration of "diabantachronnyn."

Hypothetical constituents	Silica	Ferric oxide	Ferrous oxide	Lime	Magnesia	Water	Totals
	50.43%	18.97%	3.28%	0.85%	11.82%	14.63%	99.98
Chrysotile	15.95		3.28	0.85	11.82	4.76	36.66
Anthosiderite	32.04	18.97				2.13	53.14
Colloid silica	2.44					7.74	10.18

An intense pleochroism possessed by this substance (very deep golden yellow, bright yellow, to brownish yellow) differing entirely from that of chrysotile or antigorite, agrees exactly with that characteristic of anthosiderite — a satisfactory confirmation.

It can be claimed for hardly any one of the examples given above that more than an approximation to the truth has been presented. With the imperfection of both analyses and descriptions as published, each interpretation yet calls for special tests of the very specimens of these micro-aggregates used in the analyses, for confirmation: *e. g.*, strong alkaline reaction or other evidence of free magnesia in "picrofluite" and "diabantachronnyn," and optical identification of prochlorite, chloritoid, etc., in the others. It is certain that, in each of the specimens represented by these analyses, there existed a certain intermixture of minerals the identity and exact proportion of which should have been identified by the analyst. For such determination in any analysis certain accurate data are indispensable. In place of the usual meagerness in description of physical properties, omission of optical examination and common imperfection of the chemical analysis itself, it is obvious that, in a proper investigation of any mineral, its complete examination, physical and optical, should precede on the very specimen used for the chemical analysis. Only under such conditions can exact results be obtained from the universally heterogeneous materials which are found in nature. It seems likely, however, from the results above shown, through this old simple method, toward disclosure of latent mineral constitution, that it may prove of advantage even if now applied to the series of mineral substances whose chemical analyses have been published.

[ANNALS N. Y. ACAD. SCI., VOL. XVIII, No. 4, Part II, p. 147. 15 April, 1908.]

THE CHESTER, NEW YORK, MASTODON.

The accompanying plate gives a facsimile reproduction of a sketch and description of the skull and tusks of a mastodon found at Chester near Goshen, N. Y., which seem to have some value on account of the representation of the tusks in place. The sheet of legal cap paper, yellowed with age, bearing the sketch in pencil and the legend in ink were found in December 1907, in an old book in the library of the Lyceum of Natural History, now the New York Academy of Sciences. A transcript of the legend follows.

Delineated by P. S. Townsend, M. D.,

(from Nature) May 29, 1817.

Appearance of the Tusks of the Elephas Mastodonta, disinterred at Chester, township of Goshen, Orange County, State of New York, May 29th, 1817; by Drs. Mitchill, P. S. Townsend and Townsend Seely. The tusks are continuous with the upper jaw the four teeth of which are observable at their base. These tusks are nine feet in length, of pure ivory: becoming more and more of a bony nature before they expand into the jaw where they are entirely of the same nature with that bone. The tooth immediately situated upon the base of the tusk is 3 inches square, the one adjacent 6 by 3. The circumference of the tusk at the base 26 inches. The position of the jaw is horizontal and inverted. It lay about 6 feet below the surface of the soil, which soil to that depth consisted of a loose black mould mingled apparently with the comminuted fibres of sea-weeds and having the smell of Limus — it then changed to a pure pale-bluish clay.

P. S. T.

N. B. The nasal bones (?) are observable at the divergence of the tusks & are continuous with them.

Drs. Townsend (also spelled Townshend) and Mitchill were two of the founders of the Lyceum of Natural History and were prominent scientists of New York of the early part of the nineteenth century. Dr. Mitchell was the first president of the Lyceum, serving from 1817 to 1823 inclusive. The village of Chester is now in the township of the same name. No record has been found showing the later history of this specimen.

E. O. HOVEY,
Recording Secretary.

[ANNALS N. Y. ACAD. SCI., VOL. XVIII, No. 5, Part II, pp. 149–180. PLL. VI–VIII.
Author's separates published 23 April, 1908.]

THE PRODUCTION OF SOUND IN THE DRUMFISHES, THE SEA-ROBIN AND THE TOADFISH.[1]

BY R. W. TOWER.

CONTENTS.

Introduction.

The production of sounds by certain fishes has long been an interesting subject of investigation. Some species, as *Scomber brachyurus*, by rubbing together the pharyngeal teeth make a noise resembling a harsh grunt; some, as the puffer, or swellfish, make a similar sound by rubbing together the incisor teeth of the upper and lower jaw. In other cases stridulation has been recorded, and sounds are also said to be produced by the forcing of air through the pneumatic duct in those fishes in which the air-bladder

[1] Read by title at the meeting of the Academy on 13 April, 1908.

communicates with the exterior. Besides these kinds of sound production, which are of no special interest in this discussion, there are two others. One is the drumming of the squeteague, croaker and other drumfishes (Sciænidæ); the other is the so-called grunt of the sea-robin (*Prionotus*) and the common toadfish (*Opsanus*). With the difference in the kind of sound made by the drumming and the grunting fishes there will be found to be a distinct difference in the structure of the swim-bladder, which is the organ chiefly involved in the production of sound by these species.

Anatomy of the Swim-Bladder.

The Drumfishes.

Bearded drum (*Pogonias cromis*).— The swim-bladder of the drum is characterized by its large size and the enormous number of its diverticula. The bladder occupies, as is the case in nearly all of the sciænoid fishes, the entire length of the abdominal cavity. The diverticula are finger-like processes which arise laterally from the bladder and open into its large cavity. These tube-like appendages in the adult ramify through the connective tissue, and in many cases adhere firmly to the aponeuroses of the neighboring muscles. The air-bladder itself lies free in the abdominal cavity, attached on the dorsal side to the body of the fourth vertebra and covered on the ventral side by the peritoneum, which is continued from the parietal walls. When examined carefully, the air-bladder is seen to be made up of three layers: the outside is of a hyaline character and is composed of extremely tough fibrous tissue; the middle layer, which is separated from the outer layer only with great difficulty, is connective tissue containing elastic fibres; the inner layer is a very delicate connecting tissue, lined with pavement epithelium. Jäger (1903) has recently discovered that this inner layer does not cover the entire bladder-lumen, but on the dorsal surface there is an oval space in which the inner layer disappears, with the exception of the pavement epithelium. This space he calls the "oval," and maintains that it can be increased or diminished by the action of small muscles. In the middle layer ramify all the blood-vessels, which break into small branches and then enter the inner layer, where, in the region of the "oval," they form an anastomosing capillary net-work almost as complete as is found in the "red-body." This net-work is thus separated from the lumen of the air-bladder only by the single layer of pavement epithelium. The function of the "oval," according to Jäger, is the absorption of oxygen and the diminution of the amount of gas in the bladders of fishes having no pneumatic duct. Thus the "oval" and the pneumatic ducts serve the same physiological function. Adhering to a portion of the dorsal surface of the air-bladder, just posterior to the point of attachment to the vertebræ in the male, is the central tendon of the two red drumming muscles.[1] Upon opening the bladder of the drum, there is found on the inside, running almost the entire length, the red vascular body which has been described as the blood gland, or "red body."

Squeteague (*Cynoscion regalis*).— In the squeteague the swim bladder (fig. 1) is a long carrot-shaped organ, tapering to a point at the posterior end, and sending out from the broad anterior end three diverticula — two lateral horns and a central rounded "head." The dorsal surface of the "head" is attached by its outer or fibrous tunic to the sides of the body of the fourth vertebra, which broadens out to receive it. The lateral appendages of the swim-bladder of the drum are wanting in the air-bladder of the squeteague, which has nothing to mar its smooth even contour except the two lateral horns already described, which arise from the most anterior part of the organ. On the inside of the air-bladder is found the characteristic "red-body," or "blood-gland," which is present in the drum. The drumming muscles are present in the male squeteague only. Their insertion is lateral in the common fascia of the *rectus abdominis* muscle, about a half-inch from the mid-ventral line. The muscles, one on either side, are bilaterally symmetrical and originate from a central tendon, which lies free in the mid-dorsal line just above the swim-bladder and between it and the kidney. The anterior extremity of this central tendon is inserted by its middle third into the dorsal surface of the neck of the swim-bladder, while the right and left thirds merge into the fascia that support the peritoneum. Posteriorly, in the region of the anus, the tendon narrows down to a cup-shaped extremity that receives the tip of the swim-bladder, and then gradually tapers to a point, which is inserted into the base of the first anal fin-ray. A closed cavity is thus formed, bounded laterally by the two drumming muscles, ventrally by the confluent abdominal muscles, and dorsally by the central tendon. This closed bag or cavity contains the viscera

[1] Dufossé (Annales des Sciences Naturelles, ser. V, vol. XIX. 1874, p. 39) has described in *Trigla lyra* two red muscles which he called intra-costal muscles. From his description I am unable to identify them with the "drumming muscle" just mentioned. In no case has it been possible to find these "drumming muscles" in any of the Triglidæ.

Dufossé attributed to these intra-costal muscles the function of motor agents of the skeleton. "Considérés uniquement comme agents moteurs du squelette, ces muscles intra-costaux ont evidemment pour functions: d'une part, de fléchir latéralement ou de maintenir l'épine dorsale dans sa rectitude ordinaire, suivant qu'un seul muscle se contracte, ou bien que la contraction de ces deux muscles est simultanée, quand les os scapulaires leur servent de point fixe; d'autre part, d'attirer en dedans ces derniers os, et par suite les scapulaires et les humeraux, (Cuvier), lorsque la colonne vertébrale est préalablement fixée." It is evidently from this supposed function that Dufossé gave the name of intra-costals to these muscles.

and swim-bladder, the latter having the "central tendon" directly applied to its dorsal surface.

The blood-vessels and nerves supplying the drumming muscles are only

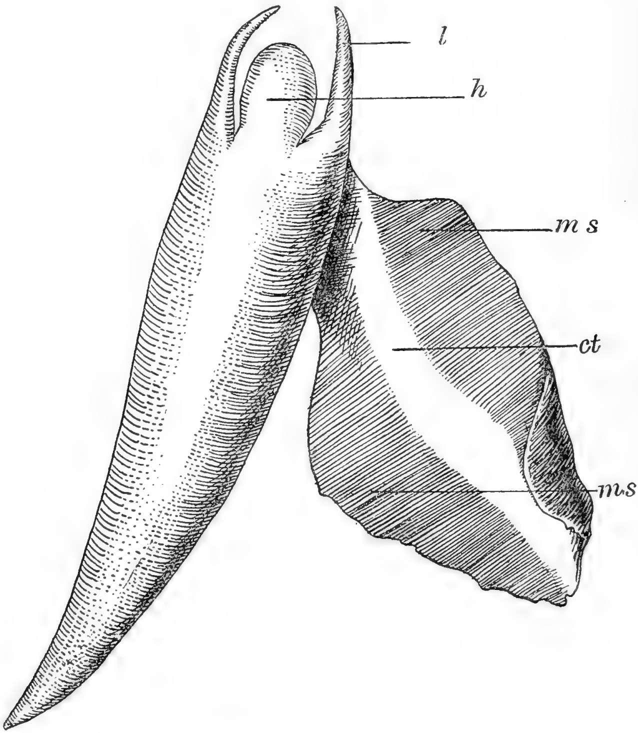


Fig. 1. SWIM-BLADDER OF CYNOSCION REGALIS.

The two m. sonifici (m s) are shown laterally displaced. h, head; l, lateral horn; c t, central tendon of m. sonifici.

accessory branches from the arteries and nerves of the abdominal muscles. An embryological study of the origin of these accessory blood-vessels and nerves and their relation to the muscle at the time when it is first laid down would be instructive. For the drumming muscles the name *musculus sonificus* has been suggested and is used in the following discussion.[1]

In young squeteague two inches long, it is impossible to distinguish macroscopically a differentiation of this muscle. But if a piece of the peritoneum with the underlying fascia is removed and examined under the microscope there are seen striations typical of voluntary muscles. The muscle fibres run in the direction of the short diameter of the fish, *i. e.*, circularly around the air-bladder. These young squeteague have been heard to "drum," and the contractions of the *m. sonificus* can be easily felt when the fish is held firmly in the hand. In the young this muscle has not acquired the deep red color that so characterizes it in the adult.

a. a. a. Lateral horns of air-bladder.
b. Hinder point of air-bladder.
msv. The muscles which must make the air-bladder act as a sound producing organ.

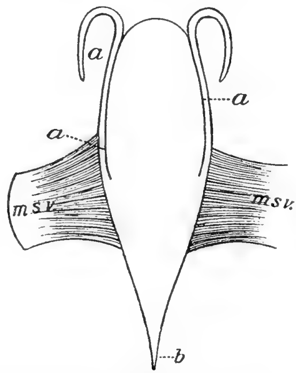


Fig. 2. SWIM-BLADDER OF MICROPOGON UNDULATUS AFTER SÖRENSEN.

Croaker (*Micropogon undulatus*).— Another sciænoid, known in American waters as the croaker, is of interest from an anatomical standpoint. The difference between the bladder of this fish and that of the squeteague, except for its being considerably smaller, is that the central head is not present, and the two lateral horns are reduced to two very small tubes. It is therefore an even more simple organ than that of the squeteague. The two bilateral *sonifici* have the same arrangement in both animals, and the description of the muscles of one applies equally well to those of the other. Sörensen states that "the form of the air-bladder needs no other description than that given in figure 9" (a copy of which is here appended as fig. 2).

[1] Dr. Hugh M. Smith and Dr. Theodore Gill suggested several anatomical names, from which *musculus sonificus* was selected as being the most appropriate. The author is greatly indebted to these two well-known ichthyologists for their assistance.

Sörensen made his dissection on one specimen preserved in alcohol, consequently the diagram is somewhat misleading, as can be seen by comparing it with the bladder and muscle taken from a fresh specimen (Pl. VI. fig. 1). Bridge uses this figure from Sörensen to verify the following statement: "In other fishes, the air-bladder, without possessing special muscles of its own, may, nevertheless, be partially invested by tendinous or partly muscular and partly tendinous, extensions from the muscles of the body wall." This muscle (*m. sonificus*) cannot be considered an extension of the muscles of the body wall but a unique, specific muscle which has been developed for the purpose of sound production. The muscles with the aponeuroses are united with the swim-bladder by means only of a tendon on the dorsal side immediately anterior to the base of the horns, and in no way attach themselves directly to the bladder, which is completely surrounded by the muscles and tendons. Sörensen states: "According to its structure, the air-bladder of this fish must be a sound-producing organ. Most probably the contractions of the muscles will, for a moment, compress the air-bladder and strain its dorsal wall, each of which operations must separately be able to bring the air-bladder to produce sound." Sörensen did not make any physiological experiments and based his conclusions entirely upon anatomical data. In the light of experiments soon to be described it is evident that he did not understand the "drumming" mechanism.

Other drumfishes examined.— Through the courtesy of Dr. Hugh M. Smith (1905) of the Bureau of Fisheries, it has been possible for me to examine specimens of the southern squeteague (*Cynoscion nebulosum*, Pl. VI, fig. 2), the yellow-tail (*Bairdiella chrysura*, Pl. VII, fig. 1), and the spot (*Leiostomus xanthurus*, Pl. VII, fig. 2).[1] The anatomical relations of the air-bladder and the *m. sonificus* are so similar to those noted above that no further description is necessary. In the spot the peritoneum is so pigmented with black that the *m. sonificus* is somewhat hidden.

The Sea-Robin and the Toadfish.

In these fishes there is found a swim-bladder which is so radically different in its outward appearances from that of the sciænoid fishes, and at the same time is so characteristic, that attention is immediately attracted to this organ. The sound produced, described as a grunt, differs markedly in character from the drumming of the Sciænidæ.

---

[1] These drawings were made from dissections completed by T. E. B. Pope of the Bureau of Fisheries.

Dufossé (1874) in his memoir on "Sons Expressifs Produits par les Poissons d'Europe" has given an accurate and complete anatomical description of the air-bladders of the European *Zeus faber*, *Dactylopterus volitans* and various Triglidæ. Inasmuch as the air-bladders of the Triglidæ of the North American waters differ in some respects from those described by Dufossé, I will here state briefly the structure in the species under examination, *Prionotus carolinus*, or the red-winged sea-robin, as well as of *Opsanus tau*, or the common toad-fish.

Sea-robin (*Prionotus carolinus*).— The air bladder of *Prionotus* (Fig. 3)

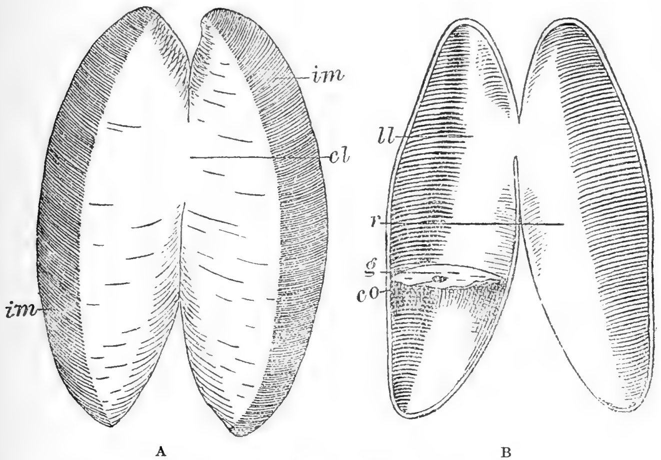
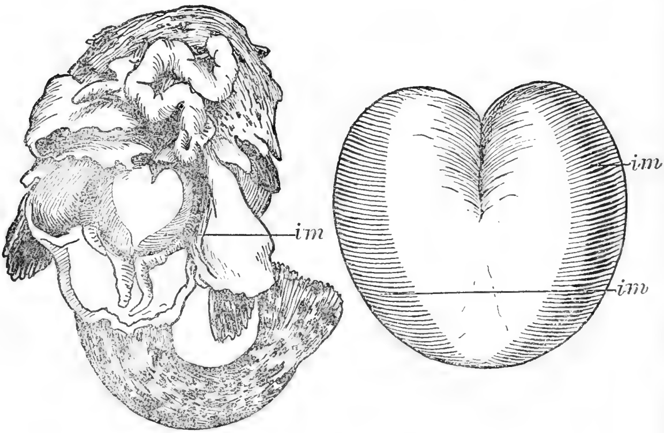


Fig. 3. Swim-bladder of Prionotus carolinus.

A. Viewed externally. i m, intrinsic muscle; c l, connecting lumen.
B. Longitudinally bisected. r, right lobe; g, internal septum; c o, central opening of septum.

is a deeply bi-lobed organ, occupying about two-thirds the space of the abdominal cavity. The two lobes are connected near the anterior end by a rather small tube. Along the outside portions of the respective lobes is found a muscle, red in color, and running from the anterior end of the lobe to the posterior end. The muscles adhere strongly to the underlying coat of the air-bladder, and can be separated from it only with difficulty. The muscle-fibres run in the plane of the short axis of the bladder. These muscles correspond to the "intrinsic muscles" of Dufossé. The bladder is not connected with the exterior by a pneumatic duct, Günther (1880) to the contrary notwithstanding, for the entire bladder has been removed from the abdominal cavity without losing any of the contained gas, an operation which would be impossible if there were any means of communication between it and the exterior.

The air-bladder itself consists of three layers — an external, a middle and an internal — together with the pair of muscles just described. The outer and middle layers are composed of thick, compact tissue, containing both elastic and non-elastic fibres. The inner membrane is a mucous



A B

Fig. 4. Swim-bladder of Opsanus tau.

A. Viewed in situ. i m, intrinsic muscle.
B. Viewed externally.

tissue provided with numerous blood vessels. Lying in this tissue are found also the blood glands or red-bodies which were described in the bladders of the sciænoids.

The left lobe (fig. 3 B) in all specimens of *Prionotus* is divided into two parts by a partition formed of the internal tunic or membrane. In the centre of this partition is a small opening, a little larger than the head of a pin. The right lobe is never divided. This perforated partition was present in all specimens examined of both sexes. The embryological history of this partition has never been investigated. There is no difference in the structure of the swim-bladder in the male and female, the intrinsic muscles being present in both. It is evident that we have here anatomically a very different structure from that in the swim-bladder of the Sciænidæ, a fact which will play a very important part in the interpretation of the physiological experiments soon to be described.

Toadfish (*Opsanus tau*).— The swim-bladder of *Opsanus* (fig. 4) is relatively a much smaller organ than in *Prionotus*. When examined externally (fig. 4 B), it seems to be deeply bi-lobed on the anterior half; but when viewed in longitudinal section (fig. 5), it is seen that less than one half of the organ is actually divided. The swim-bladder is supplied with

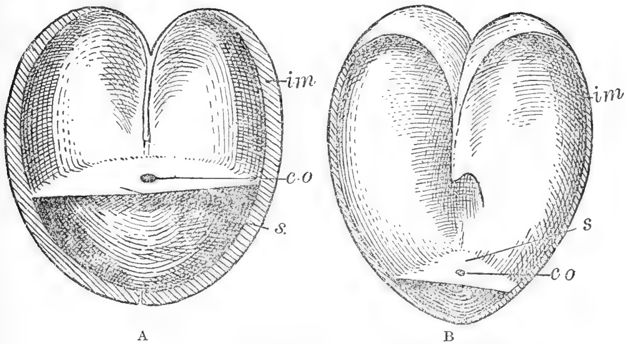


Fig. 5. Swim-bladder of Opsanus tau.

A. A specimen longitudinally bisected showing the position of the internal septum (s). c o, central opening of septum; i m, intrinsic muscle.

B. Another specimen longitudinally bisected showing the variation of the internal septum (s).

the same intrinsic muscles as that of the sea-robin. The muscles arise at the most anterior part of the right and left lobes respectively, and are separated posteriorly by only a small tendon. The muscular tissue is thick and strong, the fibres running transversely to the long diameter of the swim-bladder. An internal septum divides the bladder into two parts, an anterior and a posterior. The septum is perforated by a small opening, which forms the only means of communication between the two cavities. In the posterior cavity alone is found the blood gland.

Most interesting is the great variation found in the position of the transverse septum in different specimens. In some cases, the partition is fully one-third of the distance from the posterior end (fig. 5A) while in others it is less than one-sixth of the distance (fig. 5B). Indeed, in the large number of specimens examined, no two were found to be alike. Whether the variation is accompanied by any change in function, I was unable to determine.

Sound Production in the Drumfishes.

Recorded Observations and Theories.

It has been noticed by many fishermen that the common squeteague at times makes a very plain and unmistakable drumming noise. As to how this noise is produced they can give no explanation nor is there any account of it in scientific literature, with the possible exception of Dufossé's memoirs, which seem to be too little known at the present time. Their observations do not tell us whether it is the male[1], female, or both that produce this characteristic noise. In the anatomical discussion, it was found that only the male was supplied with the red drumming muscle which, from its relation to the air-bladder, was considered to be connected functionally with the latter organ. Further observations demonstrated that the drumming occurred only in those animals in which this red muscle was present — that is, in the male squeteague. In some other species, as *Micropogon undulatus*, drumming occurs in both male and female, and likewise the *m. sonifici* are present in both sexes.

In the rather limited amount of study that has been given to the noises produced by these fishes, some of the conclusions are mere deductions from anatomical data, without any experimental or physiological proof. In other instances, the authors confuse the sounds produced by fishes of entirely different orders, and which have swim-bladders both anatomically and physiologically different. For this reason it is very difficult to deduce correct conclusions from their writings.

As noted in a previous paper, Aristotle spoke of fishes that produce sound by some mechanism involving their air-bladder. The fact was thus known to fishermen and scientists very early; but no scientific explanations were offered nor were any experiments made which would account for these noises. Cuvier (1834) writes that "these fishes [sciænoids] swim in a troop and send forth a bellowing louder than that of the gurnards, and

---

[1] Since the above was written Dr. H. M. Smith has published the results of some observations, which show that both male and female of *Micropogon* make the drumming sound and that the male only in *Pogonias*, *Sciænops*, *Cynoscion*, *Leiostomus* and *Bairdiella* produce the drumming sound. (Science, vol. 22, 1905, p. 376.)

it has occurred that the fishermen, guided by their noises alone, have taken twenty *sciænæ* at a single throw of the net." The fishermen assure us that the noise of the *sciænæ* is sufficiently loud to be heard through twenty fathoms (120 feet) of water, and that they are careful from time to time to place their ears over the edges of the boat, that they may be directed by the noise. Some say that it is a dull humming sound; others that it is a rather sharp hissing. Some fishermen contend that the males alone make this noise in spawning time, and that it is possible to take them by imitating it and without employing any bait. That these fishes do produce noises that can be heard long distances is an undisputed fact.

The fish of this family best known to us is the "weak-fish," described by Dr. Mitchill under the name of *Labrus squeteague*. It was known by the Narragansett Indians as the squeteague; and by the French of New Orleans as the trout. The fishermen of Cuvier's time "attributed to it certain dull sounds similar to that of a drum, which are heard sometimes under the water and only in the season when it is abundant."

Another sound-producing fish of American waters which is described by Cuvier is the drum (*Pogonias cromis*). Cuvier states that "various accounts are given concerning the nature of the noise of these drums." According to Dr. Mitchill, it is when they are taken out of the water that they send forth this noise, but Schoepf says that "it is under the water that this noise is dull and hollow; that several individuals assemble around the keel of ships at anchor, and that then their noise is most sensible and continuous." This agrees with the report made by Lieut. John White, U. S. N., in 1824, in which he describes how his crew and himself, while at the mouth of the river Cambodia, were astonished by some extraordinary sounds which were heard around the bottom of the boat. It was like a mixture of the bass of the organ, the sound of bells, the guttural cries of a large frog and the tones which imagination might attribute to an enormous harp; one might have said that the vessel trembled with it. These noises increased, and finally formed a universal chorus over the entire length of the vessel and the two sides. The natives told Lieutenant White that the noises were produced by a troop of fishes. M. Humboldt describes a similar phenomenon in the South Sea on February 20th, 1803. Towards seven in the morning, he says, the whole crew were awakened by this extraordinary noise, which resembled drums beating the air. It was afterwards learned that the noise was produced by one of these sciænoids. Cuvier, in speaking of the same species, states that, "it would be an object of curious research to find out the organs in these fishes which seem to produce such strong and such continuous sounds, and that at the bottom of the water and without any communication with the external air. Most of the sciænoids have a large natatory bladder, very thick, provided with very strong muscles, but the bladder has no communication either with the intestinal canal, or with the exterior generally." This represents all that was actually known up to the time of Cuvier concerning the mechanism of the sound-producing organs. It was evidently thought by Cuvier that the air-bladder and attending muscles were of some importance in producing this phenomenon.

Somewhat later (1860), Holbrook stated that "frequent examinations of the structure and the arrangement of the air-bladders, as well as observations on the living animal just taken from the water, when the sound is at intervals still continued, have satisfied me that it is made in the air-bladder itself; that the vibrations are produced by the air being forced by strong muscular contraction through a large opening, from one large cavity, that of the air-bladder, to another, that of the cavity of the lateral horn; and if the hands are placed on the sides of the animal, vibrations will be felt in the lateral horn, corresponding with each sound."

It was not until Dufossé published his memoir on the sounds and noises produced by the fishes of Europe, in 1874, that we had any physiological explanation of the phenomenon in the sciænoid fishes which is based on actual experiments. In 1864, Moreau published the results of his experiments on the "grunting" mechanism in the Triglidæ, a process, however, which is entirely different from the "drumming" of the Sciænidæ, and should not be confounded with it. With regard to the sounds produced by certain muscles Dufossé says,

> Le phénomène physiologique connu généralement sous le nom de *trépidation* ou *trémulation* musculaire, et que Wollaston a assimilé, avec raison, à un mouvement de vibration, n'a pour ainsi dire été observé que chez l'Homme, et n'a jamais été le sujet d'une étude approfondie, soit au point de vue biologique, soit au point de vue la physique proprement dite, quelques physiologistes pensent même encore que ce mouvement assez rapide pour produire un léger bruit, désigné sous le nom de *bruit de rotation* par Laënnec et sous celui de *bruit de contraction des muscles* par d'autres auteurs, est trop faible par lui-même et trop peu important par ses effets pour devenir jamais d'un certain intérêt en physiologie générale.

This is a concise statement of what was known concerning the physiology of this noise at the time when Dufossé wrote his memoir. Dufossé divided his work into two propositions, viz:

1. Quelques muscles de certains poissons bruyants deviennent en se contractant susceptibles d'un mouvement de vibration:
2. Ce mouvement est le principe des sons que font entendre ces animaux.

To prove these propositions, Dufossé made two physiological experiments. In the first, he inserted his finger into the stomach of a lyre capable of producing an intense noise. During the production of the noise, he noticed an intense vibration which coincided exactly in duration with the sounds heard by his ear. He then punctured the wall of the air-bladder and drew out all the gas. The sound ceased, but the vibrations could still be felt. He then removed the entire swim-bladder, and applied his finger successively to the muscles and aponeuroses which lie alongside the vertebral column, and he found that all the organs were in repose except the intra-costal muscle, which vibrated and gave to his finger the same sensation as when the air-bladder was in its natural position.

In the second experiment, Dufossé opened the abdomen of a lyre just in front of the anus, and extirpated the swim-bladder entirely ("j'extirpe la vessie pneumatique tout entière"). He then inserted an artificial bladder ("poche membraneuse") and inflated it. The fish commenced again to produce a noise similar to that made before the operation. In another he cut the nerve supplying the intra-costal muscles, first the right and then the left. After both were cut, the noise ceased and could not be again renewed.

From these data, Dufossé argues that there are two factors in the producing of the noise, viz: the contraction of the intra-costal muscle, which is the primary cause of the sound, and secondarily, the reënforcement of these vibrations of the swim-bladder. The producing of the noise is voluntary. Dufossé recognizes many difficulties in this explanation, however, because the facts do not agree with those of theoretical physics, as can be seen from the following quotation:—

"Le mécanisme de la production des sons chez ces poissons a pour complément la transmission des vibrations sonores des muscles à la vessie qui est en contract avec eux. Les parois de cet organe communiquent ces vibrations au gaz qu'elle renferme, et ceux-ci vibrent de telle façon comme le prouvent surabondamment mes deux premières expériences, que l'intensité de ces vibrations est incomparablement augmentée. D' après ce résultat et en considérant que la vessie est une cavité close à parois membraneuses et souples se moulant si exactement sur la surface des organes qui les environment qu'elles ne peuvent vibrer que comme elles le feraient si elles étaient réellement adhérentes par tous les points de leur superficie à la masse de ces organes on ne peut expliquer, conformément aux principes de la physique, le renforcement des vibrations sonores qu'en admettant que le volume des gaz contenus dans vessie, ou, ce qui est le même chose, que la capacité de cet organe a naturellement des rapports exacts de grandeur avec celle des nombres de vibrations sonores que lui sont transmises. L'exactitude des rapports que suppose cette explication ne s'accordant pas avec plusieurs faits ichthyologiques, entre autres avec les incessants changements de volume que submit nécessairement la vessie pneumatique quand le poisson vient du fond de l'eau à la surface ou s'enfonce dans la profandeur des mers, cette explication n'est acceptable qu'en admettant que si ces rapports existent réellement ils doivent pouvoir varier d'une certaine quantite sans que le degré de renforcement des sons soit grandement modifié."

In speaking of the Sciænidæ, Dufossé says that the sound is produced for the most part by muscles; but a little later, in speaking of *Pseudosciæna aquila,* he says

"Le mécanisme de la production des sons chez les individus de l'espèce *Sciæna aquila* est plus compliqué que celui des poissons dont j'ai parlé jusqu' à présent (*lyre*). Je n'ai nullement la pretention de donner la théorie de ce mecanisme."

Just why Dufossé makes this statement is not intelligible, for all the drumming fishes of America that have been examined have the same mechanism, and it is very evident that the sound is produced in exactly the same way. As Dufossé examined only European forms, however, he may have observed a difference in structure that is not present in the American species.

The fact that Dufossé stated that he could not explain the mechanism in *Sciæna,* while for the Gurnard lyre his explanation was not in accordance with physical phenomenon, has possibly led more recent ichthyologists to ignore his work. Thus we find that Günther (1880) in speaking of the American drum (*Pogonias cromis*) says,

"It is still a matter of uncertainty by what means the "Drum" produces sounds. Some naturalists believe that it is caused by the clapping together of the pharyngeal teeth, which are very large molar teeth. However, if it be true that the sounds are accompanied by a tremulous motion of the vessel, it seems more probable that they are produced by the fishes beating their tails against the bottom of the vessel in order to get rid of the parasites with which that part of their body is infested."

That these explanations of Günther are unwarranted will be seen from experiments soon to be described.

Sörensen (1895) disagrees with Dufossé's statement that it is the vibration of the muscles while contracted which produce the sound and that the air-bladder only intensifies the sound. Sörensen considers the sound as being produced by vibrations of the air in the air-bladder and of the walls of the latter when set in motion by the muscles with the fascia of which it is connected.

Jordan and Evermann (1902) say that "most of the species make a peculiar noise, variously called croaking, grunting, drumming, or snoring, supposed to be produced by forcing air from the air-bladder into one of the lateral horns."

We have presented to us then, four distinct mechanisms in the Sciænoids:

1. Muscular tone; the vibrating muscle producing a sound which is intensified by the air-bladder (Dufossé).

2. Clapping together of pharyngeal teeth (Günther).
3. Vibrations of air in air-bladder and of the walls of the latter when set in motion by certain muscles (Sörensen).
4. Forcing of air from air-bladder into one of lateral horns (Holbrook, Jordan and Evermann).

Experiments to Determine Cause of Sound.

That the explanation given by Günther is wrong can be very easily seen from the following experiments, in all of which the animals were kept alive by artificial respiration, i. e. by irrigating the gills with a stream of fresh water.

Experiment I. The air was drawn from the swim-bladder of a squeteague by means of a trochar and the drumming immediately ceased.

a. The stomach was then filled with water. The drumming returned but not as loud as normal.

Experiment. II.— An incision one inch long was made in the mid-ventral line. Through this a portion of the air-bladder was pulled out but the drumming continued.

a. The bladder was now amputated and the drumming ceased.

b. A collapsed rubber balloon was then inserted into the abdominal cavity, and, as soon as it was inflated, the drumming returned with apparently normal intensity and pitch.

c. The rubber balloon was filled with salt water instead of air. The drumming continued until the water was allowed to escape; then it ceased. The tone is low and apparently changed but little under the different conditions.

Experiment III.— The air-bladder of a male squeteague was removed. The drumming ceased. The air-bladder from a female squeteague, which can produce no noise, was inserted into the abdominal cavity of the male, and the drumming immediately returned.

These three experiments show conclusively that the "clapping together of the pharyngeal teeth" has nothing to do with the production of the drumming noise in the squeteague. It is also shown in experiment III that there is no difference between the function of the bladder in the male, which drums, and that of the female, which does not drum, as far as the noise-production is concerned.

Experiment IV.— The entire viscera (intestines, spleen, liver, reproductive organs and air-bladder) were removed from a male squeteague. The drumming stopped, and the *sonificus* contracted as usual, but there was no noise. A rubber balloon filled with air was then inserted into the abdominal cavity. The drumming again returned, but was not of normal character.

a. The balloon was filled with water and the drumming continued, but was weaker and of apparently different pitch.

This experiment shows that an inflated rubber balloon can take the place of all the abdominal organs in respect to noise-production; although it does not prove that these organs may not play some part in the normal mechanism.

To determine whether there is any experimental basis for the view held by Jordan and Evermann, viz: that the drumming is produced by forcing air from the air-bladder into one of the lateral horns, the following experiments were undertaken.

Experiment V.— An incision about one inch long was made in the mid-ventral line of a male squeteague. The air-bladder was ligatured in the middle, thus separating the organ into two chambers,— the anterior containing the lateral horns, and the posterior remaining a simple closed cavity. Drumming, however, went on as in normal animals.

a. The part of the bladder posterior to the ligature was punctured. The drumming continued only in the region of the anterior part of the bladder, which remained inflated.

b. Another animal was prepared in the same way, and the part anterior to the ligation was punctured. The drumming continued only in the region of the posterior portion of the bladder, which remained inflated. In this part of the bladder there are no lateral horns.

c. The posterior end of the bladder was then folded into the anterior part of the abdomen. The drumming noise then came from the anterior part of the abdomen in the region of the inflated half-bladder.

d. The anterior half of the bladder was amputated, leaving the posterior part still inflated. This was inserted at different places and the drumming noise occurred wherever this part of the bladder was placed.

Experiment VI.— An incision was made in the mid-ventral line of a large "drummer," about half way between pectoral and anal fins. At the right angles to this incision, longitudinal incisions were made on both sides, extending nearly to the region of the kidney. These incisions were made through the drumming muscles. The air-bladder and viscera were lifted up with forceps, and the remaining part of the drumming muscle and central tendon was cut. This separated the entire muscle, tendon and insertion into halves — an anterior and a posterior part. The drumming still continued on both sides of the bisection. In order to show this still more completely, the anterior half of the abdomen was raised by inserting two fingers, which prevented the drumming in this (anterior) part, while the posterior gave the same characteristic noise. Next, the posterior half of the abdomen was raised in the same manner, and the drumming stopped in the posterior part but continued in the anterior. Upon removing the fingers, the noise continued as in normal animals.

a. The air-bladder was ligatured in the same place as the bisection of the muscle. The drumming occurred as before. Again the anterior and the posterior parts were in turn raised, and the drumming was made to occur in either part at will.

The two experiments V and VI, as well as the previous ones, prove conclusively that the lateral horns have nothing to do with producing the drumming noise; and the forcing of air into the lateral horns, if such takes place, is not the true explanation.

It remains now to consider the views of Dufossé and of Sörensen. Is this drumming a muscular tone, i. e., a sound produced by the vibrating muscle and intensified by the air-bladder (Dufossé), or do certain muscles set into vibration the air in the air-bladder and the walls of the latter (Sörensen)?

Experiment VII.— The entire abdominal viscera except the air-bladder were removed. Contractions of the muscles occurred, but no noise. The rubber balloon was inserted into the abdominal cavity and inflated (the air-bladder being intact and inflated). The drumming returned. When the balloon was allowed to collapse, the noise ceased.

a. The abdominal cavity was packed tight with cloth (the air-bladder being intact and full of air). The drumming was loud, and when the cut edges were drawn together, it increased to a normal drum. When the cloth packing was removed, the muscle still contracted, but no noise was heard. When the cavity was packed a second time with cloth, the drumming became again audible.

Experiment VIII.— The entire viscera, including the air-bladder, were next removed. Notwithstanding the large hemorrhage that occurred, the *sonifici* still contracted. The rubber balloon was inserted and inflated with air. The drumming noise returned of apparently the same pitch but not so loud as normal.

a. The central tendon was then cut longitudinally into two parts. The muscles on either side contracted rhythmically, as could be seen from the vibrations of the cut ends of the tendon. There were, however, no vibrations of the abdominal muscles, such as are seen in normal animals. This was as might be expected, because after cutting the central tendon the two drumming muscles have nothing to work against. The inflated rubber balloon now produced no sound. This seems to show that the air-bladder does not act as an intensifier of muscular tone. The experiment suggests that the air-bladder functions either in maintaining the tension inside of the abdominal cavity, or as a vibrating organ or both.

Experiment IX.— Incisions were made on both sides of the median line of the abdomen. After this operation the drumming remained perfectly normal. The *m. sonifici* were then cut from their origin on the abdominal muscles. One side was amputated first, and the drumming still continued. While the one on the opposite side was being cut, the drumming died away gradually until the drumming muscle was severed its entire length, when the noise ceased. Yet at this time the muscle contracted, as could be easily felt by touching it with the finger.

If now the air-bladder served as an intensifier of the muscular vibrations, we might ask why it suddenly ceases to fulfill that function in the above experiment. Also, in experiment II *c*, drumming occurs when the air-bladder is replaced by a rubber balloon filled with water. This water-bladder cannot be looked upon as an intensifier of sound or a resonator.

The foregoing experiments show that any part of the muscle can produce the drumming when conditions are suitable. We have also seen that by lifting a part of the abdominal muscles, the drumming over that part immediately ceases. That the most ventral parts of the abdomen are active in drumming is evident from the vibrations of this part of the body of a squeteague. The whole mid-ventral area, from pectoral fins to anus, pulsates in a strong rhythmical manner, which corresponds to the contraction of the *m. sonificus* as can be readily seen from the appended kymograph tracings.

Experiment X.— An incision one inch long was made about half way between the pectoral fins and the anus and at right angles to the long axis of the body. Great care was taken in order not to injure the drumming muscles. Between the ventral muscles and air-bladder was inserted a piece of sheet cork about two and one-half inches long and two inches wide. This stretched severely the mid-ventral part of the abdominal muscle and held it rigid, so that it could not be pulled in when the *sonificus* contracted. No noise was produced, yet the muscle apparently contracted in a perfectly normal manner. This would again show that the drumming is not a muscular tone intensified by the air-bladder.

The drumming is undoubtedly a sexual character, for in the squeteague the male only makes this noise. The female not having developed any drumming muscles is not able to produce this sound. In some other sciænoids, as the croaker, both male and female produce the drumming, but the former is said to produce a much more intense noise than the female. I have often observed that the drumming muscles in the male croaker are much thicker and heavier than in the female.

The conclusion is that by each contraction of the *m. sonificus* a sudden blow is dealt which throws into vibration the abdominal walls and organs. The physics of this phenomenon is very complex, as undoubtedly all of the abdominal parts play a rôle. But the organ that chiefly participates in the vibration is the swim-bladder with its walls made tense by the pressure of the contained gas. It is well known that in man the chest walls and abdominal walls can be set into irregular vibration by being percussed and that there is here a resonance effect produced by a resonance cavity or semifluid material which is selectively set in resonance vibration. The gas pressure in the air-bladder as well as the character of the muscular contractions which will be immediately described indicate the same conclusion.

In all of the above experiments the pitch of the drumming sound was not determined with scientific accuracy. Undoubtedly if the tone could have been determined by physical apparatus the pitch, which to the ear was apparently the same, would have been found to be different in the various experiments.

Experiments to determine character of the muscular contraction.

The character of the contraction of the red drumming muscles has never been studied, nor has the relation of the contractions to the pitch of the drumming been accurately recorded. Dufossé has given the pitch of the drumming of the meagre as well as he could determine it by the ear alone. The following experiments were performed in carrying on the present study:

Experiment XI.— The first experiment was made so as to record the number of vibrations produced by the abdominal tissue in the mid-ventral line during the process of drumming. To accomplish this, a light wooden lever was made, with a piece of sheet cork two inches long and one half inch wide attached at the bottom, and a fine wire inserted in the top at right angles to the lever. The cork was held in place on the abdomen of the squeteague by two rubber bands going around the fish and over each end of the cork strip. The revolving drum of the kymograph was then placed so that the wire point would trace on the smoked paper of the drum. Thus when the animal commenced to drum, the vibration of the part of the abdomen under the lever would be traced by the writing point on the smoked paper. The drum of the kymograph revolved once in 4.848 seconds, and its circumference was 48.5 cm. The tracings are given on Pl. VIII, fig. 1. The number of vibrations per second, as determined by comparison with the tracings of a tuning fork vibrated 100 times per second, is 24.

Experiment XII.— A control experiment was made the next day on another squeteague, but with the drum of the kymograph revolving only once in 20.202 seconds. The number of vibrations should agree or at least be within the limits of experimental error. The tracings are given on Pl. VIII, fig. 2. The number of vibrations is again 24 per second.

In both of the above experiments the lever was placed on the mid-ventral line just posterior to the pectoral fins.

Experiment XIII.— The next experiment was to determine whether the anterior and posterior ends of the abdomen vibrated synchronously, or whether the vibration passed over the abdomen like a wave, from anterior to posterior, or vice-versa. Mere observation as well as the resting of the fingers on the anterior and posterior parts at the same time detected that all the muscle-fibres contracted synchronously. To determine this more accurately, two levers were arranged — one being placed just posterior to the pectoral fins, and the other just anterior to the anus — so that they should write under each other on the smoked paper. The traces indicated that the entire abdominal mechanism vibrated synchronously; hence all the fibres of the two drumming muscles contract at the same time under stimuli controlled by the central nervous system of the animal.

Experiment XIV.— In a fresh male squeteague an incision one inch long was made on one side through the thick, white abdominal muscles until the red *m. sonificus* was exposed. The cork base of the lever was inserted through this opening until it rested on the red muscle within. With the lever in this position and the animal on its side, the writing point should not move up and down in a perpendicular plane, but should move horizontally, back and forward. This, then, should give in the kymograph reading a series of dots, representing the apex of each curve. Such a tracing was recorded on the drum of a kymograph. The vibrations were 24 per second. From this experiment it is seen that the muscle itself and the abdominal tissue vibrate at exactly the same rate.

Experiment XV.— Another experiment was made to show the effect of substituting an inflated rubber balloon for the air-bladder. The number of vibrations was 24 per second. It is thus evident that the vibrations produced in the presence of the rubber balloon are the same as in the normal condition of the animal.

The five preceding experiments agree in the rate of vibrations of the abdominal part which is in immediate relation to the drumming muscles, and which is directly connected with sound production according to our present views. It was next necessary to record the contractions of the muscle itself, and for this purpose the following two experiments were performed.

Experiment XVI.— An incision two inches long was made in the mid-ventral line just posterior to the pectoral fins. Through this opening was inserted a slender wire with a sharp hook on one end and an eye on the other. The hook was fastened directly into the fibers of the *m. sonificus.* The eye was attached to an ordinary muscle-lever which was supplied with a writing point. The kymograph was then placed so that it would receive the tracings made by the writing point.

In this experiment none of the viscera were disturbed and the noise produced differed in no way from that of the normal animal. To measure the time, a tuning fork was used, whose double vibrations of 100 per second were registered on the revolving drum. The rate of the contractions is 24 per second, which is identical with the experiments made on the abdominal walls. As is shown in Pl. VIII, fig. 3, the amplitude of the contractions is much more than in the experiments made on the abdominal walls. This is undoubtedly due to the release in tension caused by the separation of the right and left abdominal portions to which these muscles are attached, together with some resistance caused by the rubber bands. To determine this point another experiment was made in which the vibrations of the abdominal wall were registerd by a wire hook attached at one end to the *rectus abdominis* and the other to the muscle-lever. With this method the amplitude of vibration is nearly the same as that of the muscles. It was noticed, too, that when the amplitude was the greatest the loudest sound was produced in both the experiments on the abdominal walls and on the drumming muscle.

Experiment XVII.— Experiment XVI was repeated, except that the air-bladder was punctured. The drumming noise stopped. The contractions of the drumming muscles, registered as in the preceding experiment, are given on Pl. VIII, fig. 4. The number of contractions computed from those of a tuning fork is 24 per second.

It is very evident that there is no difference between the contractions when the swim-bladder is full of air and when it is collapsed, and that this organ has no effect upon the contractions of the drumming muscle. This is especially well demonstrated in the tracings where the register of the muscular contractions in an animal with the bladder intact is placed directly over these from an animal in which the bladder is collapsed (Pl. VIII, fig. 4).

Experiment XVIII.— The viscera, including the swim-bladder, were removed from a squeteague after an incision had been made in the mid-ventral line from the pectoral fins to the anus. The wire hook of the registering apparatus was inserted into the middle of the central tendon. No noise was produced. The number of contractions was 24 per second. The amplitude of vibration was less than some registered by the muscle and more than others. The experiment revealed no new factor.

In the experiments just described each contraction of the muscle, represented in the tracing by the apex of the curves, is simultaneous with the sound produced, and thus the rapid series of contractions institute the roll or "drumming."

Experiments to determine the pressure of the gas in the swim-bladder.

Experiments were made to discover, if possible, the pressure exerted on the air-bladder by the contraction of the drumming muscles.

Experiment XIX.— The pressure of gas in the air-bladder of a female squeteague (which has no drumming muscles and can not drum) was determined by making an incision one inch long in the mid-ventral line two inches anterior to the anal fin. The posterior end of the swin-bladder was ligatured and then amputated just back of the ligature. The open end of a small mercurial manometer was inserted and tied by another ligature. The first ligature was then removed and the mercury rose to a height of 4 mm., which was produced by the normal pressure of the gas in the air-bladder. The animal was kept alive by artificial respiration.

a. The same experiment was then tried on the swim bladder of a male squeteague, both while it was quiet and while it was drumming. In the quiet animal, the pressure rose to 4 mm. and remained there until drumming occurred, when it rose to 6 mm. In other words, the increased pressure brought about by the contraction of the drumming muscles equalled 2 mm. of mercury. During the drumming the meniscus of the mercury could be seen to oscillate between 4 mm. and 6 mm., as the muscles successively contracted and then relaxed.

One interesting feature is that in all the animals examined the normal pressure in the bladder was 4 mm. in the male and female — the large and small animals alike. The gas pressure within the swim-bladder maintains a tension on the elastic walls, while the increased density of the gas due to the pressure tends to produce a louder sound than would otherwise occur. These experiments show that

1. The chief cause of the drumming is the contraction of the drumming muscles.

2. As the myogram distinctly shows, the contraction of the drumming muscles is of the nature of a series of simple contractions.

3. These muscles contract at a definite rate, viz.: 24 vibrations per second.

4. By the force of each contraction the abdominal organs are set into vibration, especially the walls of the air-bladder.

5. The elastic walls of the air-bladder are always tense, because of the pressure of the contained gas. This pressure is increased each time the drumming muscles contract.

6. The vibration of the tense walls of the air-bladder and the contained gas are sufficient to produce the drumming noise.

7. The sound produced is low. The actual number of sound vibrations was not determined.

Sound production in the Sea-Robin and the Toadfish.

Experiments to Determine Cause of Sound and Character of Mechanism.

If a sea-robin is examined under artificial respiration, the single twitch of the abdomen when a grunt is made can be very easily observed. If the animal is opened along the mid-ventral line, both the contraction of the intrinsic muscles and the single twitch of the swim-bladder can be observed. The noise is of the same pitch and loudness after the abdomen has been opened as before. The removal of all the viscera except the air-bladder has no effect on the noise produced. It is noticed that the two muscles contract simultaneously.

Experiment XX.— An animal under artificial respiration was opened, and various parts of the bladder were stimulated by a current from an induction coil, viz.:

a. One of the two nerves supplying the bladder was stimulated. A perfectly normal grunt was produced.

b. The fibrous part of the bladder was then stimulated. A normal grunt was not produced.

c. The muscle itself was stimulated directly. Again a perfectly normal sound was produced.

These experiments show only that artificial stimulation of either nerve or muscle will cause a normal sound to be produced.

Experiment XXI.— The swim-bladder was removed from a fresh specimen and laid upon the operating table. The nerves and the muscles of the bladder were then stimulated successively as in experiment XX. In each case there was a grunt of the same pitch and intensity as is produced by the normal animal.

This shows very clearly that the sound-producing mechanism of the sea-robin is entirely within the bladder and its intrinsic muscles. This mechanism, then, stands in direct contrast to that of the drumfishes, just discussed.

Experiment XXII.— The swim-bladder was removed from a sea-robin. The muscle was stimulated and an audible grunt was produced. The bladder was then placed on an improvised registering apparatus, so arranged that the bladder was connected with a muscle lever and writing point. The muscle was then stimulated. An audible grunt resulted. The vibration of the bladder was registered on the drum of the kymograph. The grunt is produced by one single sharp contraction of the intrinsic muscle (Pl. VIII, fig. 6). This was repeated each time that the muscle was stimulated.

a. One of the lobes of the bladder was now punctured. Both lobes collapsed. Through the opening was inserted the rubber balloon (collapsed). This was inflated; the muscle was thus superimposed over the inflated rubber balloon. The muscle was then stimulated as before. It contracted and produced a grunt the same as in the isolated bladder full of air. Moreau (1876) concluded that it was the vibration of the perforated internal septum which was the direct cause of phonation. That this septum vibrates is true, but from the foregoing experiment it would seem that the walls of the air-bladder are the chief vibrating organ. In the sea-robin the left lobe only possessed the internal septum, but it made no difference with the sound produced whether the right lobe or the left lobe was used for the experiment.

b. The uninjured lobe was filled with salt water and closed by a ligature. The muscle was then stimulated by a current from an induction coil. A grunt occurred as when the swim-bladder was filled with air, although not so loud. These contractions were recorded by means of a kymograph and are given on Pl. VIII, fig. 7. On comparing the record with those given on Pl. VIII, fig. 6, it is evident that the curves have about the same amplitude, but are not so well sustained.

Experiment XXIV.— The swim-bladder was removed from a sea-robin as quickly as possible. The muscle was stimulated by a current from an induction coil. An audible grunt resulted. This sound was more intense when the bladder rested on the table. It is interesting to note that this particular animal did not produce any noise while alive. The isolated bladder was then placed on the registering apparatus, and records were obtained under single stimulations and also by stimulations continued for several seconds. The records are given on Pl. VIII, fig. 8. The character of the curve is changed by the continued stimulation, the muscles going into incomplete and then complete tetanus. Tetanic contraction does not appear to be the normal procedure, but is produced by artificial stimulation. And as far as could be determined, the sound was produced at the beginning of the tetanus, i. e. at the first up-stroke of the lever, and died out during the remainder of the contraction. The loudest grunts were produced at single full contractions of the intrinsic muscles. The sound produced starts with a grunt, which gradually dies out. It does not resemble drumming.

a. The bladder was then punctured and all of the air expelled from both lobes. The muscle was again stimulated, but there was no sound, although the muscle contracted as usual. The collapsed rubber balloon was inserted into one lobe of the bladder, and then inflated. Upon stimulation a grunt was produced. The bladder was now inflated still more, and upon stimulation a grunt of higher pitch was produced. When the bladder was inflated still more, the pitch became yet higher.

b. The rubber balloon was now filled with sea-water and the muscles stimulated. A grunt was produced, although the pitch was apparently changed.

It is very evident then, that in the sea-robin and the toadfish the swim-bladder with its intrinsic muscle is an organ for the production of sound. By the contraction of the intrinsic muscle the tense walls of the air-bladder are made to vibrate, thus producing the sound.

These grunts can be imitated very closely by drawing the forefinger and thumb towards each other over the surface of an inflated rubber balloon, especially if the rubber is dry or has been resined.

Conclusions.

I. The sciænoid fishes that make a drumming noise have specific sound-producing muscles which are only superficially attached to the swim-bladder. For this drumming muscle the name *musculus sonificus* has been proposed and adopted.

II. The chief cause of the drumming noise is the contraction of the *m. sonificus,* which produces a vibration of the abdominal walls and organs, especially the swim-bladder.

III. The sea-robin and the toadfish, which make a grunting noise, have muscles which are intrinsically connected with the swim-bladder and are known as *intrinsic* muscles.

IV. The cause of the grunting noise is the contraction of the intrinsic muscles which produce a vibration in the walls of the air-bladder.

V. The mechanism in the Sciænoidæ is adapted to the production of rapidly repeated sounds or rolls.

VI. The mechanism in the sea-robin and the toadfish is adapted to the production of sounds repeated at more or less long intervals.

Literature Cited.

CUVIER, GEORGES. The animal kingdom arranged in conformity with its organization, by the Baron Cuvier, with supplementary additions to each order, by Edward Griffith and others. Vol. X, Class Pisces, with supplementary additions, by Edward Griffith and Charles Hamilton Smith. London, 1834.

BRIDGE, T. W. Cambridge Natural History, vol. VII, 1904, Fishes, p. 359.

DUFOSSÉ. Recherches sur les bruits et les sons expressifs que font entendre les poissons d'Europe et sur les organes producteurs de ces phénomènes acoustiques ainsi que sur les appareils de l'audition de plusieurs de ces animaux. Annales des Sciences Naturelles, 5me ser., t. XIX, 1874, art. 5, 53 p., pl. 16, 17, 18, 19, and t. XX, art. 3, 134 p.

GÜNTHER, A. An introduction to the study of fishes. 1880.

HOLBROOK, J. E. Ichthyology of South Carolina. 1860. [2nd ed.]

JÄGER, A. Die Physiologie und Morphologie der Schwimmblase der Fische. Archiv für die gesammte Physiologie, bd. XCIV, 1903, p. 65–138.

JORDAN, D. S., and EVERMANN, B. W. American food and game fishes. 1902.

LICHTENFELT, H. Literatur zur Fischkunde, p. 68, 1906.

MOREAU, A. Sur la voix des poissons. Comptes Rendus de l'Académie des Sciences, Paris, 1864, Aug. 29, p. 436.

—— Recherches experimentales sur les fonctions de la vessie natatoire. Annales des Sciences Naturelles, 6me ser., t. IV, 1876, art. 8, 85 p.

SMITH, H. M. The drumming of the drumfishes (Sciænidæ). Science, n. s. vol. 22, 1905, p. 376.

SÖRENSEN, W. Are the extrinsic muscles of the air-bladder in some Siluroidæ and the "elastic spring" apparatus of others subordinate to the voluntary production of sounds? What is, according to our present knowledge, the function of the Weberian ossicles? Journal of Anatomy and Physiology, vol. XXIX, n. s. vol. IX, 1895, p. 109–139, 205–229, 399–423, 518–552.

—— Om Lydorganerhos Fiske. Kjöbenhaven, 1884.

WHITE, J. Voyage to the seas of China. 1824.

PLATE VI.

PLATE VI.

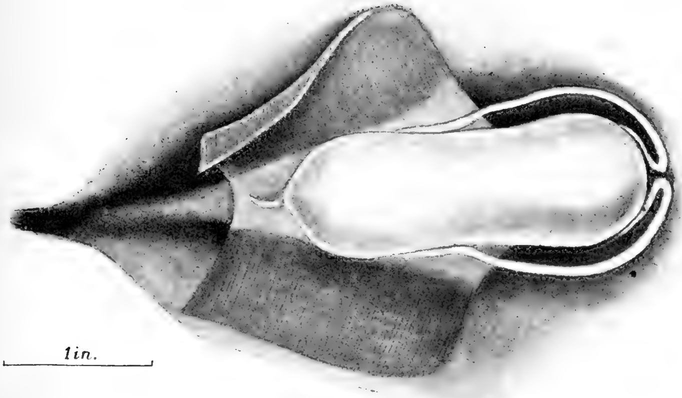
Fig. 1. Swim-bladder of Micropogon undulatus.

In normal position resting on the central tendon which joins the m. sonificus of either side.

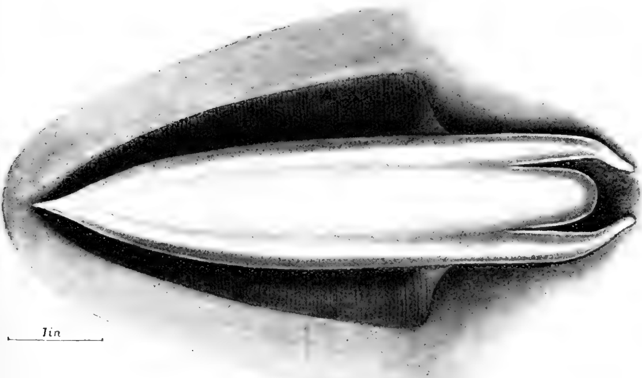
The two lateral horns extend back over the bladder three-fourths of its entire length.

Fig. 2. Swim-bladder of Cynoscion nebulosum.

In normal position resting on the central tendon which joins the m. sonificus of either side.



1



2

PLATE VII.

PLATE VII.

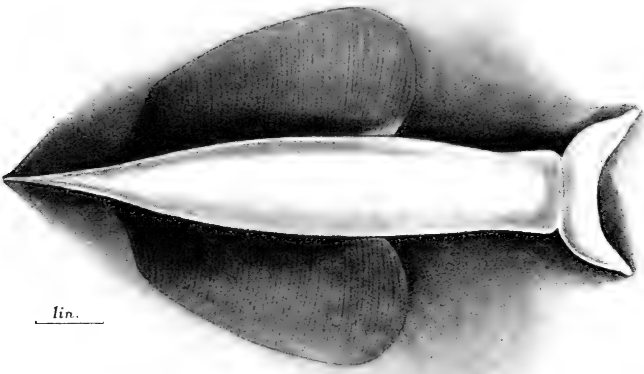
Fig. 1. Swim-bladder of Bairdiella chrysura.

In normal position resting on the central tendon which joins the m. sonificus of either side.

Fig. 2. Swim-bladder of Leiostomus xanthurus.

In normal position resting on the central tendon which joins the m. sonificus of either side.

The undissected portion at the anterior of the bladder shows how the two m. sonifici completely inclose the swim-bladder.



1

2

PLATE VIII.

PLATE VIII.

KYMOGRAPH RECORDS OF SOUND-PRODUCING SWIM-BLADDERS.

Fig. 1. Squetague. Normal swim-bladder. Twenty-four vibrations per second (rapidly revolving drum).

Fig. 2. Squeteague. Normal swim-bladder. Twenty-four vibrations per second (slowly revolving drum).

Fig. 3. Squeteague. Myogram of m. sonificus. Twenty-four vibrations per second.

Fig. 4. Squeteague. Myogram of m. sonificus.
a. Swim-bladder normal. b. Swim-bladder collapsed.

Fig. 5. Tuning fork having one-hundred double vibrations per second. Kymograph drum revolving at same rate as for Figs. 1, 3, and 4.

Fig. 6. Prionotus. Swim-bladder removed.

Fig. 7. Prionotus. Swim-bladder removed and filled with sea-water.

Fig. 8. Prionotus. Swim-bladder removed. Prolonged stimulation.

Fig. 1.

Fig. 2.

Fig. 3.

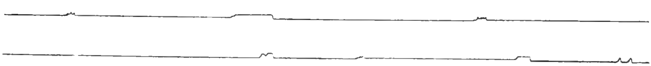
Fig. 4. a b

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.



[Annals N. Y. Acad. Sci., Vol. XVIII, No. 6, Part II, pp. 181–263. 11 May, 1908.]

THE NORTH AMERICAN SPECIES OF THE GENUS IPOMŒA.[1]

By Homer Doliver House, B. S., M. A.

Introduction.

A comparative study of specimens of the *Convolvulaceæ*, representing the species placed by Linnæus[2] in *Ipomœa* and *Convolvulus*, shows that the two groups as there constituted, are far from homogeneous. The type of *Convolvulus* is *Convolvulus major albus*, Tournefort, pl. 17 = (*Convolvulus sepium* L.). The species included in *Ipomœa* by Linnæus do not accord, except in part, with the diagnosis given by him in the Genera Plantarum (1737), where it is stated that the stamens are exserted, and pl. 39 of Tournefort[3] is cited. This is *Quamoclit foliis tenuiter incisis & pinnatis* (=*Ipomœa quamoclit* L.). Under most circumstances this would establish it as the type of the genus, but it must be remembered that the genus *Quamoclit* was an accepted and valid genus before Linnæus called it *Ipomœa* and the genus has since been restored to generic rank by Moench.[5] In the 5th. edition of the Genera Plantarum (1752), the Tournefort reference to pl. 39 is still retained, with the addition of "*Volubilis* Dill. Elth. 318." The first species figured by Dillenius under *Volubilis* is *V. zeylanica pes-triginus, pl. 318. f. 411.* (=*Ipomœa pes-triginus* L.)

In deference to historical usage and long continued uniformity, the writer does not believe it necessary to restrict *Ipomœa* to the group of species typified by *Ipomœa quamoclit* L., but is inclined to accept the species first figured by Dillinius under *Volubilis*, if it is necessary to designate a type for the genus *Ipomœa*. Without doubt the plant of greatest economic importance is *Ipomœa batatas* (L.) Lam. but as that was placed in *Convolvulus* by Linnæus and was known as *Batatas*[4] in pre-Linnæan literature, it has nothing to recommend it as an acceptable type of the genus. If *I.*

---

[1] Presented in abstract to the Academy at the regular meeting on 9 March 1908. Manuscript delivered to Secretary 10 March, 1908.

[2] Species Plantarum, 1753; ed. 2, 1762–63.

[3] Institutiones rei Herbariæ, 1700.

[4] Rumph. Amb. **5**: 367. pl. 130. 1750

[5] Moench, Meth. 453. 1794.

quamoclit were to be recognized as the type of *Ipomœa*, the present genus *Quamoclit*[1] would have to take the name *Ipomœa*. This would cause a most sweeping change of names, which would be neither logical nor conductive to the future stability of its nomenclature.

No historical review of the genus will be attempted here, but the citations of species and synonyms is made as complete as possible, with the object of supplying the absence of a bibliography and historical sketch of the genus, and its divisions. The treatment of the genus *Ipomœa* in the following pages is in many respects similar to that of Choisy,[2] Meissner,[3] Grisebach,[4] and Asa Gray.[5] The writer includes *Batatas* Choisy, *Pharbitis* Choisy, *Leptocallis* G. Don and *Bombycospermum* Presl, in *Ipomœa*; while the following genera are excluded as worthy of generic rank, *Operculina* S. Manso, *Quamoclit* (Tourn.) Moench, (incl. *Mina* Llav. & Lex.), *Exogonium* Choisy, *Calonyction* Choisy, *Turbina* Raf. and *Rivea* Choisy.

The writer is under deep obligations, for valuable suggestions and aid, to Dr. N. L. Britton of the N. Y. Botanical Garden; Dr. J. N. Rose and Mr. J. H. Painter of the U. S. National Museum; Dr. B. L. Robinson and staff of the Gray Herbarium of Harvard University.

The revision of the genus here presented is based upon the collections in the following institutions, the letter preceding each being used to indicate the locations of the specimen in the citation of specimens in the following pages.

(N). National Herbarium, U. S. National Museum, Washington, D. C.
(Y). New York Botanical Garden, New York, N. Y.
(C). Columbia University Herbarium in the N. Y. Botanical Garden.
(G). Gray Herbarium of Harvard University, Cambridge, Mass.
(M). Museo Nacional Mexicana, Mexico City, Mex. (Herb. Manual Urbina).
(J). Dept. of Agriculture, Jamaica; Hope Gardens, Jamaica, B. W. I.

Synopsis of the genus Ipomœa.

IPOMŒA L. Sp. Pl. 159. 1753.

Annual or perennial climbing or trailing vines or sometimes upright shrubby or tree-like plants. Leaves alternate; blades entire, angled, lobed

[1] Moench, Meth. 453. 1794.
[2] In DeCandolle Prodromus **9**: 335–396. 1845.
[3] Meissner, in Mart. Fl. Bras. **7**: 200–370. 1869.
[4] Fl. Br. West Indies, 466–476. 1861.
[5] Syn. Fl. N. Am. **2**[1]: 207–224. 1878.

or divided, usually petioled. Flowers solitary on axillary peduncles or in cymes, rarely in raceme-like clusters. Sepals 5, membranaceous or rather fleshy, sometimes becoming leathery, often herbaceous, closely imbricated, sometimes elongated. Corolla funnelform or funnelform-campanulate, rarely salverform, the tube often constricted within the calyx, the limb usually spreading, the plicæ ending at the middle of the margin of each lobe, rarely between the lobes. Stamens 5, included, rarely exserted. Ovary 2-, 3-, 4- or rarely 5-celled. Styles united. Capsule mostly septifragally 2-, 3-, 4- or 5-valved, sometimes thick-walled and elongated. Seeds glabrous, pubescent or hirsute on the angles, often with a long wool-like coma on the dorsal angles.

Key to the Sections of Ipomœa.

Plants erect, stout, perennial, shrubby or tree-like; leaf-blades rarely cordate. SECTION I. ORTHIPOMŒA.
Plants twining, creeping or prostrate, stout or slender; leaf-blades often cordate.
Sepals herbaceous, often elongated and hairy; ovary usually 3-celled. SECTION II. PHARBITIS.
Sepals coriaceous, membranaceous or subherbaceous; rarely elongated; ovary usually 2- or 4-celled. SECTION III. BATATAS.

Key to the Subsections.

I. ORTHIPOMŒA.

Shrubby below or with stout, erect or ascending herbaceous stems.
Sepals lanceolate, acuminate; plant silvery. 1. **Argyrophyllæ.**
Sepals ovate or ovate-oblong, usually obtuse or acute; foliage not silvery but often pubescent. 2. **Leptophyllæ.**
Arborescent, erect and woody. 3. **Arborescentes.**

II. PHARBITIS.

Inflorescence densely capitate or leafy-bracted. 4. **Cephalanthæ.**
Inflorescence not conspicuously bracted or capitate.
Ovary typically 3- or 5-celled.
Outer sepals becoming different from the inner ones, cordate or truncate and often conspicuously broadened at the base. 5. **Heterophyllæ.**
Sepals not becoming cordate or truncate nor conspicuously enlarged in fruit.

Leaf-blades entire or variously 3-lobed. 6. **Hederaceæ.**
Leaf-blades palmately 5-divided. 7. **Cissoides.**
Ovary typically 2-celled; blades often 3-lobed. 8. **Tyrianthinæ.**

III. BATATAS.

Stems prostrate or creeping, not twining. 9. **Erpipomœa.**
Stems trailing or twining, at least the tips twining.
Seeds with dorsal or marginal coma longer than the seed or completely covered with long hairs (**Eriospermæ**).[1]
Leaf-blades divided to the petiole into 3 to 9 stalked or sessile leaflets. 10. **Dactylophyllæ.**
Leaf-blades entire or, if lobed, not divided to the petiole.
Pedicels thickened and fleshy, beset with tentacular outgrowths or setæ. 11. **Setosæ.**
Pedicels not conspicuously thickened, neither tentacular nor setaceous.
Inflorescence racemose, suberect or pendant; seeds covered on all surfaces with long wool-like hair. 12. **Bombycospermæ.**
Inflorescence cymose, paniculate or the flowers solitary; seeds with dorsal or marginal hairs only.
Leaf-blades deeply 5-lobed. 13. **Palmatæ.**
Leaf-blades entire or 3-lobed, rarely 5-lobed. 14. **Jalapæ.**
Seeds glabrous or pubescent, at least without a conspicuous coma (**Leiospermæ**).
Leaf-blades palmately or pedately lobed nearly or quite to the petiole; stems slender. 15. **Pedatisectæ.**
Leaf-blades entire, toothed or 3- to 5-lobed.
Sepals small, less than 5 mm. long. 16. **Microsepalæ.**
Sepals larger, 6–20 mm. long, or longer.
Sepals thin and membranaceous, mostly obtuse, unequal; roots enlarged and tuber-like, 17. **Emeticæ.**
Sepals coriaceous; roots rarely tuber-like.
Sepals very unequal. 18. **Anisomeræ.**
Sepals equal or nearly so. 19. **Aequisepalæ.**

Section I. ORTHIPOMŒA.

Erect, bushy, shrubby or tree-like perennials; leaf-blades rarely cordate or lobed; often short-petioled; corollas mostly large and showy; sepals coriaceous or leathery; capsules thick-walled, often elongated; seeds with long wool-like hair on the dorsal angles, or the angles long-hirsute.

---

[1] In cases where it has not been possible to determine with any certainty whether the seeds are hairy or not, the species has been grouped with the *Leiospermæ*.

1. Argyrophyllæ. Plants silvery-pubescent and more or less tomentose; sepals acuminate, lanceolate; corolla white. (*Ipomœa* § *Argyrophyllæ* Baker & Rendle, in T. Dyer, Fl. Trop. Afr. 4^2: 135. 1905.)

One species in North America.	1. *I. ciervensis.*

1. **Ipomœa ciervensis** Painter; House, Bot. Gaz. **43**: 408. 1907.

Shrubby below, 30–60 cm. high, densely silvery-pubescent throughout except the corolla; leaf-blades sessile or nearly so, oblong-lanceolate, acute or obtuse and somewhat 3-lobed, 4–6 cm. long; peduncles 1 cm. long; bracts linear-spatulate or subfoliaceous; sepals ovate-lanceolate, attenuate, about 15 mm. long; corolla white, about 6 cm. long, pubescent without in bud and strigulose on the plicæ when expanded.

Type locality: Hacienda Ciervo, Queretaro, Mexico.

Distribution: Known only from the type locality.

Specimens examined: *Rose, Painter & Rose 9660*, 1905 (type — N, Y). *Altamirano 1557*, 1905 (N).

2. Leptophyllæ. Foliage pubescent or glabrous, not silvery; leaf-blades entire (divided in *I. Pringlei & I. ancisa*); sepals coriaceous, ovate to ovate-laceolate, obtuse; corolla large, purple or white. (*Ipomœa* § *suffruticosæ* Choisy, in DC. Prodr. **9**: 353. 1845.)

Corolla white or cream-colored.	
Sericeous-pubescent; outer sepals much shorter than the inner.	2. *I. petrophila.*
Glabrous or nearly so.	
Leaf-blades linear-lanceolate to oblong-lanceolate; sepals subequal.	3. *I. longifolia.*
Leaf-blades pinnately divided, 5–10 cm. long, sepals very unequal.	8. *I. ancisa.*
Corolla purple, lilac or pink.	
Plant pubescent or hirsute.	
Leaf-blades subsessile, hastately toothed at the base.	
Sparingly pubescent; sepals 10–15 mm. long.	4. *I. stans.*
Densely pubescent; sepals suborbicular, 8–10 mm. long.	5. *I. jaliscana.*
Leaf-blades not toothed at the base.	
Leaves 2 cm. long or more; sepals acute, 8–13 mm. long.	6. *I. durangensis.*
Leaves less than 1 cm. long, woolly-white; sepals obtuse, 5–6 mm. long.	9. *I. lenis.*
Plant glabrous or nearly so.	
Leaf-blades pinnately divided, 2–4 cm. long.	7. *I. pringlei.*
Leaf-blades entire, linear-lanceolate.	10. *I. leptophylla.*

2. **Ipomœa petrophila** House, Bot. Gaz. **43**: 401. 1907.

Stems erect from a large root, pale and finely tomentulose above, 30–60 cm. high; leaf-blades lanceolate, 4–10 cm. long, 3-nerved and obtuse at the ends, finely sericeous pubescent beneath; sepals unequal, oblong, obtuse, the inner ones 8–11 mm. long; corolla white with a pale purple throat, 6–8 cm. long, glabrous; the peduncles 1–3-flowered, 1–5 cm. long; capsules ovoid-conical, 14–16 mm. high, thick-walled.

Type locality: Near Chihuahua, Mexico.

Distribution: Rocky hills, northern Mexico.

Specimens examined: *Pringle 340,* 1885 (type — N). Santa Eulalia plains, *Wilkinson,* 1885 (N).

3. **Ipomœa longifolia** Benth. Pl. Hartw. 16. 1839.— Small, Fl. Southeastern U. S. 962. 1903.

Convolvulus Schumardianus Torr. Bot. Marcy's Rep. 291. 1853.
Ipomœa Carletoni Holzinger, Contr. Nat. Herb. 1: 211. 1892.
Convolvulus Queretanensis Sesse & Moc., Fl. Nov. Hisp. in La Naturaleza II. **1**: 27. 1887.— Fl. Mex. l. c. II. **2**: append. 36. 1893.

Type locality: Mexico.

Distribution: Prairies and plains, Oklahoma and Texas to Arizona and south in Mexico to Queretaro and Durango.

Illustrations: Bot. Reg. *pl. 21.* Contr. Nat. Herb. **1**: *pl. 17.*

Specimens examined: Oklahoma: *Carleton* (N); *Blankinship* (G). New Mexico: *Wright 1617,* 1851. Arizona: *Toumey 2580* (Y); *Lemmon 2834*; *Wilcox 375.* Mexico: Durango, *Palmer 229* (Y, N). Sonora: *Thurber 710.* Queretaro: *Rose, Painter & Rose 9544* (N, Y); *Hartweg 97* (G). Chihuahua: *Palmer 297.* Aguas Calientes: *E. W. Nelson 3887.*

4. **Ipomœa stans** Cav. Ic. **3**: 26. 1794.— Choisy in DC. Prodr. **9**: 355. 1845.

Convolvulus stans H. B. K. Nov. Gen. & Sp. **3**: 96. 1819.
Convolvulus firmus Spreng. Syst. **1**: 613. 1825.
Convolvulus sinuatus Sesse & Moc., Fl. Nov. Hisp. in La Naturaleza II. **1**: 24. 1887. — Fl. Mex. l. c. II. **2**: append. 38. 1893.

Type locality: Matritense.

Distribution: Northern and western Mexico.

Illustrations: Cav. l. c. *pl. 250.* Altamirano, Mat. Mex. *pl. 282.*

Specimens examined from Coahuila, San Luis Potosi, Guanajuato, Hidalgo, Valley of Mexico, Orizaba and Oaxaca.

5. **Ipomœa jaliscana** House, Muhlenbergia **3**: 39. 1907.

Ipomœa stans var. *hirsuta* Robinson, Proc. Am. Acad. **29**: 319. 1894.

Differs from *I. stans* by its more conspicuously hirsute stems and leaves, the sessile leaf-blades which are relatively broader and more deeply lobed at the base; sepals suborbicular, 6–8 mm. long.

TYPE LOCALITY: Rio Blanco, Jalisco.

DISTRIBUTION: Jalisco.

SPECIMENS EXAMINED: *Palmer 324*, 1886 (type—G, N, C). *Pringle 4488*, 1893 (G, N).

6. **Ipomœa durangensis** sp. nov.

Stems erect, 50 cm. tall, finely sericeous-pubescent, densely so above, silvery on young parts; leaf-blades elliptical-oblong, 2–3 cm. long, 5–15 mm. wide, obtuse; peduncles 1 cm. long or less, 1-flowered; sepals subequal, lanceolate, acute, 8–13 mm. long, densely silky-pubescent; corolla slender funnelform, 6–7 cm. long, violet-purple with a white tube, plicæ pubescent without, the limb 5–6 cm. broad; sepals enlarged in fruit with subspatulate tips (not accrescent); capsules globose-ovoid, subacute, 15 mm. high, thick-walled, 2-celled; seeds minutely pubescent with a short coma of hairs on the dorsal angles.

MEXICO; Durango, *E. W. Nelson 4639*, 1898 (type, sheet *No. 332692* — N, dupl. G), *4664*, 1898 (N — *332718*, G). *Palmer 366*, 1896 (N, Y, G).

7. **Ipomœa pringlei** A. Gray, Proc. Am. Acad. **22**: 307. 1887.

? *Ipomœa sescossiana* Baillon, in Bull. Soc. Linn. Par. **1**: 385. 1883.

Tall, erect and rigid; leaf-blades pinnately divided into 5–8 linear or filiform segments, 15–30 mm. long; peduncles stout, 1-flowered, as long as the leaves; sepals oblong, rounded, 7–8 mm. long; corolla blue or purple, 6–7 cm. long; capsules ovoid, 12–14 mm. high on reflexed pedicels, 2-celled; seeds tomentulose with an inconspicuous coma on the dorsal angles.

TYPE LOCALITY: Chihuahua.

DISTRIBUTION: Hilly regions of northern Mexico.

SPECIMENS EXAMINED: Chihuahua, *Pringle 782*, 1886 (type — G, N, Y). *579*, 1885 (G). *E. W. Nelson 6276*, 1899 (N). Durango, *E. W. Nelson 4729*, 1898 (N).

8. **Ipomœa ancisa** sp. nov.

Resembling *I. Pringlei*; leaf-blades 5–10 cm. long, the segments filiform, 2–5 cm. long, .5–1.5 mm. wide; peduncles very stout, 6–11 cm. long, 1-flowered; sepals very unequal, orbicular-ovate, obtuse, with scarious margins; corolla slender-funnelform, white, 7–8 cm. long, the limb 6–7 cm. broad.

MEXICO: Chihuahua, between Colonia Garcia and Pratt's ranch, below Pacheco, *E. W. Nelson 6276*, 1899 (type, sheet *No. 359993* — N).

9. **Ipomœa lenis** sp. nov.

A dwarf, perennial, shrubby plant with thickened, woody base; stems erect, 10–30 cm. tall, densely woolly or silky pubescent with white hairs; leaf-blades sessile, oblong, obtuse at both ends, 6–10 mm. long, 2–4 mm. broad; flowers solitary in the upper axils and often crowded; peduncles 5–8 mm. long; sepals equal, ovate-lanceolate, obtuse, 5–6 mm. long, the outer ones silvery-pubescent; corolla funnelform, 5–6 cm. long, blue, glabrous, the limb 4–5 cm. broad, 5-lobed.

MEXICO: Zacatecas; Near Berriozobal, *E. W. Nelson 3889*, July 8, 1896 (type, sheet *No. 266883* — N, dupl. G).

10. **Ipomœa leptophylla** Torr. in Frem. Rep. 95. 1845.— Emory, Rep. *pl. 11*.— Morris in Plant World **7**: *pls. 5 & 6*.— Small, Fl. Southeastern U. S. 964. 1903.— Roth. Bot. Wheeler 205. 1878.

Convolvulus Caddoensis Buckley in Proc. Phila. Acad. **1862**: 6. 1862.

TYPE LOCALITY: Upper Platte.

DISTRIBUTION: Dry soil, plains of South Dakota and southeastern Montana to Texas and New Mexico.

3. **Arborescentes.** Erect, woody, arborescent or shrubby perennials, often several m. tall; leaf-blades oblong-ovate to narrowly or triangular-ovate, rounded, truncate or subcordate, rarely subsagittate at the base; sepals coriaceous, obtuse; corolla white, rarely pink or purple; capsules narrowly ovoid, or oblong; the coma of hairs on the seeds very long. (*Ipomœa* Sect. *Orthipomœa*, § *Arborescentes*, Choisy in DC. Prodr. **9**: 358. 1845.

Seeds with black coma on all surfaces.
  Twigs and leaves puberulent or glabrous; leaf-blades cordate-sagittate or truncate.
    Leaf-blades oblong, acuminate. — 11. *I. fistulosa.*
    Leaf-blades ovate, short-acuminate. — 12. *I. glabriuscula.*
  Twigs and leaves densely canescent; leaf-blades ovate-cordate. — 13. *I. nicaraguensis.*
Seeds with white coma only on the dorsal angles.
  Corolla and sepal densely woolly without. — 14. *I. murucoides.*
  Corolla and sepals pubescent or glabrous, not woolly.
    Foliage more or less densely pubescent; veins prominent beneath on the blades.
      Leaf-blades ovate, cordate. — 15. *I. arborescens.*
      Leaf-blades, oblong, rounded at the base. — 16. *I. cuernavacensis.*

Foliage glabrous or nearly so.
  Sepals hairy within, 12–16 mm. long. 17. *I. intrapilosa.*
  Sepals glabrous within and without.
    Leaf-blades 2–3 cm. long; sepals 8–10 mm. long. 18. *I. calva.*
    Leaf-blades 7–13 cm. long; sepals 10–12 mm. long. 19. *I. wolcottiana.*

11. **Ipomœa fistulosa** Mart.; Choisy in DC. Prodr. **9**: 349. 1845.—Meissn. in Mart. Fl. Bras. **7**: 239. *pl. 81*. 1869.—Rose, in Gard. & For. **7**: 366. 1894.—Small, Fl. Southeastern U. S. 963. 1903.

Batatas crassicaulis Benth. Bot. Voy. Sulphur 134. 1844.
Ipomœa texana Coulter, Contr. Nat. Herb. **1**: 45. 1890.

Type locality: Brazil.

Distribution: Southern Mexico to Central America, Brazil and Peru, chiefly along rivers near the coast. Adventive northward to Texas and South Carolina.

Specimens examined from South Carolina, Texas, Vera Cruz, Chiapas, Acapulco, Tepic, Guatemala and Nicaragua.

12. **Ipomœa glabriuscula** House, Bot. Gaz. **43**: 409. 1907.

Resembling the preceding, but glabrous; leaf-blades ovate, shallowly-cordate, minutely pubescent beneath; peduncles 4–12 cm. long; sepals unequal, the inner 6–7 mm. long; corolla white, glabrous or nearly so without.

Type locality: Guatemala.
Distribution: Guatemala.
Specimens examined: *Heyde*, 1892 (type — N, *256072*).

13. **Ipomœa nicaraguensis** House, Bot. Gaz. **43**: 409. 1907.

Ipomœa fistulosa var. *nicaraguensis* Donnell Smith, Bot. Gaz. **19**: 256. 1894.

Twigs velvety-canescent; leaf-blades broadly ovate or reniform-ovate, velvety-canescent beneath, acute, shallowly cordate, 7–12 cm. long; sepals broadly ovate, rounded, minutely tomentose, 7 mm. long; corolla pink or whitish, tomentose without on the plicæ and tube.

Type locality: Rio de las Lajas, Nicaragua.
Distribution: Central America.
Specimens examined: *W. C. Shannon 5026*, 1893 (type — N).

14. **Ipomœa murucoides** Roem. & Schult. Syst. **4**: 248. 1819.

Convolvulus macranthus H. B. K. Nov. Gen. & Sp. **3**: 95. 1818.
Ipomœa macrantha G. Don, Gen. Syst. **4**: 267. 1838. Not *I. macrantha* Roem. & Schult. 1819.
Convolvulus strictus Willd.; Steud. Nom. ed. 2, **1**: 412. 1841.

A large tree, the inflorescence and young parts densely tomentose or woolly; leaf-blades oblong-lanceolate, 7–12 cm. long, rounded or obtuse at the base, long-acuminate, tomentose beneath; calyx woolly without and pubescent within; the unequal sepals 18–28 mm. long; corolla 7–8 cm. long, woolly-pubescent without; capsules 25 mm. long; seeds with a long coma of white hairs on the dorsal angles and apex.

TYPE LOCALITY: Near Guanajuato and Santa Rosa, Queretaro, Mexico.
DISTRIBUTION: Hillsides, southern Mexico and Central America.
Specimens examined from Oaxaca, Morelos, Michoacan, Pueblo, Queretaro, Valley of Mexico, Guanajuato and Guatemala.

15. **Ipomœa arborescens** (Humb. & Bonpl.) G. Don, Gen. Syst. **4**: 267. 1838.

Convolvulus arborescens Humb. & Bonpl.; Willd. Enum. **1**: 204. 1809.— H. B. K. Nov. Gen. & Sp. **3**: 94. 1818.
C. arboreus Balb.; Steud. Nom. ed. 2. **1**: 407. 1841.
Argyreia oblonga Benth. Bot. Sulph. 133. 1844.
Ipomœa murucoides var. *glabrata* Rose, Contr. Nat. Herb. **1**: 107. 1891.
Convolvulus Quanhtzahuath Sesse & Moc., Fl. Nov. Hisp. in La Naturaleza II. **1**: 23. 1887. Fl. Mex. l. c. II. **2**: append. 36, 37. 1893.

Leaf-blades finely velvety-pubescent above, paler, densely pubescent and prominently reticulate-veined beneath, ovate, cordate; sepals oval obtuse, 6–10 mm. long, tomentulose-pubescent within and without; corolla white, about 5 cm. long; capsules 2 cm. high; seeds black with a long reflexed white coma of hairs on the dorsal angles.

TYPE LOCALITY: America meridionali.
DISTRIBUTION: Dry hilly regions of western and southern Mexico.
ILLUSTRATIONS: Gard. & For. 7: p. 364. 1894.
Specimens examined from Sonora, Sinaloa and Morelos.

16. **Ipomœa cuernavacensis** House, Bot. Gaz. **43**: 410. 1907.

Convolvulus arboreus Moc. & Sesse, Fl. Nov. Hisp. in La Naturaleza II. **1**: 23. 1887. — Fl. Mex, l. c. 2: append. 38. 1893. Not C. arboreus Balb. 1841.

Closely related to the preceding, but the leaf-blades oblong, rounded at the base, long-acuminate, 10–15 cm. long and 5–6.5 cm. wide.

TYPE LOCALITY: Cuernavaca, Morelos, Mexico.
DISTRIBUTION: Morelos.
SPECIMENS EXAMINED: *Rose & Painter 6863*, 1903 (type — N).

17. **Ipomœa intrapilosa** Rose, in Gard. & For. **7**: 367. 1894.

I. murucoides var. *glabrata* A. Gray, Proc. Am. Acad. **22**: 440. 1887. Not *I. glabrata* Meissn. 1869.

Nearly glabrous throughout; leaf-blades triangular-ovate, short-acuminate, truncate or rounded at the base, 5–15 cm. long; calyx tomentose without in bud, becoming glabrate, pubescent within; sepals oval, subacute, 12–16 mm. long; corolla 4–5 cm. long, the limb 7–8 cm. broad; capsules ovoid, 2 cm. long; seeds with a long dorsal coma of white hairs.

TYPE LOCALITY: Chapala, Jalisco, Mexico.
DISTRIBUTION: Rocky hillsides, western and southern Mexico.
Specimens examined from Sonora, Acapulco, Jalisco, Oaxaca and Morelos. Type collected by *Palmer* (*No. 703*, 1886, N).

18. **Ipomœa calva** House, Bot. Gaz. **43**: 410. *fig. 1.* 1907.

Leaves clustered near the ends of the branches, blades small, 2–3 cm. long, nearly glabrous; sepals 8–10 mm. long; corolla about 5 cm. long, white, glabrous.

TYPE LOCALITY: La Junta, Guerrero, Mexico.
DISTRIBUTION: Known only from the type locality.
SPECIMENS EXAMINED. *E. W. Nelson 6992*, 1903 (type — N).

19. **Ipomœa wolcottiana** Rose, in Gard. & For. **7**: 367. 1894.

Nearly or quite glabrous; leaf-blades ovate, or ovate-lanceolate, 7–13 cm. long, rounded or truncate at the base, acuminate; sepals 10–12 mm. long; corolla white, 6–7 cm. long; capsules oblong, 18 mm. long.

TYPE LOCALITY: Manzanillo, Colima, Mexico.
DISTRIBUTION: Rocky hillsides western and southern Mexico.
ILLUSTRATIONS: Gard. & For. **7**: p. 365. 1894.
SPECIMENS EXAMINED: Colima; Manzanillo, *Palmer 1342*, 1891, (type — N, G, Y). Puebla; *Rose & Hay 5830*, 1901 (N). Morelos, Cuernavaca, *Rose & Painter 6965*, 1903 (N). Chiapas; *E. W. Nelson 3509*, 1895 (N). Oaxaca; *E. W. Nelson 2361*, 1895 (N).

Section II. PHARBITIS.

Annual or perennial twining or trailing vines with herbaceous sepals, these often with elongated tips and more or less pubescent or hispid bases; capsules globose, thin-walled, 2-, 3- or 5-celled.

Nil Medicus in Staatw. Vorles. Churpf. Phys-Oak. Ges. **1**: 210. 1791.
Convolvuloides Moench, Meth. 451. 1794.
Ornithosperma Raf. Fl. Ludov. 149. 1817.
Cleiemera Raf. Fl. Tellur. **4**: 77. 1838.
Pharbitis Choisy, in Mem. Soc. Phys. Genev. **6**: 438. 1833.— In DC. Prodr. **9**: 341. 1845.

4. Cephalanthæ. Stout, annual or perennial twiners; the inflorescence congested or capitate and subtended by herbaceous, usually pubescent or hairy bracts, or the pedicels very short and each subtended by a bract. (*Ipomœa*, Sect. *Strophipomœa* § *Cephalanthæ* Choisy, in DC. Prodr. **9**: 363. 1845.)

Sepals and bracts similar, hairy, not veined.
  Stems minutely or softly pubescent or tomentose.
    Leaf-blades silvery beneath; stems tomentose. 20. *I. maireti.*
    Leaf-blades not silvery beneath, glabrous above and stems minutely pubescent. 21. *I. invicta.*
  Stems retrorsely strigose-pubescent.
    Corolla 7–9 cm. long; western Mexico. 22. *I. lambii.*
    Corolla 3–4 cm. long; southern Mexico. 23. *I. hirtiflora.*
Sepals and bracts dissimilar; sepals veined.
  Stems hirsute; peduncles longer than the pedicels. 24. *I. ruber.*
  Stems glabrous; peduncles very short and usually shorter than the pedicels. 25. *I. fimbriosepala.*

20. **Ipomœa maireti** Choisy, in DC. Prodr. **9**: 374. 1845.

A stout, perennial vine, with densely tomentose stems; leaf-blades ovate, cordate, 7–12 cm. long, acute, finely pubescent above, densely silvery pubescent beneath; peduncles 1–3-flowered; bracts ovate, obtuse; sepals 18–22 mm. long, oblong-lanceolate, acute; corolla campanulate-funnelform, 7–8 cm. long, the limb blue, the tube white below, pubescent without.

Type locality: Mexico.

Distribution: Forests from Orizaba region to Oaxaca and Guatemala.

Specimens examined: Zuzuapan, *Purpus 2391*, 1907 (Y). Valley of Cordova, *Borgeau 1738*, 1866 (G). Oaxaca, *E. W. Nelson 2400 & 2471*, 1895; *Conzatti & Gonzalez 620*, 1897 (G). Orizaba, *A. Gray*, 1885 (G). Guatemala, *Sutton Hayes*, 1860 (G).

21. **Ipomœa invicta** sp. nov.

A stout, woody twining vine; stems, petioles and peduncles minutely pubescent: leaf-blades ovate, cordate, acute or abruptly acuminate, 8–14 cm. long, glabrous above, pubescent beneath, principal veins about 6 pairs; petioles shorter than the blades; peduncles 6–10 cm. long, 2-3-flowered; bracts oblong-spatulate, 1–2.5 cm. long; pedicels 5–8 mm. long; sepals unequal, elliptical-oblong, acute or acuminate, 2.5–3 cm. long, often tinged with red above; corolla broadly funnelform, about 6 cm. long, blue, glabrous, white below on the plicae and tube, the tube 1.5–2 cm. thick.

MEXICO: Jalisco; Vicinity of San Sebasian, 3850–5000 ft. alt. *E. W. Nelson 4087*, 1897 (type, sheet *No. 327167* — N).

22. **Ipomœa lambii** Fernald, Bot. Gaz. **20**: 535. 1895.

Stems slender, covered with reflexed, tuberculate hairs; leaf-blades ovate, acuminate, 7–15 cm. long, often 3-lobed or subhastate, strongly pubescent beneath; peduncles 5-10 cm. long, 2–4-flowered; bracts elliptical-ovate, 2–2.5 cm. long; sepals ovate-lanceolate, 1.5–2 cm. long; corolla 7–9 cm. long, rose-purple.

TYPE LOCALITY: Near Zopelote, Tepic, Mexico.
DISTRIBUTION: Western Mexico.
SPECIMENS EXAMINED: *Lamb 556*, 1895 (type— G, Y, N).

23. **Ipomœa hirtiflora** Mart. & Gal. Bull. Acad. Brux. XII. **2**: 264. 1845.— House, Muhlenbergia **3**: 38. 1907.

Stout, twining, perennial; stems densely pilose with reflexed brownish hairs; leaf-blades orbicular-ovate, entire or 3-lobed, acute, densely appressed pubescent above, silky beneath, 6–12 cm. long, deeply cordate; peduncles 12–20 cm. long, several-flowered; bracts ovate-lanceolate, 2–2.5 cm. long; sepals narrowly lanceolate, acuminate, pilose, 16–22 mm. long; corolla purple, slender, about 5 cm. long and 3 cm. broad, pilose without on the plicæ and tube.

TYPE LOCALITY: Woods, Chinantla, Mexico.
DISTRIBUTION: Southern Mexico and Guatemala.
SPECIMENS EXAMINED: Near Jacaltenango, Guatemala, *E. W. Nelson 3579*, 1895, 3500–5400 ft. alt. (N).

24. **Ipomœa ruber** (Vahl) Millsp. Field Col. Mus. Bot. **2**: 86. 1900.

Convolvulus ruber Vahl, Eclog. Am. **2**: 12. 1798.
Ipomœa setifera Poir. Encyc. **6**: 16. 1804.— Choisy in DC. Prodr. **9**: 359. 1845.— Hallier f. in Bot. Jahrb. **18**: 143. 1893.
I. brevifolia G. F. W. Mey. Fl. Esseq. 100. 1818.
C. setifera Spreng. Syst. **1**: 606. 1825.
Calystegia setifera Meissn.; Mart. Fl. Bras. **7**: 316. 1869.
I. lesteri Baker, in Kew Bull. 83. 1892.
Ipomœa assumptionis Britt. Ann. N. Y. Acad. Sci. **7**: 170. 1893.

TYPE LOCALITY: America meridionali.

DISTRIBUTION: West Indies, tropical South America and Africa.

ILLUSTRATIONS: Mart. Fl. Bras. 7: pl. 101. f. 2.

SPECIMENS EXAMINED: Jamaica, *Millspaugh 946*, 1899. Porto Rico, *Sintenis 963*, 1885; *Heller 376*, 1899; *6364*, 1903; *Millspaugh 146*, 1899; *Britton & Cowell 1392*, 1906. Guadeloupe: *Duss 2474*, 1892. Martinique; *Duss 430*. All in herb. N. Y. Bot. Garden.

Urban describes the form with pale yellow flowers as *Ipomœa ruber* var. *albo-flavida* (Sym. Ant. **3**: 345. 1902).

Ipomœa ruber var. *palustris* Urban, l. c. is described as having 1-flowered peduncles; bracts 6 mm. long, ovate; sepals prominently wing-keeled, crenulate; corolla 2.5–3 cm. long and leaf-blades elongated. Both are natives of Porto Rico, but the last variety is perhaps nearer the next.

25. **Ipomœa fimbriosepala** Choisy, in DC. Prodr. **9**: 359. 1845.—Hallier f. Bull. Soc. Bot. Belg. **37**: 97. 1898.

Aniseia hastata Meissn.; Mart. Fl. Bras. **7**: 319. 1869.
Ipomœa smithii Baker, Kew Bull. 73. 1894.

TYPE LOCALITY: Madagascar.

DISTRIBUTION: Tropical Africa, Pacific Islands and America. Reported from Guatemala, Brazil and Paraguay by Hallier; but no specimens from North America have been seen by the writer.

5. **Heterophyllæ**. Trailing or twining from thickened, tuberous, woody roots; more or less pubescent; leaf-blades deeply 3- to 5-lobed or subentire; flowers usually solitary on short peduncles; bracts small; sepals very unequal, the outer ones usually with broad, ovate bases, the inner narrower, the outer ones frequently truncate or subcordate, sometimes enlarged in fruit; corolla purple, funnelform: ovary 3-celled. (*Pharbitis* Choisy, in part.)

Sepals merely acute, not attenuate.
  Leaf-blades deeply 3- to 5-lobed; sepals ovate, 20 mm. × 12 mm.; corolla 8–9 cm. long. — 26. *I. laeta.*
  Leaf-blades hastate and subentire; sepals 10 mm. long; corolla less than 5 cm. long. — 27. *I. oreophila.*
Sepals with attenuate tips.
  Outer sepals linear-lanceolate without conspicuously broadened bases; corolla 6–8 cm. long. — 28. *I. lindheimeri.*
  Outer sepals with conspicuously broadened bases.
    Appressed sericeous-pubescent; corolla 6–9 cm. long. — 29. *I. heterophylla.*
    Loosely pubescent with hispid, whitish pili, only the leaves loosely sericeous-pubescent; corolla 3–4 cm. long. — 30. *I. pubescens.*

26. **Ipomœa læta** A. Gray, Proc. Amer. Acad. **22**: 439. 1887.

Stems densely and softly pubescent; leaf-blades suborbicular, 3–5 cm. long, deeply 3-lobed, deeply cordate, lobes contracted below and the blade sometimes sub–5-lobed; peduncles about as long as the petioles; sepals oblong-ovate, acute, hirsute, rounded at the broad base, 2 cm. long; corolla 9–10 cm. long, pubescent without, pink-purple.

TYPE LOCALITY: Rio Blanco, Jalisco, Mexico.

DISTRIBUTION: Trailing among grasses and low plants. Jalisco.

SPECIMENS EXAMINED: *Palmer 341*, 1886 (type — G, N, C). Hills near Guadalajara. *Pringle 4456*, 1893 (G, N, C).

27. **Ipomœa oreophila** sp. nov.

Low and feebly twining, about 1 m. long from a woody root; stems and foliage glabrous or minutely pubescent; leaf-blades ovate-hastate or triangular-ovate, entire except for the spreading basal auricles which are 1–2-lobed or toothed; blades 3–5 cm. long, 2–4 cm. wide; peduncles slightly longer than the petioles; pedicels less than 1 cm. long; outer sepals similar to the leaf-blades in shape, pubescent, subherbaceous, triangular-ovate, hastate or subcordate, acute, 10–12 mm. long; corolla funnelform, 6 cm. long, the limb blue, the tube white below.

MEXICO: Hidalgo; Rocky hills, Lena Station, 8300 ft. alt. *Pringle 10034*, 24 Aug., 1905 (type — G, Y). Chiapas; Near San Cristobal, *E. W. Nelson 3149*, 1895 (*233090* — N, G). Valley of Mexico; Mt. Zocoalco, Guadeloupe, *Borgeau 728 & 797*, 1866 (G).

28. **Ipomœa lindheimeri** A. Gray, Syn. Fl. N. Am. **21**: 210. 1878.

Ipomœa heterophylla Torr. Bot. Mex. Bound. 149. 1859. Not *I. heterophylla* Ortega. 1800.
Pharbitis lindheimeri Small, Fl. Southeastern U. S. 964. 1903.

Foliage finely but densely appressed pubescent; leaf-blades deeply 3- to 5-lobed, the middle lobe with a contracted basal portion longer than the expanded part, lateral lobes similar; sepals linear-lanceolate, 2–2.5 cm. long; corolla 6–9 cm. long.

TYPE LOCALITY: Valley of the Rio Grande, below Donana.

DISTRIBUTION: Hills and prairies, Texas to New Mexico, and northern Mexico.

SPECIMENS EXAMINED: Western Texas; *Wright 508, 990*; *Schott*, 1851; *Jermy 185*; *Harvard*, 1881; *F. Tweedy 170*; *Reverchon 654;* Comache Spring, *Lindheimer 1031*, 1851; *Heller 1776; Bray 18; Earle & Tracy 150; Stanfield*, 1896. New Mexico: *Wright 1613*. Coahuila; *Palmer 906*, 1880. Chihuahua; *Pringle 1339*, 1887; *Townsend & Barber 220*, 1899.

Ipomœa lindheimeri subintegra var. nov.

Leaf-blades entire or angled, shallowly cordate, acuminate, 1–4 cm. long; sepals ovate-lanceolate, 16–18 mm. long, 4–8 mm. broad; corolla 6–7 cm. long.

ARIZONA: Near Ft. Huachuca, *Lemmon 2835*, 1882 (type—G).

29. **Ipomœa heterophylla** Orteg. Hort. Matr. Dec. **1**: 9. 1800.— Willd. Enum. Hort. Berol. **1**: 207. 1809.[1]

Ipomœa ortegæ Poir. Encyc. Suppl. **4**: 633. 1816.
Ipomœa willdenowii Roem. & Schult. Syst. **4**: 211. 1819.
Convolvulus heterophyllus Spreng. Syst. **1**: 592. 1825.
Batatas heterophylla G. Don, Gen. Syst. **4**: 261. 1838.
Batatas willdenowii G. Don, l. c.
Convolvulus willdenowii Steud. Nom. ed. 2. **1**: 412. 1841.
Pharbitis heterophylla Choisy, in DC. Prodr. **9**: 344. 1845.

Foliage appressed sericeous-pubescent; leaf-blades deeply 3- to 5-lobed; sepals with ovate or suborbicular densely hirsute bases and long attenuate tips, 20–24 mm. long, 10–15 mm. wide, enlarged in fruit; corolla 5–6 cm. long, the tube fully 10 mm. thick at the top of the calyx.

TYPE LOCALITY: Mexico.
DISTRIBUTION: Dry places, northern Mexico to western Texas.
ILLUSTRATIONS: Jacq. Fragm. 37. *pl. 42. f. 4.*
SPECIMENS EXAMINED: San Luis Potosi, *Schaffner 426 & 619* (Y). Chihuahua; *E. W. Nelson 6159 & 6284*, 1899 (N).

Ipomœa heterophylla æmula var. nov.

Sepals ovate-lanceolate, 20–25 mm. long, 6–8 mm. broad; corolla large, the tube 4 mm. thick at the base, 6–7 mm. thick above the calyx, subsalverform, the limb 6–7 cm. broad.

CHIHUAHUA: Hills near Guerrero, *Pringle 1339*, 1887 (type — G, Y, N).

Ipomœa heterophylla subcomosa var. nov.

Stems and foliage very densely appressed sericeous-pubescent; peduncles 1–2 cm. long; outer sepals 15–18 mm. long at flowering time, 8–10 mm. broad at the truncate base, becoming twice as long and a half broader in fruit, the tips attenuate, tinged with red; corolla 6–7 cm. long, the tube only 2–3 mm. thick above the calyx, the limb 5 cm. broad.

DURANGO, *Palmer 590*, 1896 (type — N, G, Y).

---

[1] *Ipomœa heterophylla* R. Br. 1810. = Ipomœa polymorpha Roem. & Schult. 1819.

30. **Ipomœa pubescens** Lam. Tabl. Encyc. **1**: 265. 1891.— Encyc. **6**: 15. 1804.— Meissn. in Mart. Fl. Bras. **7**: 224. 1869.

Convolvuloides pilosa Moench, Meth. 452. 1794.
Ipomœa Papiriu & subtriloba Ruiz. & Pav. Fl. Peruv. **2**: 11. 1799.
Ipomœa varia Roth, Catal. **2**: 17. 1800.
Convolvulus pubescens Willd. Enum. Hort. Berol. **1**: 203. 1809.
Convolvulus Papiria Spreng. Syst. **1**: 592. 1825.
Batatas Papirin & subtriloba G. Don, Gen. Syst. **4**: 261. 1838.
Pharbitis varia, G. Don, l. c. 263.
Pharbitis pubescens Choisy, in DC. Prodr. **9**: 344. 1845.

Stems retrorsely hispid and pubescent with long whitish pili; leaf-blades similar to the preceding but more hispid-pubescent; sepals narrowly ovate, acuminate, 15–18 mm. long, 7–8 mm. broad at the rounded or subcordate base, becoming 20 by 18 mm. in fruit; corolla 3–4.5 cm. long, the tube white, 7–8 mm. thick above the calyx, the purple 5-angled limb 2.5–5 cm. broad.

Type locality: America (Lam.); Prov. Tarma, Peru (Ruiz. & Pav.).

Distribution: Stony hills, western Texas and Mexico to Peru and Bolivia.

Illustrations: Ruiz. & Pav. l. c. *pl. 120. f. a.*

Specimens examined: Western Texas; *C. Wright 509* (G). Mexico: *Dr. J. Gregg 389,* 1848–49 (G). Queretaro; *Pringle 7194,* 1896 (G). *Rose, Painter & Rose 9541,* 1905 (N). Durango; *E. W. Nelson 4638, 4747 & 4962,* 1898 (N). Hidalgo; *Purpus 1393,* 1905 (N, Y). *Rose, Painter & Rose 8354,* 1905 (N). Valley of Mexico; *Rose, Painter & Rose 9541,* 1905 (N, Y).

The above cited specimens are identical with *Rusby's 1988,* 1885, from near La Paz, Bolivia, which agrees in all particulars with the descriptions of Lamark and of Ruiz & Pavon.

6. **Hederaceæ.** Annuals or perennials, rarely with tuberous roots; stems and foliage usually pubescent or hirsute; peduncles usually several or many flowered; sepals equal or nearly so, broadest at or near the base, usually densely hispid and acute to acuminate or attenuate-caudate; corolla blue or white; ovary 3-celled or sometimes 5-celled.

Sepals acute, 8–15 mm. long.
  Stems prostrate; ovary 5-celled; leaf-blades hastate-cordate or lobed; root tuberous. 31. *I. decasperma.*
  Stems twining; ovary 3-celled, leaf-blades ovate.
    Stems and leaves hirsute to glabrate.
      Leaf-blades usually entire; corolla 4–6 cm. long. 32. *I. purpurea.*
      Leaf-blades usually 3-lobed; corolla 2.5–3 cm. long. 33. *I. hirsutula.*
    Stems and leaves densely and softly tomentose. 34. *I. jamaicensis.*
Sepals attenuate or caudate-attenuate.

Leaf-blades canescent, silvery or silky-white beneath at least when young.
Sepals pilose; leaf-blades silvery-canescent beneath. 35. *I. mutabilis.*
Sepals glabrous or nearly so; leaf-blades silky-pubescent, glabrate above with age. 36. *I. villosa.*
Leaf-blades hispid-pubescent to glabrate.
Tips of sepals caudate-spatulate, obtuse; corolla white. 37. *I. ampullacea.*
Tips of sepals caudate-acuminate; corolla blue.
Foliage pubescent or hirsute.
Sepals glabrous; 25–30 mm. long; leaf-blades hastately 5–7 lobed and cordate-hastate. 38. *I. thurberi.*
Sepals pubescent or hispid.
Leaf-blades entire, silky-pubescent. 39. *I. barbigera.*
Leaf-blades 3–5-lobed or angled; hispid-pubescent.
Tips of sepals linear-attenuate, hirsute or hispid at the base.
Bases of the sepals conspicuously broadened; lobes of the leaf-blades contracted below; corolla 2.5–3 cm. long.
Sepals densely hirsute; tips strongly spreading. 40. *I. hederacea.*
Sepals sparingly barbate with whitish hairs, tips not strongly spreading. 41. *I. desertorum.*
Bases of the sepals not conspicuously broadened, linear-lanceolate; lobes of the leaf-blades rarely contracted below; corolla 3–6 cm. long. 42. *I. Nil.*
Tips of sepals merely long-acuminate, erect, slightly pubescent.
Bracts 4–8 mm. long; sepals puberulent or sparingly pubescent. 43. *I. vahliana.*
Bracts 12–20 mm. long; sepals appressed pubescent with silvery hairs. 44. *I. Learii.*
Foliage and stems nearly glabrous or finely appressed-pubescent; sepals glabrous or nearly so, veined and merely acuminate, 16–20 mm. long. 45. *I. cathartica.*

31. **Ipomœa decasperma** Hallier f. Bull. Herb. Boiss. **5**: *pl. 14.* 386. 1897.

Trailing from a large woody root; finely pubescent; leaf-blades orbicular-reniform, cordate-hastate, 2–4 cm. broad or sometimes 3- to 5-lobed; peduncles 1- to 3-flowered; sepals ovate, acuminate, 10–12 mm. long, hirsute; corolla purple, 5–6 cm. long; capsules globose, 10 mm. in diameter, 5-celled, 5- to 10-seeded, 5-valved.

Type locality: Valley of Mexico.

Distribution: Rocky hillsides, central Mexico.

Specimens examined: Near Durnago, *Palmer 591 & 592,* 1896 (N,Y,G).

32. **Ipomœa purpurea** (L.) Lam. Illus. **1**: 466. 1791.— Roth, Catal. 27. 1797.— Britton, Manual 752. 1901.

Convolvulus calycibus tuberculatus pilosis, Vind. Cliff. 18.— Hort. Ups. 38.— Gronov. Virg. 141.— Roy. Lugdb. 428.

C. purpureus, folio subrotundo, Bauh. Pin. 295.— Ehret. Pict. 7. *f.* 2.

C. folio cordato glabro, Dill. Elth. 100.

C. caeruleus minor, folio subrotundo, Dill. Elth. 97.

Convolvulus purpureus L. Sp. Pl. ed. 2, 219. 1762.
Convolvulus mutabilis Salisb. Prodr. 123. 1796.
Ipomœa discolor Jacq. Hort. Schoenb. **3**: 6. 1798.
Ipomœa glandulifera Ruiz. & Pav. Fl. Peruv. **2**: 12. 1799.
Ipomœa hispida Zuccagni, in Roem. Coll. 127. 1806.
Ipomœa intermedia Schult. Obs. Bot. 37. 1809.
Convolvulus eriocaulos Willd.; Roem. & Schult. Syst. **4**: 301. 1819.
Convolvulus intermedius Roem. & Schult. l. c. 264.
Ipomœa Zuccagnii Roem. & Schult. l. c. 230.
Pharbitis hispida Choisy, in Mém. Soc. Phys. Genèv. **6**: 440. 1833.— In DC. Prodr. **9**: 341. 1845.
Convolvulus Schultesii Roem. & Schult.; Steud. Nom. ed. 2, **1**: 411. 1841.
Pharbitis purpurea Voigt. Hort. Suburb. Calc. 354. 1845.— Small, l. c. 964.

TYPE LOCALITY: America.

DISTRIBUTION: Thickets and waste places throughout tropical America. Cultivated and a frequent escape northward to Ontario and Nova Scotia.

ILLUSTRATIONS: Dill. Elth. *pl. 84. f. 97.* Jacq. Hort. Schoenb. *pl. 261.* Ruiz. & Pav. Fl. Peruv. *pl. 121. f. a.* Bot. Mag. *pls. 113, 1005 & 1682.* Weinmann, Phytanth. 2: *pls. 414 & 415.* Britt. & Brown, Illus. Fl. 3: *f. 2949.* Bailey, Cyclop. Am. Hort. *f. 1167.* Knorr. Thes. Hort. *pls.* 187 *& 189.*

33. **Ipomœa hirsutula** Jacq. f. Eclog. **1**: 63. 1811–16.

Convolvulus flore purpureo, calyce punctato, Dill. Elth. 99.

Convolvulus hederaceus var. γ. L. Sp. Pl. 154. 1753. Ed. 2, 219. 1762. in part, as to the Dillenian citation above.

?*Ipomœa punctata* Pers. Syn. **1**: 184. 1805. (excl. habitat).
Pharbitis diversifolia Lindl. Bot. Reg. **33**: *pl. 1988.* 1837.
Pharbitis punctata G. Don, Gen. Syst. **4**: 263. 1838.
P. Nil var. *diversifolia* Choisy, in DC. Prodr. **9**: 343. 1845.
Ipomœa affinis Mart. & Gal. in Bull. Acad. Brux. XII. **2**: 263. 1845.
Pharbitis cathartica Hook. Bot. Mag. *pl. 4289.* 1847. Not *P. cathartica* Choisy, 1845.
Ipomœa mexicana A. Gray, Syn. Fl. N. Am. $\mathbf{2}^1$: 210. 1878.
Convolvulus hederaceus Sesse & Moc. Fl. Nov. Hisp. in La Naturaleza II. **1**: 22, 1887.— Fl. Mex. l. c. II. in. **2**: append. 21. 1893.
Ipomœa hirta Th. Dur. in Bull. Acad. Bot. Belg. II. **27**: 175. 1888.

Type locality: Mexico.

Distribution: Western Texas to Arizona, Central America and probably in South America.

Illustrations: Dill. Elth. *pl. 83. f. 96.* Jacq. f. Eclog. **1**: *pl. 44.* Hook. Bot. Mag. *pl. 4289.* Bot. Reg. *pl. 1988.*

Specimens examined from Texas, New Mexico, Arizona; Sonora, Jalisco, Chihuahua, Durango, Valley of Mexico, Aguas Calientes, Queretaro, Oaxaca, Mechoacan and Guatemala.

34. **Ipomœa jamaicensis** (Spreng.) G. Don, Gen. Syst. **4**: 278. 1838. — Meissn. in Mart. Fl. Bras. **7**: 225. 1869.

Convolvulus folio lanato, etc. Sloan. Jam. 55.— Hist. **1**: 154.

Convolvulus tomentosus L. Sp. Pl. 156. 1753.
?*C. roseus* Mill. Dict. No. 18. 1768.
C. jamaicensis Spreng. Syst. **1**: 595. 1825. Not *C. jamaicensis* Jacq. 1768.
Pharbitis tomentosa Choisy, in DC. Prodr. **9**: 342. 1845.
Pharbitis jamaicensis Gib. Enum. Pl. Montev. 28. 1873.
Ipomœa tomentosa Urb. Sym. Ant. **3**: 344. 1902. Not *I. tomentosa* Choisy, 1845.

Type locality: Jamaica.

Distribution: Jamaica to tropical South America.

Illustrations: Sloan. Hist. *pl. 98. f. 2.* Pluk. Alm. *pl. 167. f. 4.* Meissn. in Mart. Fl. Bras. 7: *pl. 77.*

Specimens examined: Jamaica: Great Goat Isl., *Harris 9212,* 1906 (Y).

35. **Ipomœa mutabilis** Lindl. Bot. Reg. **1**: 39. 1815.

Convolvulus mutabilis Spreng. Syst. **1**: 593. 1825. Not *C. mutabilis* Salisb. 1797.
Pharbitis mutabilis Boj. Hort. Maurit. 227. 1837.
Pharbitis dealbata Mart. & Gal. in Bull. Acad. Brux. XII. **2**: 272. 1845.
Ipomœa dealbata Hemsley, Biol. Cent.-Am. Bot. **2**: 386. 1882.
Ipomœa Learii Meissn. in Mart. Fl. Bras. **7**: 224. 1869. Not *I. Learii* Paxton, 1839.

Stems densely and softly pubescent; leaf-blades orbicular-ovate, entire or 3-lobed, 6–15 cm. long, appressed-pubescent above, silvery-canescent beneath; sepals linear-lanceolate, 10–15 mm. long, appressed silky-pilose; corolla 7–8 cm. long, blue with a white tube.

Type locality: Near Vera Cruz, Mexico.

Distribution: Wooded slopes and mountain forests, Tamaulipas to Vera Cruz, Orizaba and Oaxaca to Brazil.

Illustrations: Bot. Reg. *pl. 39.*

Specimens examined: Tamaulipas; Victoria, *Palmer 201,* 1907 (N, Y); Orizaba; *Karwinsky 590, & 591,* 1841–42 (Y). *Müller 581 & 905,* 1855 (C). *Botteri 469 & 586* (Y, G); *Borgeau 2212 & 2814,* 1866 (G); *Seaton 36 & 449,* 1891. Vera Cruz; Jalapa, *Chas. L. Smith 1791,* 1894 (G). Oaxaca; Tentila, *Rev. Lucius C. Smith 657,* 1895 (G).

36. **Ipomœa villosa** Ruiz. & Pav. Fl. Peruv. **2**: 12. 1799[1].— Griseb. Fl. Br. W. Ind. 473. 1864.— Lefroy in Jones & Goode, Nat. Hist. Bermuda 90. 1884.

Ipomœa congesta R. Br. Prodr. **1**: 485. 1810.
Convolvulus congestus Spreng. Syst. **1**: 601. 1825.
Convolvulus Ruizii Spreng. l. c. 594.
Pharbitis insularis Choisy in Mém. Soc. Phys. Genèv. **6**: 439. 1833.— In DC. Prodr. **9**: 341. 1845.
Ipomœa insularis Choisy; Steud. Nom. ed. 2, **1**: 817. 1841.
Pharbitis rosea Choisy, in DC. Prodr. **9**: 342. 1845.

Type locality: Peru.

Distribution: Thickets near the sea shore, circumtropical and chiefly insular.

Illustrations: Ruiz. & Pav. l. c. pl.

Specimens examined: Bermuda; *Kemp,* 1885; *Harshberger,* 1905, *Brown & Britton 156,* 1905. Socorro Id. (Pacific), *Barkelew 245* (in part), 1903. Clarion Id. *A. W. Anthony 403,* 1897. Reported from Trinidad by Grisebach.

37. **Ipomœa ampullacea** Fernald, Proc. Am. Acad. **33**: 89. 1897.

Stems woody below from a tuberous root, retrorsely hispid; leaf-blades entire or 3-lobed; sepals pubescent, 2.5–4 cm. long, ovate below, acuminate and becoming spatulate-attenuate with age; corolla white, 6 cm. long, pubescent without.

Type locality: Near Acapulco, Mexico.

Distribution: Known only from the type locality.

Specimens examined: Acapulco, *Palmer 483,* 1894–95 (type — G, Y, N).

38. **Ipomœa thurberi** A. Gray, Syn. Fl. N. Am. 2^1: 212. 1878.— In Proc. Am. Acad. **19**: 90. 1883.

Stems hispid or glabrate from an elongated, tuberous root; leaf-blades cordate-hastate, 2–4 cm. long, the spreading basal lobes acute and often bifid or the blades

---

[1] **Ipomœa comosa** nom. nov.

Batatas villosa Choisy, in DC. Prod. **9**: 337. 1845.
Ipomœa villosa Meissn. in Mart. Fl. Bras. **7**: 244, 1869. Not I. villosa R. & P. 1799. Brazil.

3-5-lobed, pubescent above; sepals glabrous 2.5–3 cm. long, acuminate; corolla white with a pink or purplish limb.

TYPE LOCALITY: Southeastern border of Arizona, near Santa Cruz.

DISTRIBUTION: Southern Arizona and Sonora.

SPECIMENS EXAMINED: *Thurber 966,* 1857 (type — G); *C. Wright,* 1851 (G). Tanner's Canon, near Ft. Huachuca, *Lemmon 2833,* 1882 (G, N). *Wilcox 356 & 425,* 1894 (N).

39. **Ipomœa barbigera** Sweet, Brit. Fl. Gard. **1**: *pl. 86.* 1823.

Pharbitis barbigera G. Don, Gen. Syst. **4**: 262. 1838.
Ipomœa hederacea var. *integrifolia* Hallier f. in Jahrb. Hamb. Wiss. Anstalt. **16**: 42. 1898.

Convolvulus caeruleus minor, folio subrotundo, Dill. Hort. Elth. 97. and therefore *C. hederaceus β,* L. Sp. Pl. 154. 1753. and *Ipomœa purpurea β,* Roem. & Schult. Syst. **4**: 232. 1819.

Leaf-blades orbicular-ovate, entire or deeply 3-lobed, thick-textured, ciliate, densely appressed hirsute with silky hairs above; sepals densely hirsute, 15–25 mm. long with spreading, ciliolate tips; corolla 3–3.5 cm. long, deep-blue with purple rays and a white tube.

TYPE LOCALITY: Mississippi (Dill.).

DISTRIBUTION: Sandy fields and thickets, Georgia and Florida to Alabama and Mississippi and Louisiana.

ILLUSTRATIONS: Dill. Hort. Elth. *pl. 82. f. 94.* Sweet, l. c.

SPECIMENS EXAMINED: Georgia; *Cuthbert,* 1900. *Pollard & Maxon 438,* 1900 (N). Florida; Eustis, *Nash 2482,* 1895 (Y). Jacksonville, *Curtiss 6529,* 1899 (N, Y). Tallahassee, *Berg* (Y). Mississippi; *Schuebert,* 1896 (Y). Louisiana; Vicinity of Alexandria, *C. R. Ball 597,* 1899 (N, Y, G).

40. **Ipomœa hederacea** (L.) Jacq. Collect. **1**: 124. 1786.— Britton, l. c. 752.

Convolvulus calycibus tuberculatis pilosis, L. Virid. Cliff. 18.— Hort. Ups. 38.— Gronov. Virg. 141.— Roy. Lugdb. 428.

Convolvulus Virginianus elegans, incanis foliis tripartito divisis, flore amœna purpureo, Pluk. Phytogr. 3: pl. 451. f. 7. 1692.

Convolvulus caeruleus, hederaceo folio, magis anguloso, Dill. Hort. Elth. **1**: 96. 1732.

Convolvulus hederaceus η L. Sp. Pl. 154. 1753. Spreng. Syst. **1**: 593. 1825.
Convolvulus Nil L. Sp. Pl. ed. 2, 219. 1762 (in part as to the above Dillenian citation),— Michx. Fl. Bor.-Am. **1**: 189. 1803.

Convolvulus hederæfolius Salisb. Prodr. 123. 1796.
Ipomœa scabra Forsk. Fl. Aegypt.-Arab. 44. 1775.
Ipomœa barbata Roth. Catal. **1**: 37. 1797.
Ipomœa nil Pers. Syn. **1**: 184. 1805.— Pursh, Fl. Am. Sept. **1**: 146. 1814. Not *I. nil* Roth, 1797.
Ipomœa avicularis Raf. Fl. Ludov. 47. 1817.
Ipomœa scabrida Roem. & Schult. Syst. **4**: 223. 1819.
Ipomœa phymatodes Spreng. Nov. Prov. 24. 1819.
Ipomœa cœrulea Koen. in Roxb. Fl. Ind. **2**: 91. 1824.
Cleiemera hederacea Raf. Fl. Tellur. **4**: 77. 1838.
Pharbitis hederacea Choisy in Mém. Soc. Phys. Genèv. **6**: 440. 1833.— In DC. Prodr. **9**: 344. 1845.— Small, l. c. 964.
Pharbitis variifolia Decne. Nouv. Ann. Mus. Par. **3**: 390. 1834.
Pharbitis forskalii, barbata, purshii & scabrida G. Don, Gen. Syst. **4**: 263. 1838.
Pharbitis cœrulescens Sweet, Hort. Brit. ed. 3, 482. 1839.

Type locality: Virginia, Carolina (Dill.).

Distribution: Dry or sandy soil, fields and thickets, Virginia to Kansas, Texas, Florida and tropical America. Adventive northward to Connecticut, central New York, Ontario and Illinois.

Illustrations: Dill. Hort. Elth. *pl. 80. f. 92.* Bot. Mag. *pl. 188.* Plukn. Phytogr. l. c. Bot. Reg. *pls. 85 & 276.* Britton & Brown, Illus. Fl. **3**: *f. 2950.* Jacq. Ic. Rar. **1**: *pl. 36.* Knorr. Thes. Hort. *pl. 190.*

41. **Ipomœa desertorum** sp. nov.

Closely related to the preceding; pale-green; stems scabrous and sparsely pilose with loosely reflexed hairs; leaf-blades 3-lobed, lobes rarely contracted below, usually triangular-lanceolate and acuminate, appressed-hirsute above, stiffly hirsute beneath and on the petioles; peduncles 1–few flowered; bracts filiform, 4–6 mm. long; sepals linear-lanceolate, 18–26 mm. long, tips scarcely spreading, margin ciliate and base not conspicuously broadened, sparingly barbate with stiff, whitish hairs arising from conspicuously white prominent papilliæ; corolla 3 cm. long, blue with a white tube; seeds finely rough-pubescent.

Arizona: Tuscon, *Thornber 29,* 1903 (type — Y). New Mexico: Florida Mts., *Mulford 1088,* 1895 (Y). Sonora: Guaymas, *Palmer 295,* 1887 (N, Y, G). St. Magdalena, *Schott,* 1851 (C). Canon de los Guerryos, *C. E. Lloyd* (Lumholtz Exped.) *432,* 1894 (G). Chihuahua: Southwestern part, *Palmer 105,* 1885 (N, G).

42. **Ipomœa nil** (L. in part) Roth, Catal. Bot. **1**: 36. 1797.— Hallier f. in Jahrb. Hamb. Wissensch. Anst. **15**: 44. 1898; **16**: 42. 1898.— Bull. Soc. Roy. Bot. Belg. **37**: 94. 1898.

Convolvulus cœruleus major, folio hederaceo, Dill. Hort. Elth. 97.
C. annuus, folio cordatis rarius trilobis, calycibus tuberculato pilosis, L. Hort. Cliff. 67.

Convolvulus hederaceus L. Sp. Pl. ed. 2, 219. 1762, in part as to f. 93 of Dillenius.
Convolvulus nil L. Sp. Pl. ed. 2, 219. 1762 (in part).
C. dillenii Desr. in Lam. Encyc. **3**: 544. 1789.
Convolvuloides triloba Moench, Meth. 451. 1794.
Ipomœa cuspidata Ruiz. & Pav. Fl. Pereuv. **2**: II. 1799.
Ipomœa dillenii Roem. & Schult. l. c. 227.
Convolvulus peruvianus Spreng. Syst. **1**: 593. 1825.
Pharbitis nil Choisy in Mém. Soc. Phys. Genèv. **6**: 440. 1833.— In DC. Prodr. **9**: 342. 1845.
P. cuspidata G. Don, Gen. Syst. **4**: 270. 1838. Choisy, l. c.
P. speciosa Choisy in DC. Prodr. **9**: 343. 1845.
P. nil var. *limbata* Hook. f. Bot. Mag. *pl.* 5720.
I. trichocalyx Steud. Nom. Ed. 2, **1**: 819. 1841.
I. longicuspis Meissn. in Mart. Fl. Bras. **7**: 227. 1869.
I. hederacea Baker & Rendle, in T. Dyer, Fl. Trop. Afr. $\mathbf{4}^2$: 159. 1905.

Usually larger than *I. hederacea*; lobes of the leaf-blades rarely contracted below, middle lobe usually dilated at the base; sepals linear-lanceolate, not dilated at base, 20–30 mm. long, 3–4 mm. broad, densely hispid; corolla 4.5–6 cm. long.

TYPE LOCALITY: Africa.

DISTRIBUTION: Circumtropical. In America; Florida, Bermudas, West Indies, Mexico and Central America to Paraguay and Peru.

ILLUSTRATIONS: Dill. Elth. *pl. 81 f. 93.* Bot. Mag. *pl. 5720.* Bentley & Trin. Med. *pl. 185.* Ruiz. & Pav. Fl. Peruv. 2: *pl. 119 f. a.*

SPECIMENS EXAMINED: Florida; Marco, *Hitchcock 227*, 1900. Jacksonville, *Curtiss 5281*, 1894; *5800*, 1896. Jamaica; *Harris 9155*, 1906 (Y). St. Thomas; *Eggers*, 1887 (Y). St. Croix; *Ricksecker 187*, 1896 (Y). Martinique; *Duss 431 & 1231*, 1884 (Y). Guadeloupe; *Duss 2475*, 1893 (Y). Guatemala; *J. Donnell Smith* (legit *Heyde & Lux.*) *4732*, 1889 (G). Nicaragua; *Chas. L. Smith*, 1893 (G). Costa Rica; *J. Donnell Smith* (legit *Tonduz 9864*) *7090*, 1896 (G). Nicoya, *Tonduz 13678*, 1900 (Y).

43. **Ipomœa vahliana** nom. nov.

Convolvulus acuminatus Vahl, Symb. Bot. **3**: 26. 1794.
Ipomœa acuminata Roem. & Schult. Syst. **4**: 228. 1819. Meissn. l. c. 226.— Griseb. l. c. 473. Not *I. acuminata* Ruiz. & Pav. 1799.
Ipomœa punctata Macf. in Hook. Bot. Misc. **2**: 116. 1831. Not *I. punctata* Pers. 1805.
Ipomœa nil Gardn. in Hook. Journ. Bot. **1**: 180. 1842. Not *I. nil* Roth, 1797.
Pharbitis acuminata Choisy in DC. Prodr. **9**: 348. 1845.

Leaf-blades ovate, entire or 3-lobed, lobes rarely contracted below; sepals elongated, linear-lanceolate, 15–30 mm. long, sparingly pilose, tips appressed to the corolla-tube; corolla 5.5–7 cm. long.

TYPE LOCALITY: St. Croix.

DISTRIBUTION: Thickets near the coast, West Indies and the gulf region of Mexico, Central America to Brazil.

ILLUSTRATIONS: Bot. Reg. *pl. 39.* Meissn.; Mart. Fl. Bras. **7**: *pl. 78.*

SPECIMENS EXAMINED: Cuba; *C. Wright 1647,* 1859 (G).

44. **Ipomœa learii** Paxton, Bot. Mag. **6**: 267. 1839.

Pharbitis learii Hook. Bot. Mag. *pl.* 3928, 1841.— Lindl. Bot. Reg. *pl.* 56. 1841.— Choisy in DC. Prodr. **9**: 343. 1845.— Fletcher in Bailey's Cyclop. Am. Hort. 819. 1900.

Closely resembling *I. vahliana,* and perhaps identical; stems finely pubescent and tomentulose; leaf-blades glabrous above, finely pubescent beneath with pale hairs; peduncles capitately 3- to 9-flowered; bracts linear, 12–20 mm. long; sepals linear-lanceolate, 18–22 mm. long, minutely pubescent with appressed silvery hairs; corolla 5–6 cm. long, blue, turning rosy in age, the tube white below.

TYPE LOCALITY: Said to come from Ceylon by Paxton, but Lindley (l.c.) says that to be a mistake. The species is common in cultivation, and only the following herbarium specimens can be referred here.

Guatemala; *C. C. Deam 316,* 1905 (G). Costa Rica: *Pittier 16277,* 1902 (G).

45. **Ipomœa cathartica** Poir. Encyc. Suppl. **4**: 633. 1816.— Griseb. Fl. Br. W. Ind. 473. 1861.

Convolvulus africanus Nicolson, Hist. Nat. St. Dom. 260. 1776.
Convolvulus pudibundus Lindl. Bot. Reg. *pl. 999.* 1826.
Ipomœa pudibunda G. Don, Gen. Syst. **4**: 276. 1838.
Pharbitis cathartica Choisy in DC. Prodr. **9**: 342. 1845.
Ipomœa fastigiata Chapm. Fl. Southern States 344. 1860. Not *I. fastigiata* Sweet.

Glabrous or nearly so; leaf-blades entire to deeply 3-lobed; sepals glabrous or nearly so, lanceolate, attenuate, 15–20 mm. long, appressed to the corolla-tube, 5- to 7-nerved at the base; corolla sometimes white.

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: Thickets in sandy or calcarious soil, peninsular Florida, Bermudas, Bahamas and West Indies, gulf region of Mexico, Central and tropical South America.

7. Cissoides.

One species: Corolla small, white. 46. *I. cissoides.*

46. Ipomœa cissoides (Lam.) Griseb. Fl. Br. W. Ind. 473. 1861.[1]

Convolvulus cissoides Lam. Tabl. Encyc. **1**: 462. 1791.— Vahl, Eclog. Am. **2**: 15. 1798.
Convolvulus calycinus H. B. K. Nov. Gen. & Sp. **3**: 109. 1819.
Convolvulus orinocensis Willd.; Roem. & Schult. Syst. **4**: 303. 1819.
Batatas cissoides Choisy in Mém. Soc. Phys. Genèv. **6**: 437. 1833.— in DC. Prodr. **9**: 339. 1845.
Merremia cissoides Hallier f. Bot. Jahrb. **16**: 552. 1893.

Rough-pubescent and hirsute; leaflets 5, sessile or stalked, lanceolate, or ovate-lanceolate, acute at the base, obtuse or acute at the apex, repand-dentate, 2–5 cm. long; outer sepals ovate at the base, 8–15 mm. long; corolla white, 3 cm. long or less.

TYPE LOCALITY: Cayenne.

DISTRIBUTION: Cuba and southern Mexico to Colombia and Brazil.

SPECIMENS EXAMINED: Cuba; *Wright 3084* (G); *Curtiss 378,* 1904 (G, Y); *Wilson 1224 & 3639,* 1904 (Y); Mexico: Acapulco, *Palmer 143,* 1895 (Y, N). Guatemala; *Heyde & Lux. 4355,* 1892 (Y).

Ipomœa cissoides guadaloupensis (Steud.).

Convolvulus pilosus Wikstr. in Vet. Acad. Handl. Stock. **1827**: 60. 1828.
Convolvulus guadaloupensis Steud. Nom. Ed. 2, 409, 1841.
Batatas cissoides ver. *integrifolia* Choisy in DC. Prodr. **9**: 339. 1845.

Leaflets usually larger, entire, acuminate, less pubescent but the stem strongly pilose; corolla larger.

SPECIMENS EXAMINED: Cuba; *Combs 680,* 1896 (Y–G, in part).

8. Tyrianthinæ. Twinning, perennial or annual vines, usually with pubescent foliage and sepals. Ovary 2-celled, 4-seeded; seeds glabrous.

Leaf-blades cordate-hastate, the basal lobes rounded, laterally acute.
  Sepals 12–18 mm. long or less.
    Sepals 2 mm. wide × 10–12 mm. long, with lax tips; corolla 2–3 cm. long. 47. *I. iostemma.*
    Sepals 3–5 mm. wide × 14–18 mm. long; corolla 5–6 cm. long. 48. *I. variabilis.*
  Sepals 20–30 mm. long; corolla 2–3 cm. long. 49. *I. portoricensis.*
Leaf-blades not hastate at the base.
  Corolla 2–3 cm. long; sepals hispid; lobes of the leaf-blades lanceolate. 50. *I. barbatisepala.*
  Corolla 5–8 cm. long; sepals pubescent or tentacular.
    Sepals densely tentacular, 18–20 mm. long. 51. *I. silvicola.*

[1] B. D. Jackson, Journn. Bot. **30**: 547. 1892, on the dates of Grisebach's Flora.

Sepals not tentacular.
Corolla glabrous, tube 1–1.5 cm. thick.
Sepals acute or subobtuse; plant more or less densely pubescent. 52. *I. longipedunculata.*
Sepals long-acuminate, plant sparingly pubescent. 53. *I. orizabensis.*
Corolla pubescent without, the tube 1.5–2.5 cm. thick.
Sepals about 12 mm. long; leaf-blades strigose-pubescent beneath. 54. *I. tyrianthina.*
Sepals 22–30 mm. long; leaf-blades silvery-pubescent beneath. 55. *I. venusta.*

47. **Ipomœa iostemma** sp. nov.

Slender, annual, twining, herbaceous, 1–2 m. long or less; stems very slender, sparingly hirsute; leaf-blades ovate and entire to hastate-ovate or 3-lobed, cordate, acuminate, 2–5 cm. long, 1.5–4 cm. wide, pubescent with scattered, inconspicuous hispidulous hairs, lateral lobes acute and short, middle lobe elongated; petioles shorter than the blades; peduncles shorter than the petioles and stouter, usually 1-flowered; bracts linear, 8–10 mm. long; sepals linear, 10–12 mm. long and 1–2 mm. broad at the base, the lax tips caudate-acuminate, glabrous; corolla 2–3 cm. long, the violet-purple limb shading into white below.

COSTA RICA: Nicoya, *Tonduz 13680*, Jan. 1900 (type — Y). MEXICO: Ixtapa, Jalisco, *E. W. Nelson 4141*, 1897 (N).

48. **Ipomœa variabilis** (Schlecht. & Cham.) Choisy in DC. Prodr. **9**: 383. 1845.

Convolvulus variabilis Schlecht. & Cham. in Linnaea **5**: 116. 1830.— Hallier f. Bull. Herb. Boiss. **7**: 411. 1899.

A twining annual, glabrous except for the calyx; leaf-blades ovate-lanceolate, acute or acuminate, 5–8 cm. long, entire or usually cordate-hastate, the basal lobes laterally acute; peduncles shorter than the petioles, hirsute at the base, 1–2 cm. long, 3- to 5-flowered; bracts linear-lanceolate; sepals broadly lanceolate or ovate-lanceolate, 12–15 cm. long, hirsute with spreading hairs at the base, glabrous above; corolla blue (or purple), 5–6 cm. long, the limb as broad with 5, rounded lobes; tube white, plicæ purple or rose; capsules 8–10 mm. thick; seeds smooth.

TYPE LOCALITY: Vera Cruz.
DISTRIBUTION: Mexico.
SPECIMENS EXAMINED: Vera Cruz, *Müller 119*, 1853 (C, Y). (Hallier, l. c. cites *Seler 2532, 3410*, from Guatemala.)

49. **Ipomœa portoricensis** (Spreng.) G. Don, Gen. Syst. **4**: 278. 1838.

Convolvulus portoricensis Spreng. Syst. **1**: 595. 1825.
?*Convolvulus meyeri* Spreng. l. c. 597.
Ipomœa meyeri G. Don, Gen. Syst. **4**: 275. 1838.— Hallier f. Jahrb. Hamb. Wiss. Anstalt. **16**: 43. 1898.
Ipomœa brachypoda Benth. Bot. Voy. Sulphur 135. 1844.
Ipomœa decurtata Hallier f. Bot. Jahrb. **16**: 495. 1893.

Similar in habit and leaf-blades to the two preceding; peduncles 1–3 cm. long, 2- to 10-flowered; sepals linear-lanceolate, 2–3 cm. long, 4–6 mm. broad, hirsute, attenuate; corolla 2.5–3 cm. long, blue; capsules 1 cm. thick.

Type locality: Porto Rico.

Distribution: West Indies, southern Mexico to Panama and Guiana.

Specimens examined: Cuba; *Wright 451*, 1856–7 (G). Jamaica; *Marsh* (G); *Harris 6931*, 1897 (Y). Porto Rico; *Sintenis 828*, 1885 (Y); *Heller 6225*, 1902 (Y). Panama; *Cowell 49 & 291*, 1905 (Y). Santa Marta, Colombia, *Herbert H. Smith 1573 & 1574*, 1899 (Y).

50. **Ipomœa barbatisepala** A. Gray, Syn. Fl. N. Am. 2^1: 212. 1878.

Type locality: Declivity of mountain near El Paso, Texas.

Distribution: Dry or rocky hillsides, western Texas to Arizona and Oaxaca.

Specimens examined: Texas; *C. Wright 507*, 1849 (type — G); *Pringle 68*, 1884 (G). Arizona; *Lemmon 444*, 1881 (G); *Griffiths 2032*, 1900 (N); *Thornber 76*, 1903 (Y). Oaxaca; *Conzatti & Gonzalez 697½*, 1897; *1094*, 1900 (G — cf. Greenm. Proc. Am. Acad. **39**: 84. 1903).

51. **Ipomœa silvicola** House, Bot. Gaz. **43**: 411. *f. 4.* 1907.

More or less densely pubescent; leaf-blades ovate, entire or 3-lobed, appressed sericeous-pubescent above, more densely so beneath; peduncles 1- to 3-flowered; sepals unequal, lanceolate, acuminate, 18–28 mm. long, appressed-pubescent and densely tentacular below; corolla 6–7 cm. long, glabrous.

Type locality: Rio de Las Canas, Guatemala.

Distribution: Forests of southern Mexico to Panama.

Specimens examined: Mexico: Chiapas, *E. W. Nelson 3253 & 3419*, 1895 (N). Guatemala; *John Donnell Smith* (legit *Heyde & Lux.*) *4022*, 1892 (type — N, C). Panama; *Sutton Hayes*, July 1860 (G).

52. **Ipomœa longipedunculata** (Mart. & Gal.) Hemsley, Biol. Cent.-Am. Bot. **2**: 389. 1882.

Pharbitis longipedunculata Mart. & Gal. in Bull. Acad. Brux. XII. **2**: 271. 1845.

Stems reflexed hispid to nearly glabrate; leaf-blades orbicular-ovate, 6–10 cm. long, acute or acuminate, entire or rarely 3-lobed, deeply cordate, densely pubescent above and ciliate; peduncles usually elongated, 8–20 cm. long, hirsute, 1- to 5-flowered; pedicels 1–4 cm. long; sepals subequal, oblong-lanceolate, the outer ones usually obtuse, the inner acute, 12–15 mm. long, hirsute, the inner ones with scarious margins; corolla rose-purple, 6–8 cm. long, glabrous.

TYPE LOCALITY: "Crescit in Mexico, in Sylvis El Sabino prope Ixmiquilpan."

DISTRIBUTION: Thickets and forests, San Luis Potosi to Guatemala.

SPECIMENS EXAMINED: San Luis Potosi, *Palmer 45*, 1902 (N, Y, G). Vera Cruz: Orizaba, *Müller 242 & 1567*, 1855 (C); *Seaton 256*, 1891 (C, G); *Pringle 7053*, 1895 (G). Morelos; *Purpus 1755*, 1905 (Y, G). *Rose & Hay 5665*, 1901 (N, G). Mexico; *Borgeau 498*, 1856 (G), *1738*, 1866 (Y). *Pringle 6452*, 1896 (G, N, C), *Urbina*, 1881 (M); *Altamirano*, 1888 (M). Oaxaca; *E. W. Nelson 1184*, 1894 (N); *Conzatti & Gonzalez 143 & 473*, 1895 (G); *Pringle 5665*, 1894 (G), *8432*, 1900 (G, Y, N). Jalisco; *Palmer 335*, 1886 (N, C, G), *Pringle 4448*, 1893 (G, N, C).

Guatemala; San Miguel Uspantam, Quiche, *John Donnell Smith* (legit *Heyde & Lux.*) *3189*, 1892 (G).

53. **Ipomœa orizabensis** (Pelletan) Ledenois; Steud. Nom. ed. 2, 818. 1841.

Ipomœa batatoides Benth. Pl. Hartw. 46. 1840. Not *I. batatoides* Choisy, 1837.
Convolvulus orizabensis Pelletan, in Jour. de Chemie Médicale, de Pharmacie et de Toxicologie **10**: 1. 1834.
Ipomœa mestitlanica Choisy in DC. Prodr. **9**: 389. 1845.

Root tuberous; stems glabrous or finely pubescent; leaf-blades ovate, shallowly cordate, 3-lobed or entire, 7–10 cm. long, acuminate, lateral lobes not spreading; peduncles 1- to 5-flowered; sepals lanceolate, thin, smooth, subequal, acuminate, 10–15 mm. long; corolla 7–8 cm. long, the purplish-blue limb shading into white below.

TYPE LOCALITY: Near Orizaba, Mexico.

DISTRIBUTION: Dry or stony places, northern Mexico to Oaxaca.

ILLUSTRATIONS: Bot. Reg. *pl. 36*.

SPECIMENS EXAMINED: Nuevo Leon; near Monterey, *Pringle 8737*, 1903 (G, N, Y). Oaxaca; Cerro de San Felipe, *Conzatti & Gonzalez 447*, 1897 (G). Valley of Oaxaca, *E. W. Nelson 1159*, 1894 (N, G).

54. **Ipomœa tyrianthina** Lindl. Bot. Reg. Misc. 87. 1832.— Choisy in DC. Prodr. **9**: 375. 1845.

?*Convolvulus serotinus* DC. Cat. Hort. Monsp. 97. 1813.
?*Ipomœa serotina* Roem. & Schult. Syst. **4**: 215. 1819.
Convolvulus sanguineus Willd.; Roem. & Schult. l. c. 302.
Convolvulus superbus H. B. K. Nov. Gen. & Sp. **3**: 103. 1819.
Ipomœa superba G. Don, Gen. Syst. **4**: 275. 1838. Not *I. superba* Ledeb. 1822, or Schrank, 1828.
Pharbitis tyrianthina Hook. Bot. Mag. **69**: *pl. 4024*. 1843.
Pharbitis serotina Choisy in DC. Prodr. **9**: 341. 1845.

Resembling *I. longipedunculata*, but usually more hipid-pubescent; sepals oblong, hispid, acutish, subequal, 12–15 mm. long; corolla campanulate-funnelform, 6–7 cm. long, the tube 2–3 cm. thick, pubescent without.

Type locality: Between Aguasarco and Volcan Jorullo, Michoacan, Mexico (H. B. K.).

Distribution: Mountain Forests, southern Mexico.

Specimens examined: Guerrero; Near Chilpancingo, 9000–10200 ft. alt. *E. W. Nelson 2161*, 1894 (G, N).

55. **Ipomœa venusta** (Mart. & Gal.) Hemsley, Biol. Cent.-Am. Bot. **2**: 385. 1882.

Calonyction venustum Mart. & Gal. in Bull. Acad. Brux. XII. **2**: 269. 1845.— Walp. Rep. **6**: 531. 1846–47.

Stout, perennial, woody below; stems velvety-pubescent and tomentose; leaf-blades orbicular-ovate, 10–20 cm. long, shallowly cordate, acute, entire or slightly 3-lobed, appressed-pubescent above, silvery-canescent beneath; sepals oblong-lanceolate, acute or obtuse, 22–30 mm. long, silky-tomentose without; corolla campanulate-funnelform, 8–9 cm. long, the tube about 2 cm. thick, hirsute without on the plicæ and tube.

Type locality: Province of Tobasco, Mexico.

Distribution: Southern Mexico and Central America.

Specimens examined: Puebla; Huatusco, *Conzatti 850*, 1898 (G). Guatemala: Chiapas, Santa Rosa, *J. Donnell Smith* (legit *Heyde & Lux*) *4350*, 1892 (G, C).

Section III. BATATAS.

9. **Erpipomœa**. Creeping or prostrate, annual or perennial vines; roots sometimes tuberous, or stems rooting at the nodes; leaf-blades entire or lobed.

Stems rooting at the nodes.
  Leaf-blades entire or toothed.
    Leaf-blades broadly sagittate, the basal auricles blunt or toothed. 56. *I. reptans.*
    Leaf-blades not sagittate or hastate.
      Leaf-blades broadly ovate, cordate, acute. 57. *I. asarifolia.*
      Leaf-blades suborbicular, obcordate or emarginate at the apex, not cordate. 58. *I. pes-capræ.*
  Leaf-blades variously lobed or oblong-lanceolate, not cordate; corolla cream-colored. 59. *I. stolonifera.*
Stems prostrate, but not rooting at the nodes.
  Corolla white or purple only at the base.
    Leaf-blades 3- to 9-toothed. 60. *I. schaffneri.*
    Leaf-blades not toothed, entire and strongly reticulate-veined beneath. 61. *I. hartwegii.*
  Corolla blue or purple or only the tube white.
    Peduncles usually exceeding the leaves; blades triangular-ovate and hastate, sinuately toothed at the base, pubescent. 62. *I. ignava.*
    Peduncles very short; leaf-blades deltoid-reniform to triangular-ovate, angled or toothed, nearly or quite glabrous. 63. *I. eximia.*

56. **Ipomœa reptans** (L.) Poir. Encyc. Suppl. **3**: 460. 1813.— Choisy in DC. Prodr. **9**: 349. 1845.

Olus-vagum, Rumph. Amb. **5**: 419. *pl.* 155. *f. I.*
Ballel, Rheed. Mal. **11**: 107. *pl.* 52.
Convolvulus reptans L. Sp. Pl. 158. 1753.
Convulvolus repens Desr. in Lam. Encyc. **3**: 547. 1789.— Vahl, Symb. Bot. **1**: 17. 1790.— Willd. Sp. Pl. **1**: 874. 1798 (excl. syn. L, and Gronov.) — Roxb. Fl. Ind. **2**: 68. 1824. Not *C. repens* L. 1753.
Convolvulus adansonii Desr. l. c. 560.
Ipomœa aquatica Forsk. Fl. Aegypt.-Arab. 44. 1775.— Lam. Illus. **1**: 467. 1791. — Encyc. **6**: 18. 1804.
Ipomœa repens Roth; Roem. & Schult. Syst. **4**: 244. 1819.— Roth, Nov. Pl. Sp. 110. 1821.
Ipomœa clappertoni R. Br. in Denh. & Clapp. Trav. Append. 240. 1826.
Ipomœa subdentata Miq. Fl. Ind. Bat. **2**: 614. 1856.

Fleshy and glabrous; leaf-blades ovate-lanceolate or triangular, sagittate or subhastate, 3–8 cm. long, basal auricles obtuse, acute or toothed; corolla white tinged with magenta below, about 4 cm. long.

Type locality: India.
Distribution: Wet shores, circumtropical.
Illustrations: Naves; Blanco, Fl. Fillip. *pl. 149.*

SPECIMENS EXAMINED: Cuba; *Combs 656*, 1895 (Y); *Curtiss 685*, 1905 (Y); *Britton, Britton & Shafer 505*, 1903 (Y). Guadeloupe; *Duss 3502*, 1894–95 (Y).

57. **Ipomœa asarifolia** (Desr.) Roem. & Schult. Syst. **4**: 251. 1819.

Convolvulus asarifolius Desr. in Lam. Encyc. **3**: 562. 1789.
Ipomœa beladambœ Roem. & Schult. Syst. **4**: 233. 1819.
Convolvulus flagelliformis Roxb. Fl. Ind. **2**: 68. 1824.
Amphione asarifolia Raf. Fl. Tellur. **4**: 79. 1838.
Ipomœa flagelliformis Steud. Nom. Ed. 2, 816. 1841.
Ipomœa urbica Choisy in DC. Prodr. **9**: 349. 1845.
Ipomœa latifolia Mart. & Gal. in Bull. Acad. Brux. XII. **2**: 266. 1845.
Ipomœa nympheæfolia Griseb. Cat. Pl. Cub. 203. 1866. Not *I. nymphiæfolia* Blume, 1826.
Ipomœa grisebachii Prain, Journ. As. Soc. Beng. **63**: 107. 1894.
Ipomœa vogelii Baker in Kew Bull. 71. 1894.
Ipomœa repens Baker & Rendle in Dyer, Fl. Trop. Afr. **4**[2]: 172. 1905. (excl. syn.) Not *I. repens* Roth, 1819.

Leaf-blades orbicular-ovate, 10 cm. broad or broader, cordate, acute, entire; peduncles 1- to 5-flowered; sepals unequal, 8–10 mm. long, obtuse, corolla 6–8 cm. long, purple.

TYPE LOCALITY: Senegal, Africa.

DISTRIBUTION: Sandy fields and shores, tropical Africa, Asia, West Indies and gulf coast of Mexico.

ILLUSTRATIONS: Wight, Il. *pl. 887*.

SPECIMENS EXAMINED: Cuba; *Wright 3089* (C), *Shafer 527*, 1903 (Y); *Britton & Wilson 359*, 1903 (Y); *Wilson 1167*, 1904 (Y). Isle of Pines, *Curtiss 219*, 1903–04 (Y). Jamaica; *Harris 9826*, 1907 (Y). Mexico: Chiapas, *Caec. & Ed. Seler 1802*, 1896 (G).

58. **Ipomœa pes-capræ** (L.) Roth, Nov. Sp. Pl. 109. 1821.

Convolvulus marinus seu Soldanella, Piso & Marcgraf. Hist. Nat. Braz. **1**: 51. 1648.
C. foliis subrotundis apice emarginatis basi integris, Roy. Lugdb. 428.
C. maritimus zeylandicus, folio crasso cordiformi, Herm. Lugdb. 174.
Schoranna Adamboe, Rheed. Mal. **11**: 117.
C. marinus catharticus, folio rotundo, flore purpureo, Plum. Am. 89.

Convolvulus pes-capræ L. Sp. Pl. 159. 1753.
Convolvulus brasiliensis L. l. c.
Ipomœa biloba Forsk. Fl. Aegypt.-Arab. 44. 1775.
Convolvulus maritimus Desr. in Lam. Encyc. **3**: 550. 1789.

Convolvulus bauhiniæfolius Salisb. Prodr. 125. 1796.
Ipomœa crassifolia Pers. Syn. **1**: 184. 1805.
Ipomœa maritima R. Br. Prodr. 486. 1810.
Convolvulus capripes Stokes, Bot. Mat. Med. **1**: 327. 1812.
Ipomœa orbicularis Ell. Bot. S. C. & Ga. **1**: 257. 1817.
Ipomœa brasiliensis G. F. W. Mey. Prim. Fl. Esseq. 97. 1818.
Convolvulus bilobatus Roxb. Fl. Ind. **2**: 73. 1824.
Convolvulus retusus Colla, App. Hort. Ripul. **3**: **31**. 1825.
Convolvulus rotundifolius Schum. & Thonn. Beskr. Guin. Pl. 102. 1827.
Ipomœa rotundifolia G. Don, Gen. Syst. **4**: 265. 1838.
Plesiagopus savona Raf. Fl. Tellur. **4**: 265. 1838.
Bonanox orbiculata Raf. l. c. 77.
Latrienda brasiliensis Raf. l. c. 81.
Ipomœa bilobata G. Don; Sweet. Hort. Brit. ed. 3, 483. 1839.
Ipomœa halophila Poepp.; Steud. Nom. ed. 2, **1**: 817. 1841.
Ipomœa ægopoda St. Lag, in Ann. Soc. Bot. Lyon **7**: 70. 1880.
Quamoclit pes-capræ Maza, Fl. Habana 346. 1897.

Type locality: India.

Distribution: Sandy beaches and shores, circumtropical. In America, from Georgia and Florida to Paraguay and throughout the West Indies.

Illustrations: Herm. Lugdb. *pl. 175*. Plum. Am. *pl. 104*. Rheed. Mal. **11**: *pl. 57*. Rumph. Amb. **5**: *pl. 159. f. 1*. Bot. Reg. *pl. 319*. Vell. Fl. Flum. **2**: *pl. 62*. Naves in Blanco, Fl. Fillip. ed. 3, *pl. 29*.

59. **Ipomœa stolonifera** (Cyrill.) Poir. in Lam. Encyc. **6**: 20. 1804. Baker & Rendle in Dyer, Fl. Trop. Afr. 4^2: 171. 1905.

Convolvulus albus, folio lacinato, maritimus, Plum. Cat. 1. 1703.
Convolvulus foliis obtusis, palmato-lobatis, etc. Plum. Am. 79.

Convolvulus littoralis L. Syst. ed. 10, 924. 1759.
Convolvulus stoloniferbus Cyrill, Pl. Rar. fasc. **1**: 14. 1788.
Convolvulus dianthus J. F. Gmel. Syst. 343. 1791.
Convolvulus acetosæfolius Vahl, Eclog. Am. **1**: 18. 1796.
Ipomœa carnosa R. Br. Prodr. 485. 1810.
Ipomœa acetosæfolia Roem. & Schult. Syst. **4**: 247. 1819.
Convolvulus auritus Roem. & Schult. l. c. 301.
Convolvulus incurvus Schumach. & Thonn. Beskr. Guin. Pl. 99, 1827.
Ipomœa incurva G. Don, Gen. Syst. **4**: 266. 1838.
Ipomœa humilis G. Don, l. c.— Choisy in DC. Prodr. **9**: 390. 1845.
Convolvulus obtusilobus Michx. Fl. Bor.-Am. **1**: 139. 1803.
Batatas acetosæfolia Choisy in Conv. Rar. 124. 1837.— In DC. Prodr. **9**: 338. 1845.
Latrienda imperati Raf. Fl. Tellur. **4**: 81. 1838.
Ipomœa Deppeana G. Don, Gen. Syst. **4**: 276. 1838.
Convolvulus sinuatus Petagne; Steud. Nom. ed. 2, **1**: 411. 1841.
Ipomœa littoralis Boiss. Fl. Orient. **4**: 112. 1879.— Hallier f. Bot. Jahrb. **18**: 144. 1894. Not *I. littoralis* Blume, 1826.

Ipomœa imparati Griseb. Cat. Pl. Cub. 203. 1866.
Batatas littoralis Choisy, in DC. Prodr. **9**: 338. 1845.
Ipomœa sinuata Kuntze, Rev. Gen. Pl. **2**: 442. 1891.
Batatas incurva Benth. in Hook. Niger Fl. 467. 1849.

Type locality: Antilles.

Distribution: Sandy soil and shores, circumtropical. In America, from South Carolina and Florida to South America and West Indies.

Illustrations: Plum. Am. *pl. 90. f. 2.* Cyrill, Pl. Rar. fasc. **1**: *pl. 5.* Mart. Fl. Bras. **7**: *pl. 94.*

60. **Ipomœa schaffneri** S. Wats. in Proc. Am. Acad. **18**: 123. 1882–83.

Stems puberulent; leaf-blades orbicular, deeply cordate, acute, 3–4 cm. broad, unequally and sinuately dentate near the base; sepals equal, ovate, acute, 8 mm. long, 4–5 mm. broad, pubescent.

Type locality: Near San Luis Potosi, Mexico.

Distribution: Arid plains and thickets, northern Mexico.

Specimens examined: *Schaffner 621*, 1876 (type — G, N).

61. **Ipomœa hartwegii** Benth. Pl. Hartw. 15. 1839.— Choisy in DC. Prodr. **9**: 376. 1845.

Stems finely pubescent, herbaceous, 50–100 cm. long; leaf-blades ovate, deeply cordate, entire, acute, 2–3 cm. long; petioles about as long and 2-glanded at the apex; peduncles 4–6 cm. long, 1–2-flowered; sepals somewhat unequal, narrowly ovate, obtuse or rounded at the apex, puberulent, dark-colored with pale scarious margins, 7–9 mm. long; corolla 6–7 cm. long, white.

Type locality: Mexico.

Distribution: Stony or dry thickets, central Mexico.

Specimens examined: *Hartweg 96* (dupl. type — G). Michoacan, *Dr. Nicolas Leon*, 1885 (M). Queretaro; San Juan del Rio, *Pringle 10028*, 1905 (G, Y, N). Between Hacienda Ciervo and Cadereyta, *Rose, Painter & Rose 9704*, 1905 (Y, N).

62. **Ipomœa ignava** sp. nov.

Stems trailing from a perennial, tuberous root; pubescent, slender; leaf-blades triangular-ovate or triangular-hastate, 1–6 cm. long and as broad, obtuse, sinuately toothed toward the base, basal auricles 5–15 mm. long, appressed-hirsute or glabrate above, pubescent beneath, on the petioles and at the base of the peduncles; peduncles slender, often exceeding the leaves, 1-flowered; pedicel 5–10 mm. long; sepals very unequal, oblong-lanceolate, outer ones 4–5 mm. long, obtuse and muricate, inner 5–7 mm. long and rounded; corolla slender-funnelform, 5–7 cm. long, blue, the white tube constricted just above the calyx, limb 5-lobed, 4–6 cm. broad; capsules globose, 1 cm. or less thick, 2-celled, 4-seeded; seeds glabrous.

MEXICO: Oaxaca; Las Sedas to La Carbonera, *Conzatti & Gonzalez 261*, 1897 (type — G); La Carbonera, 7200 ft. alt, *804*, 1895 (G).

63. **Ipomœa eximia** House, Muhlenbergia **3**: 44. *pl. 2 f. d.* 1907.

Similar to the preceding species, nearly or quite glabrous; leaf-blades deltoid-reniform or triangular-ovate, 2–2.5 cm. broad, cordate, obtuse, the margin angled or toothed, sparingly hirsute above, finely so on the veins beneath and on the margin; peduncles 2 cm. long or less, 1- to 3-flowered; sepals very unequal, outer ones and the pedicels muricate, oblong-lanceolate, blunt, 5–8 mm. long; corolla very slenderly funnelform, deep rose-purple, 4–5 cm. long, the abruptly expanded limb subentire, 3.5–4 cm. broad.

TYPE LOCALITY: Orizaba, Mexico.
DISTRIBUTION: Vicinity of Orizaba.
SPECIMENS EXAMINED: Orizaba *Müller*, 1855 (type — C, N).

10. **Dactylophyllæ.** Stout, twining, perennial vines, the stems woody below; leaf-blades divided into 3 to 9, sessile or stalked leaflets; flowers solitary or usually in irregular corymbose clusters; sepals coriaceous or leathery, obtuse, rarely acute; corolla tube constricted within or just above the calyx; capsules thick-walled, ovoid, acute, usually apiculate, 2-celled, 4-seeded; the ovary supported by a prominent culpiform disk.

Coiladena Raf. Fl. Tellur. **4**: 12. 1838.
Modesta Raf. l. c. 75. (in part).

Leaflets three; sepals unequal. — 64. *I. ternata.*
  Corolla white; sepals 10–15 mm. long.
  Corolla red; sepals 8–10 mm. long. — 65. *I. lineolata.*
Leaflets five to seven.
  Sepals 6–7 mm. long.
    Leaflets linear to linear-lanceolate, acute at both ends.
      Leaflets linear or oblinear and revolute. — 66. *I. fawcettii.*
      Leaflets linear-lanceolate, acuminate at both ends, not revolute. — 67. *I. dactylophylla.*
    Leaflets lanceolate to ovate-lanceolate.
      Leaflets oblanceolate, obtuse. — 68. *I. carolina.*
      Leaflets acuminate. — 69. *I. furcyensis.*
  Sepals 9–10 mm. long or longer.
    Capsules scarcely exceeding the calyx.
      Stamens exserted; sepals equal. — 70. *I. horsfalliæ.*
      Stamens included; sepals unequal. — 71. *I. rubella.*
    Capsules twice as long as the calyx; corolla scarlet or purple. — 72. *I. plumieriana.*

64. **Ipomœa ternata** Jacq. Hort. Schœnb. **1**: 16. *pl. 37.* 1797.—Choisy in DC. Prodr. **9**: 361. 1845.

Convolvulus ternatus Spreng. Syst. **1**: 590. 1825.
Batatas ternata G. Don, Gen. Syst. **4**: 262. 1838.
Ipomœa thomsoniana Mast. in Gard. Chron. **2**: 818. 1883.

Leaflets oblong-ovate or elliptical-ovate, stalked, acute or obtuse at the ends, broadest near the middle, thick and firm, becoming subchartaceous; peduncles usually 1-flowered; sepals 10–15 mm. long, ovate, rounded; corolla dull-white with cream-colored rays, 5–6 cm. long.

Type locality: Jamaica.
Distribution: Forests of Jamaica, and cultivated in other West Indian islands.
Specimens examined: Jamaica; *Harris 7410*, 1898; *9005*, 1905 (Y).

65. **Ipomœa lineolata** Urb. Symb. Ant. **3**: 355. 1903.

Lateral nerves of the leaflets at an angle of about 60° and about 10–12 pairs, lineolate-anastomosing close to the margin; leaflets subpellucid, pale beneath, 5–6 cm. long, cuspidate-acuminate; peduncles 2–3-flowered; corolla red, the disk pink.

Type locality: Jamaica.
Distribution: Forests of Jamaica.

66. **Ipomœa fawcettii** Urban, sp. nov.

Slender, several m. long, from a perennial root, glabrous; leaf-blades divided into 5–7, spatulate filiform or narrowly linear leaflets 1–3 cm. long, revolute with age, obtuse; petioles short; flowers solitary or clustered on short leafy branches; pedicels 5–12 mm. long; sepals unequal, broadly oblong, rounded or obtuse, 4–6 mm. long, the inner ones longer and thinner than the outer; corolla subsalverform 3–4.5 cm. long, tube pale green, limb pale lilac, about 1.5–2 cm. broad with rounded, obtuse lobes; capsules ovoid, longer than the calyx, 2-celled; 4-seeded; seeds with a very long coma of light-brown hairs.

Jamaica: Road to Wareka, *Harris 8605*, 1904 (Y); *10010*, Nov. 19, 1907 (type — Y).

67. **Ipomœa dactylophylla** Griseb. Cat. Pl. Cub. 203. 1866.

Slender, glabrous or minutely puberulent; leaf-blades with 5, sessile, linear-lanceolate, entire leaflets, 3–5 cm. long, acuminate, abruptly acute at the base; peduncles shorter than the petioles, 1-flowered, 8–12 mm. long, the pedicel about as long; sepals equal, oblong-lanceolate, acute, 5–7 mm. long; corolla about 4 cm. long, the crimson limb 2.5–3 cm. broad.

TYPE LOCALITY: Eastern Cuba.

DISTRIBUTION: Thickets, eastern Cuba.

SPECIMENS EXAMINED: *C. Wright 3093* (co-type — G). Pinar del Rio, *Palmer & Riley 332*, 1900 (N).

68. **Ipomœa carolina** L. Sp. Pl. 160. 1753. Not *I. carolina* Pursh, 1814.

Convolvulus minor pentaphyllus, flore purpureo minore, Catesb. Car. **2**: 9. *pl.* 91.

Ipomœa caroliniana Poir. Encyc. Suppl. **6**: 11. 1816.
Ipomœa heptaphylla Griseb. Mem. Am. Acad. **8**: 527. 1863. Not *I. heptaphylla* Rottb. & Willd. 1803.
Quamoclit heptaphylla Maza, Fl. Habanera 346. 1897.

Leaflets 5 to 7, subspatulate, substalked, 3–8 cm. long, tapering to the base, apex rounded or obtuse; peduncles shorter than the petioles, 2- to 10-flowered; sepals subequal, elliptical to ovate, rounded or obtuse, thin, 6–8 mm. long; corolla 3–4.5 cm. long, tubular-funnelform, the limb 5-lobed, 2–3 cm. broad, tube greenish below; capsules oblong.

TYPE LOCALITY: Carolina, Bahamas (L.); Cuba (Griseb.).

DISTRIBUTION: Bahamas and Cuba.

SPECIMENS EXAMINED: Cuba; "prope villam Monte Verde & Nouvelle Sophie," *C. Wright 1371*, 1859 (G, Y). Calicita, *Combs 509*, 1895 (G); Matanzas, *Britton & Wilson 41*, 1903 (Y); Cayamos, *Earle & Baker 2459*, 1904 (Y); Santiago, *Underwood & Earle 1674*, 1903 (Y); Sagua, *Britton & Wilson 381*, 1903 (Y). Bahamas: New Providence, *Britton & Brace 180*, 1904 (Y). Andros, *Northrop 569*, 1890 (Y); *Brace 4950*, 1906 (Y).

69. **Ipomœa furcyensis** Urb. Symb. Ant. **3**: 351. 1902.

Leaflets 2–5 cm. long, 5–10 mm. wide, tapering to the base, the apex acuminate, membranaceous or chartaceous with age; peduncles 3–6 cm. long, 3- to 7-flowered; sepals about 10 mm. long, tinged with red, 3.5–4.5 mm. wide, the inner a little broader and longer, obtuse; corolla 5–6 cm. long, slightly constricted below the limb.

TYPE LOCALITY: Furcy mountains, Hayti.

DISTRIBUTION: Mountains of Hayti.

SPECIMENS EXAMINED: La Brande to Mt. Balance, *Nash & Taylor 1739*, 1905 (Y).

70. **Ipomœa horsfalliæ** W. Hook. in Bot. Mag. **61**: *pl. 3315*. 1824. — Urb. Sym. Ant. **3**: 352. 1902.

Ipomœa pendula Choisy in DC. Prodr. **9**: 387. 1845. Not *I. pendula* R. Br. 1810.
Convolvulus horsfalliæ D. Dietr. Syn. Pl. **1**: 664. 1839.
Coiladena hyemalis Raf. Fl. Tellur. **4**: 12. 1838.

A woody twiner, several m. high; leaflets 5 or 7, obovate or oblanceolate, acuminate at the base, the apex abruptly acuminate, subchartaceous; peduncles 4–12 cm. long; pedicels 15–25 mm. long; sepals rubescent, 10–12 mm. long; corolla light purple or rose, 5–6 cm. long, narrowly funnelform, the 5-lobed limb about 4 cm. broad; stamens exserted, 30–40 mm. long.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico, Virgin Islands, Guadeloupe and Martinique. Common in cultivation.

ILLUSTRATIONS: Bot. Mag. *pl. 3315.* Paxt. Bot. Mag. **3**: *pl. 50.* Knowl. & Westc. Fl. Cab. **1**: *pl. 29.* Maund. Bot. **1**: *pl. 31.*

SPECIMENS EXAMINED: Martinique; *Duss 1882 & 3086,* 1895 (Y).

71. **Ipomœa rubella** House, Bot. Gaz. **43**: 414. 1907.

Ipomœa pulchella W. Hook. in Bot. Mag. **73**: *pl.* 4305. 1847. Not *I. pulchella* Roth, 1821.
Ipomœa macrorrhiza Griseb. Fl. Br. W. Ind. 471. 1861.— Mast. in Gard. Chron. New Ser. **23**: 566. 1885. Not *I. macrorrhiza* R. & S. 1819.
Ipomœa grisebachii Urb. Sym. Ant. **3**: 353. 1903. Not *I. grisebachii* Prain, 1894.

Leaflets 5, or rarely 3, stalked, obovate or obovate-lanceolate, 6–12 cm. long, tapering to the base, the apex short-acuminate, subcoriaceous; peduncles many-flowered; sepals green, tinged with red on the margins and apex, oval or ovate, the inner obovate, 9–11 mm. long, obtuse; corolla pale rose-colored, 6–6.5 cm. long; capsules 10–12 mm. long.

TYPE LOCALITY: Manchester, Jamaica.

DISTRIBUTION: Forests of Jamaica.

SPECIMEN EXAMINED: Jamaica, *Marsh* (G). *Harris 8651, 8727,* 1904 (Y); *Britton 536,* 1906 (Y); *Underwood 3410,* 1906 (Y).

72. **Ipomœa plumieriana** House, Bot. Gaz. **43**: 413. 1907.

Convolvulus coccineus heptaphyllus, radice crassissima, Plum. Cat. 1. 1703 — Plum. Am. 79. (excl. syn. Sloan. Browne and Pluk.)
Convolvulus macrorrhizos L. Syst. ed. 10, 923. 1759.— Sp. Pl. ed. 2, 223. 1762.
Ipomœa macrorhizos Roem. & Schult. Syst. **4**: 311. 1819.— Choisy in DC. Prodr. **9**: 388. 1845.— Urb. Sym. Ant. **3**: 352. 1902. Not *I. macrorrhiza* Michx. 1803.
Batatas macrorrhiza G. Don, Gen. Syst. **4**: 261. 1838.

Leaflets 7- (rarely 5-, 6- or 8-) stalked, elliptical-oblong or lanceolate, 5–10 cm. long, acuminate at the base, apex abruptly acuminate, membranaceous or chartaceous; peduncles 1–6 cm. long, several flowered, sepals suborbicular, the inner longest, 9–10 mm. long; corolla scarlet or purplish, 5–6 cm. long, the tube dilated-campanulate and slightly contracted above; capsules twice as long as the calyx.

Type locality: America (L.); Jamaica (Plum.).

Distribution: Forests of Jamaica, Hayti and St. Domingo.

Illustrations: Plum. Am. *pl. 90. f. 1.*

Specimens examined: Jamaica; Gordontown road, *Harris*, Jan. 7, 1902 (J). Barrack Hill, *W. Cradwick*, July 1890 (J). Port Antonio, *Britton 890*, 1906. (Y).

11. Setosæ. Twining or climbing perennial vines; leaf-blades ovate, cordate, acute, entire or 3-lobed; flowers solitary or cymose; peduncles thickened and fleshy; sepals ovate-lanceolate or ovate, setaceous or tentacular; pedicels more or less tentacular or setaceous.

Gomphius Raf. Fl. Tellur. **4**: 75. 1838.

Petioles and often the leaves, calyces and pedicels bristly with long, spreading setæ; leaf-blades 3-lobed. 73. *I. setosa.*
Petioles not setaceous.
Peduncles longer than the subtending petioles; sepals 8–9 mm. long, densely tentacular. 74. *I. tentaculifera.*
Peduncles shorter than the petioles; sepals 11–12 mm. long, acute, sparingly tentacular. 75. *I. lozani.*

73. **Ipomœa setosa** Ker. Bot. Reg. *pl. 335.* 1818.

Convolvulus setosus Spreng. Syst. **1**: 594. 1825.
Gomphius setosa Raf. Fl. Tellur. **4**: 75. 1838.
Batatas setosa Lindl. Bot. Reg. Index xv. 1839.
Calonyction setosum Hallier f. Bull. Herb. Boiss. **5**: 1048. 1897.

The orbicular-ovate, deeply 3-lobed leaf-blades 10–20 cm. long; peduncles as long as the petioles, 3- to 9-flowered; pedicels 25–30 mm. long, thickened and fleshy, lactescent in fruit; sepals oblong, obtuse, 10–14 mm. long, accrescent in fruit, densely setaceous; corolla purplish-red, 5–6 cm. long, tube cylindrical; capsules 15–20 mm. thick, 4-celled, 4-seeded.

Type locality: Brazil.

Distribution: Tropical America. Introduced with coffee seed into the West Indies, Mexico and Gulf States.

Illustrations: Bot. Reg. l. c. Bull. Herb. Boiss. **5**: *pl. 17, 18.*

Specimens examined: Florida; Manatee, *Simpson 111*, 1890 (Y). Louisiana; Franklin, *O'Niell*, 1900 (Y).

Ipomœa setosa campanulata (Hallier f.). comb. nov.

Ipomœa macrantha Peter, in Engl. & Prantl. Nat. Pflanzenfam. IV. 3a: 31. 1891. Not *I. macrantha* Roem. & Schult. 1819.
Calonyction campanulatum Hallier f. in Bull. Herb. Boiss. **5**: 1050. 1897.

Sepals becoming 20–22 mm. long, the setæ weak; corolla lilac, about 8 cm. long, campanulate-funnelform, the tube constricted at the base.

Type locality: Vera Cruz, Mexico.

Distribution: Mexico and Central America.

Specimens examined: Guatemala; San Jose, *Sutton Hayes*, 1860 (G).

Ipomœa setosa pavoni (Hallier f.). comb. nov.

Ipomœa setosa Griseb. Fl. Br. W. Ind. 469. 1861.
Calonyction pavoni Hallier f. in Bull. Herb. Boiss. **5**: 1048. 1897.

Similar to *I. setosa*, the stem clothed with weaker, hair-like setæ; flowers cincinnial in short, axillary dichasia, long-peduncled; pedicels clavate; the outer sepals with a few weak setæ; corolla campanulate, white or pale violet-purple, the tube conspicuouly dilated above the calyx, 5–7 cm. long.

Type locality: Jamaica.

Distribution: West Indies and tropical South America.

74. **Ipomœa tentaculifera** Greenm. Proc. Am. Acad. **33**: 482. 1898.

Root, tuberous and perennial; leaf-blades ovate, 8–10 cm. long, entire, acuminate; peduncles 7–12 cm. long, 1-flowered; the pedicel 4–6 cm. long; sepals oblong, obtuse or rounded, the tentacular outgrowths 7–10 mm. long; corolla violet-purple, 7–8 cm. long.

Type locality: Tomellin Canon, Oaxaca, Mexico.

Distribution: Oaxaca, Mexico.

Specimens examined: *Pringle 6702*, 1897 (type — G, Y, N).

75. **Ipomœa lozani** Painter; House, Bot. Gaz. **43**: 411. *f. 3.* 1907.

Perennial from a tuberous root; leaf-blades narrowly ovate, deeply cordate-sagittate, abruptly narrowed toward the apex, attenuate, 5–8 cm. long, the basal lobes rounded, converging and overlapping; peduncles shorter than the petioles; pedicel 3–4 cm. long; sepals puberulent, only slightly tentacular, oblong-lanceolate acute; corolla purple, 6–7 cm. long, white below.

Type locality: San Juan del Rio, Queretaro, Mexico.

Distribution: Stony Hills, Queretaro and Tamaulipas.

Specimens examined: *Rose, Painter & Rose 9542*, 1905 (type — N, Y); *Pringle 10029*, 1905. Tamaulipas; Between Victoria and Janmave Valley, *E. W. Nelson 4440*, 1898 (N).

12. Bombycospermæ. Stout, woody, perennial vines, with flowers in dense, axillary, suberect or pendant racemes; seeds covered on all three surfaces with long white, crinkled, wool-like hair.

Bombycospermum Presl. Reliq. Haenk. **2**: 137. 1837.
One species. 76. *I. bombycina.*

76. **Ipomœa bombycina** (Choisy) Benth. & Hook. Gen. Pl. **2**: 873. 1876.

Bombycospermum mexicanum Presl. Reliq. Haenk. **2**: 137. *pl.* 71. 1837.
Batatas bombycina Choisy, in DC. Prodr. **9**: 340. 1845.

Leaf-blades ovate, acuminate, rounded or obtuse at the base, 8–10 cm. long, glabrous above, pubescent beneath; flowering racemes 5–15 cm. long, many-flowered; pedicels about 1 cm. long; sepals ovate, 4–6 mm. long, obtuse, silky-pubescent; corolla about 4.5 cm. long, the tube 1.5 cm. long by 3 mm. thick, the limb campanulate, 3 cm. long and about 1 cm. thick, silky-pubescent without, purplish; capsules 1.5–2 cm. high and 7–8 mm. thick.

TYPE LOCALITY: Western Mexico.

DISTRIBUTION: Southwestern Mexico.

SPECIMENS EXAMINED: Guerrero; Tecpan, *Langlasse 939*, 1899 (N). Acapulco; *Palmer 370*, 1894–95 (N, G).

13. **Palmatæ.** Twining, annual or perennial vines, with palmately or digitately divided leaf-blades; seeds hirsute or lanata on the dorsal angles.

Modesta Raf. Fl. Tellur. **4**: 75. 1838 (in part).

Segments of the leaf-blade parted nearly or quite to the petiole.
- Margin of the corolla-limb crenulate. — 77. *I. Cavanillesii.*
- Margin of the corolla-limb not crenulate.
  - Peduncles stout, 1–9-flowered; sepals obtuse. — 78. *I. cairica.*
  - Peduncles filiform, 1–2-flowered. Sepals acute, equal; corolla violet. — 79. *I. pulchella.*
    - Sepals unequal, obtuse; corolla white. — 80. *I. quinquefolia.*

Segments of the leaf-blades parted to or but slightly beyond the middle.
- Corolla rose-purple; plant stout, perennial from a tuberous root. — 81. *I. digitata.*
- Corolla yellow, with a purple throat; plant slender, annual. — 82. *I. flavo-purpurea.*

77. **Ipomœa cavanillesii** Roem. & Schult. Syst. **4**: 214. 1819.—Griseb. Fl. Br. W. Ind. 470. 1861.

Ipomœa pentaphylla Cav. Ic. **3**: 29. *pl. 256.* 1794. Not *I. pentaphylla* Jacq. 1788.
Convolvulus cavanillesii Spreng. Syst. **4**: 590. 1825.
Batatas cavanillesii G. Don, Gen. Syst. **4**: 262. 1838.
Ipomœa bouvetii Duchass. & Walp. in Linnaea **23**: 752. 1850.

Closely resembling *I. cairica*; sepals ovate or ovate-lanceolate, 6–7 mm. long, coriaceous, glabrous or the outer ones punctate-scabrous; corolla pale rose-colored, white below, about 5 cm. long, the ovate, rounded lobes of the limb crenulate; seeds lanate.

TYPE LOCALITY: "Colitur in R. horto Matritense, ex seminbus missis ab Hispanio."

DISTRIBUTION: West Indies and northern South America.

78. **Ipomœa cairica** (L.) Sweet, Hort. Brit. 287. 1827.

Convolvulus foliis laciniatis vel quinquefolius, Bauh. Pin. 295.
C. quinquefolius, seu foliis laciniatis, flore purpureo cærulea, Bauh. Prodr. 134.
Convolvulus ægyptius Vesl. Aegypt. 73. *pl. 74.*

Convolvulus cairicus L. Syst. ed. 10, 922. 1759.— Sp. Pl. ed. 2, 222. 1762.
Ipomœa palmata Forsk. Fl. Aegypt.-Arab. 43. 1775.— Choisy in DC. Prodr. **9**: 386. 1845.
Ipomœa senegalensis Lam. Illus. **1**: 464. 1791.
Ipomœa stipulacea Jacq. Hort. Schoenb. **2**: 39. 1797.
Convolvulus quinquelobus Vahl, Symb. Bot. **3**: 32. 1794.— Willd. Sp. Pl. **1**: 863. 1798.
Convolvulus tuberculatus Desr. in Lam. Encyc. **3**: 545. 1789.
Ipomœa vesciculosa Beauv. Fl. d'Owar. **2**: 73. 1807.
Ipomœa tuberculata Roem. & Schult. Syst. **4**: 208. 1819.
Ipomœa quinqueloba Roem. & Schult. l. c.— G. Don, Gen. Syst. **4**: 279. 1838.
Convolvulus digitatus Roxb. Fl. Ind. (ed. Carey) **1**: 479. 1832.
Ipomœa digitifolia Sweet, Hort. Brit. ed. 2, 372. 1830.
Ipomœa heptaphylla Voigt. Hort. Suburb. Calc. 360. 1845.
Batatas senegalensis G. Don, Gen. Syst. **4**: 261. 1838.

Stems more or less warty; leaf-segments 2–5 cm. long; sepals equal, 6–7 mm. long, ovate-lanceolate, obtuse; corolla 5–6 cm. long, the limb slightly 5-lobed; capsules 10–12 mm. high; seeds hairy.

TYPE LOCALITY: Egypt.

DISTRIBUTION: Circumtropical. Introduced into Mexico and Florida.

ILLUSTRATIONS: Sloan. Jam. 1: *pl. 96. f. 2.* Jacq. Hort. Schoenb. *pl. 129.* Bot. Reg. *pl. 96, 768.* Bot. Mag. *pl. 699.* Trans. Hort. Soc. **1**: *pl. 11.* Mart. Fl. Bras. **7**: *pl. 105.* Beauv. l. c. *pl. 106.* Sertum Bot. **2**: V–CL. 1829.

SPECIMENS EXAMINED: Grenada; *W. E. Broadway,* Dec. 16, 1904 (Y). Florida; Waste ground, Pensacola, *Curtiss 6496,* 1899 (Y).

79. **Ipomœa pulchella** Roth, Nov. Pl. Sp. 115. 1821.— Choisy, Mém. Soc. Phys. Genèv. **6**: 473. 1833.— In DC. Prodr. **9**: 386. 1845. Griseb. Fl. Br. W. Ind. 470. 1861. Not *I. pulchella* G. Don, 1838.

Convolvulus Aegyptiacus, etc. Moris. Hist. **2**: 18. 1680.

Convolvulus heptaphyllus Rottl. & Willd. in Ges. Naturf. Fr. Neue Schr. **4**: 196. 1803. — Roxb. Hort. Beng. 14. 1814.— Fl. Ind. **2**: 66. 1824.

Convolvulus bellus Spreng. Syst. **1**: 590. 1825.
Ipomœa radicans Bertol.; Choisy in DC. Prodr. **9**: 389. 1845.
Ipomœa gracillima Prain, Journ. As. Soc. Beng. **63**: 111. 1894.
Ipomœa spirale House, Muhlenbergia **3**: 40. 1907.

Slender, glabrous or nearly so; leaf-segments linear-lanceolate, acute or acuminate at each end, 1–3 cm. long, entire or the outer ones bifid; petioles longer than the blades or shorter; peduncles filiform, as long as the petioles or longer, frequently twisted and tendril-like, used in climbing; pedicel 8–16 mm. long, stouter than the peduncle; bracts minute, about 1 mm. long; sepals equal, narrowly ovate or lanceolate, 4–5 mm. long, becoming 6–7 mm. long in fruit; capsules 10 mm. high or less; corolla pale violet, campanulate-funnelform, 18–30 mm. long.

Type locality: East Indies.

Distribution: Tropics of the Old World. West Indies, Mexico to Central America, Peru and Brazil. Introduced into Louisiana.

Specimens examined: Porto Rico: Guanica, *Sintenis 3679*, 1886 (G). Mexico; Yaqui River, *Palmer 24*, 1864 (N.). Louisiana: near New Orleans, *R. S. Cocks*, June 1905 (Y).

80. **Ipomœa quinquefolia** L. Sp. Pl. 162. 1753.[1]

Convolvulus foliis digitatis glabris, caule laevi, Roy. Lugdb. 429.
Convolvulus quinquefolius glaber americanus, Plukn. Alm. 116, *pl.* 167. *f.* 6.

Convolvulus quinquefolius L. Syst. ed. 10, 923. 1759.— Desr. in Lam. Encyc. **3**: 566. 1789.
Convolvulus palmatus Mill. Dict. No. 8, 1768.
Convolvulus hispaniolœ Spreng. Syst. **1**: 590. 1825.
Convolvulus ampelopsifolius Cham. & Schlecht., in Linnaea **5**: 118. 1830.
Pharbitis quinquefolia Raf. Fl. Tellur. **4**: 81. 1838.
Fraxima quinquefolia Raf. l. c. 83.
Latrienda palmatus Raf. l. c. 81.
Ipomœa hispaniolœ G. Don, Gen. Syst. **4**: 1838.
Batatas quinquefolia Choisy, Conv. Rar. 127. 1837.— In DC. Prodr. **9**: 339. 1845.
Merremia quinquefolia Hallier f. Bot. Jahrb. **16**: 552. 1893.

Type locality: America.

Distribution: Thickets, West Indies and Mexico to Central America, Brazil and Peru.

---

[1] Not closely related to the African species, *Ipomœa quinquefolia* Hotchster, which may well take the following name.

Ipomœa hochsteri nom. nov.

Ipomœa quinquefolia Hochst., Hallier f. Bot. Jahrb. 18: 147, 1894.— Native of tropical and southern Africa, cf. Baker & Rendle in Dyer, Fl. Trop. Afr. 4[2]: 177. 1905.

81. **Ipomœa digitata** L. Syst. ed. 10, 924. 1759.

Quamoclit foliis digitatis, flore coccineo, Plum. Am. 81.
Pal-modecca Rheed. Mal. **11**: 101.

Convolvulus paniculatus L. Sp. Pl. ed. 2, 223. 1762.— Willd. Sp. Pl. **1**: 865. 1798.
Ipomœa mauritiana Jacq. Hort. Schoenb. **2**: 39. 1797.
Ipomœa paniculata R. Br. Prodr. 486. 1810.— Hallier f. Bot. Jahrb. **18**: 150. 1894.
Ipomœa enneloba Beauv. Fl. d'Owar. **2**: 69. 1807.
Ipomœa tuberosa G. F. W. Mey. Prim. Fl. Esseq. 113. 1818. Not *I. tuberosa* L. 1753.
Convolvulus roseus H. B. K. Nov. Gen. & Sp. **3**: 108. 1819.
Ipomœa quinqueloba Willd.; Roem. & Schult. Syst. **4**: 789. 1819.
Ipomœa pentaloba Roem. & Schult. l. c. Index. 828.
Batatas paniculata Choisy in Mem. Soc. Phys. Genev. **6**: 436. 1833.— In DC. Prodr. **9**: 339. 1845. (excl. syn. Willd., Spreng., Andr., Bot. Reg. *75,* and Bot. Mag. *1790.*)
Quamoclit digitata G. Don, Gen. Syst. **4**: 75. 1838.
Modesta paniculata Raf. Fl. Tellur. **4**: 260. 1838.
Modesta congesta Raf. l. c.
Ipomœa baalan Montr. in Mem. Acad. Lyon **10**: 238. 1860.

Type locality: America.

Distribution: Forests and thickets at low altitudes, circumtropical.

Illustrations: Plum. Am. *pl. 92. f. 1.* Jacq. Hort. Schoenb. *pl. 200.* Rheed. Mal. **11**: *pl. 49.* Bot. Reg. *pl. 62.* Beauv. l. c. *pl. 101.* Naves in Blanco Fl. Fillip. ed. 3, Ic. *pl. 32.* Revue Hort. 1853. p. 20. Kerner, Hort. *pl. 65.*

82. **Ipomœa flavo-purpurea** Urb. Sym. Ant. **3**: 245. 1902.

Ipomœa punctata C. Wright in Sauv. Fl. Cub. 105. 1870. Not *I. punctata* Macf. 1831.

The linear-lanceolate leaf-segments minutely hispidulous and pellucid-punctate; petioles pilose; peduncles 1-flowered; sepals sparingly pilose, ovate-oblong, subulate, 6–7 mm. long, corolla about 2 cm. long; capsules 4-celled; seeds lanate and pilose on the dorsal angles.

Type locality: Cuba: "En las sabanas del potrero Manati y en Casilda Trinidad."

Distribution: Cuba.

Specimens examined: Cuba, *C. Wright* (without No. in Hb. Gray).

14. Jalapæ. Twining or trailing, mostly perennial vines with stout or woody stems below, frequently with tuberous, woody roots; sepals leathery, usually obtuse; corolla white, pink or purple, mostly slender-funnelform.

Corolla white or cream-colored or tinged with magenta below.	
Leaf-blades subtruncate, plicate, glabrous; peduncles shorter than the petioles.	83. *I. plicata.*
Leaf-blades cordate, not plicate.	
Sepals about 7 mm. long.	
Stems and sepals setaceous-hispid.	84. *I. crinita.*
Stems and sepals glabrous.	85. *I. populina.*
Sepals 10–20 mm. long, or longer.	
Foliage white-tomentulose or silvery-pubescent beneath.	
Corolla densely pubescent, the white-canescent sepals 18–20 mm. long.	86. *I. præcana.*
Corolla glabrous; sepals 12–16 mm. long.	87. *I. macrorhiza.*
Foliage glabrous or pubescent, not silvery.	
Sepals aristate; capsules ovoid, apiculate.	88. *I. scopulorum.*
Sepals blunt or obtuse.	
Calyx 10 mm. thick or more at flowering time; sepals oblong.	89. *I. pandurata.*
Calyx 5–6 mm. thick; sepals lanceolate; leaves minutely pubescent to velvety-pubescent in var.	90. *I. sabulosa.*
Corolla blue, pinkish or purple.	
Sepals more than 10 mm. long (except no. 94).	
Leaf-blades silvery-pubescent beneath or velvety-pubescent.	
Corolla 7–10 cm. long; leaf-blades tomentose beneath.	
Leaf-blades entire or 3-lobed.	91. *I. jalapa.*
Leaf-blades palmately 5-lobed.	92. *I. leonensis.*
Corolla 6 cm. long or less.	
Leaf-blades silvery-pubescent beneath, oblong, rounded or subcordate at the base.	
Sepals oval, 10–13 mm. long.	93. *I. lacteola.*
Sepals 6–8 mm. long.	94. *I. hypargyrea.*
Leaf-blades densely velvety-pubescent above and below, broadly ovate and equally 3-lobed.	95. *I. passifloroides.*
Leaf-blades glabrous or finely pubescent.	
Sepals tomentulose, 12–14 mm. long; leaf-blades triangular-ovate and lobed.	96. *I. rupicola.*
Sepals glabrous or minutely pubescent.	
Leaf-blades finely pubescent, oblong-ovate to oblong-lanceolate, shallowly cordate.	97. *I. nicoyana.*
Leaf-blades glabrous above.	
Sepals equal; corolla rose-purple to white, 8–10 cm. long.	98. *I. calantha.*
Sepals unequal; corolla blue, 5–6 cm. long.	99. *I. cyanantha.*

Sepals less than 10 mm. long.
  Sepals 6–8 mm. long; leaf-blades lobed or entire; corolla purple; Cuban. 100. *I. obtusata.*
  Sepals 4–6 mm. long; leaf-blades entire.
    Corolla pink, 6–8 cm. long. 101. *I. carnea.*
    Corolla purple, about 4.5 cm. long; leaf-blades submembranaceous. 102. *I. microsticta.*

83. **Ipomœa plicata** Urb. sp. nov.

Slender, perennial, climbing over trees and bushes, 6–10 m. long, branching, woody below with a rough, whitish bark; finely pubescent above; leaf-blades ovate or ovate-lanceolate, more or less plicate, acuminate, 4–10 cm. long, glabrous above, finely pubescent beneath; petioles 1–4 cm. long; peduncles shorter than the petioles, 1- to 3-flowered; pedicels 1 cm. long; sepals yellowish-green, 10–13 mm. long, acute, puberulent; corolla 4–5 cm. long, campanulate-funnelform, fragrant; limb about 4 cm. broad, with 5, rounded lobes; capsules ovoid, apiculate, longer than the calyx, 2-celled; seeds densely lanate.

Jamaica: Mount Diablo, 2800 ft. alt., *Harris 8997*, Aug. 29, 1905 (type — Y).

84. **Ipomœa crinita** Brandegee, Zoe **5**: 216. 1905.

The woody stems as well as the petioles and peduncles pilose with white, spreading hairs, 4–5 mm. long; leaf-blades 3-lobed, about 14 cm. broad; peduncles elongated, 20–22 cm. long, subumbellately flowered; outer sepals pilose, 7 mm. long, apiculate.

Type locality: Culiacan, Mexico.
Distribution: Ravines and thickets, western Mexico.
Specimens examined: *Brandegee*, Sept. 12, 1904 (dupl. type — G).

85. **Ipomœa populina** sp. nov.

A stout, woody, perennial twining vine, climbing over trees; stems 1–2 cm. thick, with a smooth bark; leaf-blades ovate, entire, acute, shallowly cordate, 5–8 cm. long, reticulate-veined beneath; petioles slender, longer than the blades; peduncles stout, on the stems of the preceding year, 8–12 cm. long, cymosely many-flowered, the angled pedicels 2.5–3 cm. long; sepals subequal, orbicular-ovate, 5–8 mm. long, spreading in fruit; corolla tinged with magenta at the base, 6 cm. long; limb 6–8 cm. broad with 5, rounded lobes, tube 12–15 mm. thick; capsules thick-walled, oblong, 2 cm. long and 1 cm. thick, 4-valved, 2-celled; seeds twice as long as thick, with a long, white dorsal coma.

Mexico: Acapulco, *Palmer 482*, 1894–95 (type — N, G).

86. **Ipomœa præcana** sp. nov.

Stout, woody, perennial; stems densely canescent or silvery, furrowed; leaf-blades orbicular, 8–12 cm. long, shallowly cordate, veins 5–7 pairs, densely pubescent or nearly glabrate above, silvery-pubescent beneath; petioles 3–5 cm. long; peduncles shorter than the petioles, 3- to 5-flowered; pedicels 5–10 mm. long and with the calyx strongly furrowed or wrinkled when dried; sepals 18–20 mm. long, imbricated, canescent, obtuse, glabrous within; corolla subsalverform, 6–7.5 cm. long, pubescent without, the tube constricted and glabrous at the base; limb 6–10 cm. broad.

MEXICO: Oaxaca; Reyes, 2500–4000 ft. alt. *E. W. Nelson 1823*, Oct. 20, 1894 (type — N, G). Morelos; Near Cuernavaca, on lava beds, *Pringle 7229*, 1896 (G).

87. **Ipomœa macrorhiza** Michx. Fl. Bor. Am. **1**: 141. 1803.—G. Don, Gen. Syst. **4**: 277. 1838.

Ipomœa jalapa Pursh, Fl. Am. Sept. **1**: 146. 1814. (as to descr. excl. syn. L.).
Convolvulus macrorhizus Ell. Bot. S. C. & Ga. **1**: 252. 1817.
Ipomœa mechoacan Nutt. in Am. Jour. Sci. **5**: 289. 1822.
Ipomœa michauxii Sweet, Hort. Brit. 288. 1826.— Chapm. Fl. Southern U. S. 343. 1860.
Ipomœa Purshii G. Don, in Sweet; Hort. Brit. ed. 3, 484. 1839.

Perennial from a napiform or thickened fusiform root, tomentulose-pubescent; leaf-blades entire or lobed; peduncles 1–5-flowered; sepals unequal, outer ones 10–12 mm. long, inner 15–20 mm. long; corolla 7–10 cm. long, magenta at the base; capsules 4-celled.

TYPE LOCALITY: "In maritimis Georgiæ et Floridæ." (Michx.)

DISTRIBUTION: Light sandy soil, near the coast, South Carolina to Florida and northern Mexico.

ILLUSTRATIONS: Bot. Reg. *pl. 342.*

SPECIMENS EXAMINED: Florida; *Curtiss 2165, 4381*; *Boring*, 1899 (Y); *Cheshire*, 1881 (Y); *Chapman* (Y); *Berg* (Y); *Levenworth* (G). South Carolina; *Mellichamp* (G). Tamaulipas, Mexico, *E. W. Nelson 4441* 1898 (N).

88. **Ipomœa scopulorum** Brandegee, Zoe **5**: 169. 1903.

Pubescent throughout; leaf-blades entire, cordate, 6–7 cm. long; peduncles about as long as the leaves, 1–4-flowered; sepals ovate aristate, coriaceous, unequal, 1–2 cm. long; corolla 6–8 cm. long.

TYPE LOCALITY; Mazatlan, Lower California.

DISTRIBUTION: Rocky or dry thickets, Cape region, Lower California, and northwestern Mexico.

SPECIMENS EXAMINED: Mazatlan, *Brandegee,* (N); Culiacan, Sinaloa, Brandegee, Oct. 11, 1904 (G).

89. **Ipomœa pandurata** (L.) G. F. W. Mey. Prim. Fl. Esseq. 100. 1818.— Small, Fl. Southeastern U. S. 962. 1903.

Convolvulus foliis inferioribus cordatis, superioribus trilobis, etc. Gronov. Virg. 141.

Convolvulus panduratus L. Sp. Pl. 153. 1753. Ell. Bot. S. C. & Ga. **1**: 254. 1817.
Convolvulus ciliolatus Michx. Fl. Bor.-Am. **1**: 139. 1803.
Convolvulus candicans Soland; Sims, Bot. Mag. *pl.* 1603. 1813.
Ipomœa ciliosa Pursh, Fl. Am. Sept. **1**: 146. 1814.
Ipomœa ciliolata Pers. Syn. **1**: 183. 1805.— G. Don, Gen. Syst. **4**: 270. 1838.
Ipomœa candicans G. Don, Gen. Syst. l. c. 273.
Convolvulus rubescens Choisy in DC. Prodr. **9**: 338. 1845.

TYPE LOCALITY: Virginia.

DISTRIBUTION: Dry fields, southern Ontario, New York and Connecticut to Michigan, Kansas, Florida and Texas.

ILLUSTRATIONS: Dill. Elth. *pl. 85, f. 99.* Plukn. Amalth. *pl. 385. f. 3.* Bot. Mag. *pl. 1603, 1939.* Bot. Reg. *pl. 588.* Britt. & Br., Illus. Fl. 3: *f. 2945.*

90. **Ipomœa sabulosa** sp. nov.

Ipomœa pandurata Conzatti & Smith, Syn. Fl. Mex. **3**: 48. 1895.

Resembling the preceding species; perennial from a tuberous root; foliage minutely pubescent; leaf-blades ovate, acuminate, shallowly-cordate or subtruncate, 5–8 cm. long; peduncles 1- to 3-flowered, the subulate bracts 5–8 mm. long and often not opposite when the peduncle is 1-flowered; outer sepals about 10 mm. long, acute, pubescent, inner ones 12–14 mm. long by 3–4 mm. wide, obtuse and submembranaceous; corolla 5–6 cm. long, constricted within the calyx, creamy-white with magenta base; limb 6–7 cm. broad with 5, rounded lobes.

MEXICO: Oaxaca; Jayacatlan, *Rev. L. C. Smith 142,* 1894 (type G). San Luis Potosi; Villar, *Pringle 5473,* 1893 (G).

Ipomœa sabulosa mollicella var. nov.

Leaf-blades entire or hastately lobed; softly and densely velvety-canescent; sepals 10–12 mm. long.

MEXICO: Oaxaca, Cuesta de Dominguillo, 4000 ft. alt. *Albert L. Smith 640,* 1895 (type — G).

Ipomœa sabulosa hirtella var. nov.

Leaf-blades ovate to oblong-ovate, hirsute above with harsh, conspicuously whitish hairs, more densely so beneath; rarely glabrate above.

MEXICO: Chiapas, Near San Cristobal, 7000–8000 ft. alt. *E. W. Nelson 3281*, 1895 (type — 233075 — N, G).

91. **Ipomœa jalapa** (L.) Pursh; Bot. Mag. *pl. 1572.* (as synonym) 1 Au. 1813. *I. jalapa* Pursh, Fl. Bor. Am. **1**: 146. 1814 (excl. descr.).

Convolvulus radice tuberosa cathartica, Houst. in Mill. Dict. No. 19. 1741.
C. foliis variis, pedunculis unifloris, radice tuberosa, Mill. Dict. No. 32. 1759.
C. americanus jalapium dictus, Ray. Hist. 724.
Bryonia mechoacana nigricans, Bauh. Pin. 298.— Hist. 151.
Jalapium, mechoacanna nigra, Dal. Pharm. 201.

Convolvulus jalapa L. Mant. 43. 1759.— Mill. Dict. ed. 8, 1768.
Convolvulus mechoacan Vitm. Summa Pl. **1**: 434. 1789.
Convolvulus lividus Moc.; Steud. Nom. ed. 2, **1**: 409. 1841.
Convolvulus jatiauca J. F. Gmel. Syst. 339. 1796.
Batatas jalapa Choisy, Conv. Rar. 125. 1837.— In DC. Prodr. **9**: 338. 1845.

Leaf-blades triangular-ovate, entire or 3-lobed, plicate-veined; peduncles usually very short, 1-flowered; sepals subequal, broadly ovate, obtuse or rounded, 9–12 mm. long; the slender corolla pink or purple.

TYPE LOCALITY: Near Vera Cruz, Mexico.

DISTRIBUTION: Gulf region of Mexico to Venezuela.

ILLUSTRATIONS: Bot. Mag. *pl. 1572.* Bot. Cab. *pl. 518.* Wagner, Pharm. *pls. 151, 152.* Nees & Esenbeck, Off. Pfl. **1**: *pl.197,198.* Cassone, Fl. Med. Farm. *pl. 349.* Woodv. Med. Bot. *pl. 21.* Plench, Ic. Pl. Med. *pl. 94.*

SPECIMENS EXAMINED: San Luis Potosi, *Pringle 3511*, 1890 (G). Venezuela; *Fendler 2083* (G).

92. **Ipomœa leonensis** Robinson, Proc. Am. Acad. **26**: 170. 1891.

Leaf-blades palmately 5-lobed, 6–12 cm. broad, punctate above, with a soft, deciduous, white tomentum beneath, lobes obtuse; sepals ovate, rounded, about 8 mm. long, canescent; corolla 5–7 cm. long.

TYPE LOCALITY: Near Monterey, Mexico.

DISTRIBUTION: Calcareous ledges Nuevo Leon to Oaxaca.

SPECIMENS EXAMINED: Monterey, *Pringle 2840*, 1889 (type — G). San Luis Potosi, *Pringle 5040*, 1891 (G). Oaxaca; Cerro de Huanculla *Conzattii & Gonzalez 1215*, 1901 (G).

93. **Ipomœa lacteola** nom. nov.

Ipomœa calophylla Wright; Griseb. Cat. Pl. Cub. 204. 1866. Not *I. calophylla* Fenzl. 1844.

Leaf-blades oblong, 4–8 cm. long, softly pubescent above, silvery-pubescent beneath; petioles 1–3 cm. long; sepals unequal, rounded or obtuse; corolla 5–6 cm. long.

TYPE LOCALITY: Cuba.
DISTRIBUTION: Cuba and Isle of Pines.
SPECIMENS EXAMINED: Cuba; *C. Wright 3098* (co-type — C).

94. **Ipomœa hypargyrea** Griseb. Cat. Pl. Cub. 204. 1866.

A twining woody vine, appressed silvery-pubescent; leaf-blades oblong-lanceolate, subcordate, 4–8 cm. long, glabrate above, silvery beneath; short petioled; peduncles 1–3-flowered; sepals chartaceous, glabrous, subequal, obtuse; corolla 6–7 cm. long, campanulate above the ventricose base, rose-purple; capsules exceeding the calyx.

TYPE LOCALITY: Cuba.
DISTRIBUTION: Cuba.
SPECIMENS EXAMINED: *C. Wright 449*, (Herb. Gray, in part) *No. 449* is cited under *I. argentifolia* A. Rich., and part of the Gray herbarium sheet is that species.

95. **Ipomœa passifloroides** sp. nov.

Perennial, densely villous-pubescent; leaf-blades broadly ovate, cordate, 4–7 cm. long, subequally 3-lobed, lobes shallow, often rounded, velvety appressed-pubescent above and beneath; petioles short; the short peduncles 2- to 5-flowered; bracts ovate, obtuse, 6–8 mm. long; pedicels densely hirsute; calyx glabrous; sepals chartaceous, suborbicular, scarious-margined, 7–9 mm. long; corolla glabrous, purple, campanulate-funnelform above the strongly ventricose base, 4–5 cm. long, tube 12–14 mm. thick above, the limb 22–25 mm. broad, slightly 5-lobed; capsules black, glabrous, 2-celled, 4-seeded; seeds minutely pubescent, hirsute on the angles.

CUBA: Jiquarito Mountain, Sierra Maestra, 3400 ft. alt. *Norman Taylor 504*, Sept. 18, 1906 (type — Y). A specimen collected by *Wright* without number in Herb. Gray, "Pinal San Juan de B., Nov. 24."

96. **Ipomœa rupicola** sp. nov.

Related to *I. jalapa*. Trailing or twining from a woody, enlarged root; tomentulose, becoming glabrate; leaf-blades triangular-ovate, cordate-hastate, 2–5 cm. long and as broad, acuminate, basal auricles acute or obtuse often bifid; petioles longer than the blades; peduncles 1–1.5 cm. long, 1-flowered; bracts minute; pedicel 1 cm. long, or less; sepals equal, oblong to oblong-ovate, obtuse or the outer ones subacute, tomentose or sericeous, 12–14 mm. long; corolla pubescent in bud and on the plicæ without when expanded, funnelform, 6–7 cm. long, the blue or purple limb 6 cm. broad.

Mexico: Tamaulipas; Jonmave Valley, 2000 ft. alt. *E. W. Nelson 4448,* 1898 (type — 332519 — N, G).

97. **Ipomœa nicoyana** sp. nov.

A high-twining, woody, perennial vine with terete stems; finely pubescent; leaf-blades oblong-ovate, shallowly-cordate or cordate-sagittate, acuminate, 10–20 cm. long, finely pubescent, roughly so above, reticulate-veined beneath; petioles shorter than the blades; peduncles shorter than the petioles, 3-several flowered; sepals equal, lanceolate, abruptly acute, 12 mm. long, pubescent or glabrate, chartaceous in fruit; pedicels 10–15 mm. long; corolla campanulate above the strongly ventricose base, 5–6 cm. long, purple, the white tube 15–18 mm. in diameter; capsules ovoid, apiculate, thick-walled, 15 mm. high, 2-celled; seeds densely lanate.

Costa Rica: Forests near Nicoya, *Tonduz 13671,* 1900 (type — Y).

98. **Ipomœa calantha** Griseb. Cat. Pl. Cub. 202. 1866.

Stems woody, muricate in lines, glabrescent below; leaf-blades orbicular-ovate to oblong-ovate, cordate, acute, entire, glabrous above, pubescent beneath, 5–8 cm. long; petioles as long; peduncles 1- to 5-flowered; sepals equal, ovate, obtuse, 10–13 mm. long; corolla rose-colored or nearly white, 8–10 cm. long, ventricose at the base; capsules 12 mm. in diameter.

Type locality: Cuba.

Distribution: Cuba and Porto Rico.

Specimens examined: Cuba; Bahia Honda, *C. Wright 3091* (co-type — G, N). Porto Rico: Coano, *Sintenis 3128,* 1886 (G).

99. **Ipomœa cyanantha** Griseb. Fl. Br. W. Ind. 469. 1861.

Type locality: Mountains of St. Andrews, Manchester, Jamaica.

Distribution: Forests, mountains of Jamaica.

Specimens examined: Road to Flamstead, 1200 ft alt. *Harris 9034,* 1905 (Y). Sheldon, Blue mountains, 2500 ft. alt. *Fawcett* (ex herb. Bot. Dept. Jam.) *10078,* 1907 (Y).

100. **Ipomœa obtusata** Griseb. Cat. Pl. Cub. 202. 1866.

A slender, herbaceous glabrous vine; leaf-blades ovate-oblong or deltoid-ovate, cordate, obtuse or acute, margins repand or irregularly lobed, often 3-lobed with 2–4 lateral acuminations, 2–6 cm. long; short petioled; peduncles longer than the petioles, 2–5-flowered; pedicels about 1 cm. long; sepals ovate, rounded, subequal, 6–8 mm. long; corolla purple, campanulate above the ventricose base, limb 3 cm. broad with 5, short, rounded lobes; capsules globose.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Cuba.

SPECIMENS EXAMINED: *C. Wright 3092* (co-type — C, G). A specimen in the Nat. Herb. without number, and labelled *I. alterniflora* is identical.

101. **Ipomœa carnea** Jacq. Enum. 13. 1760.— Select. Stirp. Am. Hort. 26. 1763.— Choisy in DC. Prodr. **9**: 374. 1845.

Convolvulus carneus Spreng. Syst. **1**: 602. 1825.
Convolvulus pareiræfolius Bert.; Spreng. l. c. 613.
Ipomœa pareiræfolia G. Don, Gen. Syst. **4**: 273. 1838.
Batatas pareiræfolia Choisy, Conv. Rar. 123. 1837.— In DC. Prodr. **9**: 337. 1845.

TYPE LOCALITY: Near Cartagena (Colombia).

DISTRIBUTION: Thickets near the coast, West Indies and Central America to Brazil.

ILLUSTRATIONS: Jacq. Stirp. Am. Hort. *pl. 18.*

SPECIMENS EXAMINED: Jamaica: *Harris*, Jan. 1894 (J). Nicaragua; *C. Wright* (U. S. North Pacific Expl. Exped.) (C). Panama, *Cowell 171*, 1905 (Y).

102. **Ipomœa microsticta** Hallier f. in Bull. Herb. Boiss. **7**: 411. 1899.

Stems slender, woody, glabrous, terete; leaf-blades ovate, entire, cordate, 4–9 cm. long, submembranaceous, acuminate, densely and minutely black-puncticulate beneath with microscopic glands; lateral veins about 8 pairs; petioles with a pair of punctiform nectaries at the summit; peduncles stout, 4–14 cm. long, many-flowered; pedicels slender, angled, subclavate, 10–13 mm. long; sepals elliptical, convex, coriaceous, unequal, inner ones 6 mm. long; corolla purple, strongly ventricose at the base, 4–5 cm. long.

TYPE LOCALITY: Near Santa Lucia Cozumalhuapa, Guatemala.

DISTRIBUTION; Forests of Central America.

SPECIMENS EXAMINED: *Seler 2427*, 1896 (dupl. type — G).

15. Pedatisectæ. Slender, herbaceous-stemmed, twining or erect, annual or perennials with or without tuber-like roots: leaf-blades pedately or rarely palmately parted, rarely cuneate and subentire in *I. madrensis* and *I. egregia*: corolla usually small, rarely elongated (*I. leptosiphon* and *I. tenuiloba*), funnel-form, never, ventricose at the base.

Leptocallis G. Don, Gen. Syst. **4**: 260. 1838.

Annuals or perennials without tuber-like roots.
  Stems erect, slender and weak; corolla 15 mm. long or less.
    Leaf-blades ternate. 103. *I. ternifolia.*

Leaf-blades pedately 5–9-divided.
Sepals equal; corolla rose-purple. 104. *I. costellata.*
Sepals unequal; corolla cream-colored with a purple throat. 105. *I. painteri.*
Stems trailing or twining.
Corolla 15 mm. long or less; leaf-blades palmately divided. 106. *I. wrightii.*
Corolla 3–8 cm. long.
Sepals attenuate-acuminate; corolla 4 cm. long.
Foliage pubescent; segments of the leaf-blades entire; sepals keeled.
Leaf-blades pilose and ciliate. 107. *I. delphinifolia.*
Leaf-blades finely pubescent. 108. *I. leptotoma.*
Foliage glabrous; segments of the leaf-blades toothed. 109. *I. divergens.*
Sepals lanceolate, acute.
Segments of the leaf-blades oblong-lanceolate and obtuse.
Corolla 3 cm. long, funnelform. 110. *I. pedatisecta.*
Corolla 5 cm. long, subsalverform. 111. *I. valida.*
Segments of the leaf-blades acute or acuminate.
Sepals glabrous; corolla 7–8 cm. long. 112. *I. tenuiloba.*
Sepals setosely-hirsute; leaf-blades densely sericeous-pubescent. 113. *I. pilosissima.*
Perennials, from tuberous-like roots.
Leaf-blades with 5–7, linear or filiform segments.
Corolla white, 8–10 cm. long; stems twining. 114. *I. leptosiphon.*
Corolla purple, 2–5 cm. long.
Leaf-blades sessile or petioles shorter than the blades; peduncles shorter than the petioles.
Sepals 5–6 mm. long, or less.
Plant strict, the filiform leaf-segments rarely over 1 cm. long. 115. *I. muricata.*
Plant lax and branching, the linear-spatulate leaf-segments 1–3 cm. long. 116. *I. patens.*
Sepals 7–9 mm. long; peduncles 1–3 cm. long. 117. *I. plummeræ.*
Leaf-blades long-petioled; sepals unequal. 118. *I. lemmoni.*
Leaf-blades entire or cuneate at the base.
Blades with 1–2 obliquely ascending lobes at the base. 119. *I. madrensis.*
Blades incised-dentate at the broad apex. 120. *I. egregia.*

103. **Ipomœa ternifolia** Cav. Ic. **5**: 52. *pl. 478. f. 1.* 1794.— Choisy in DC. Prodr. **9**: 353. 1845.

Convolvulus ternifolius Spreng. Syst. **1**: 613. 1825.
Leptocallis ternata G. Don, Gen. Syst. **4**: 260. 1838.

TYPE LOCALITY: Acapulco, Mexico.
Not known by any recent collection.

104. **Ipomœa costellata** Torr. Bot. Mex. Bound. 149. 1859.— A. Gray, Syn. Fl. N. Am. 2[1]: 214. 1878.

TYPE LOCALITY: Mouth of the Pecos River, western Texas.

DISTRIBUTION: Arid regions of western Texas, New Mexico, Arizona south to the Valley of Mexico.

SPECIMENS EXAMINED: Texas; *Wright 505* (type -- G, C, N); *Havard 47*, 1883; *Hayes*, 1858; *Neally 624*, 1889; *Coues & Palmer 29*, 1865 (G). New Mexico; *Fendler 665*, 1847 (G); *Wright 1615* (G, C); *Earle 331*, 1900 (Y); *Rusby 299*, 1881 (C); *Metcalfe 766*, 1903 (Y); *Parry 997* (C); *Mulford 1111*, 1895 (Y). Arizona; *Lemmon 442*, 1881 (N, Y); *Wilcox 351*, 1894 (N); *Griffiths 5976*, 1903 (N); *Toumey, 1894* (Y); *Pringle*, 1884 (C); *Rothrock 623a, 631, 520, 679*, 1874; *Thurber* 1057, 1851 (G).

Lower California, *Brandegee*, 1893; Durango, *Palmer 649*, 1896 (N, Y, G); Coahuila; *Palmer 2095*, 1880 (N, G); Sonora; *C. E. Lloyd 430*, 1894 (G); Chihuahua; *Townsend & Barber 383*, 1899 (N, Y, G); *Palmer 104*, 1885 (N, C). Valley of Mexico, *Borgeau 726*, 1865–66 (G).

105. **Ipomœa painteri** House, Muhlenbergia 3: 41. *pl. 3. f. 1.* 1907.

Resembling *I. costellata*; stems finely hirsute; sepals broadly lanceolate, the outer ones 5 mm. long, the inner 6–8 mm. long; each plicæ of the limb ending in 2, minute, black cusps at the margin.

TYPE LOCALITY: Guadeloupe, Federal Dist., Mexico.

DISTRIBUTION: Stony hillsides, central Mexico.

SPECIMENS EXAMINED: *Rose & Painter 6826*, 1903 (type — N); Queretaro; Hacienda Ciervo, San Juan del Rio, *Rose, Painter & Rose* 9632, 1905 (N, Y).

106. **Ipomœa wrightii** A. Gray, Syn, Fl. N. Am. 2: 213. 1878.

TYPE LOCALITY: Western Texas.

DISTRIBUTION: Western Texas.

SPECIMENS EXAMINED: *Wright* (type — G). Apparently closely related to, if not identical with *I. pulchella*.

107. **Ipomœa delphinifolia** Mart. & Gal. Bull. Acad. Brux. XII. 2: 265. 1845.— Walp. Rep. 6: 535. 1847.

Closely related to *I. leptotoma*, but described as having pubescent and pilose-ciliate leaf-blades; sepals about 6 mm. long, and corolla 4–5 cm. long, purple.

TYPE LOCALITY: Tehuacan, Puebla, Mexico. Not known by any recent collections.

108. **Ipomæa leptotoma** Torr. Bot. Mex. Bound. 150. 1859.— A. Gray, Syn. Fl. N. Am. 2^1: 214. 1878.

Ipomœa radiatifolia Kellogg, Proc. Cal. Acad. I. **7**: 163. 1877.
Pharbitis leptotoma Peter, in Engl. & Prantl. Nat. Pflanzenfam. IV. **3a**: 32. 1891.

Type locality: Near Santa Cruz Valley, Sonora, Mexico.

Distribution: Arid mountain regions of southern New Mexico, Arizona and south to Oaxaca.

Specimens examined: New Mexico; *Wright 1614*, 1851 (G, C); Arizona; *Dr. Smart 405*, 1867 (C); *Lemmon 3039*, 1883 (G, N, Y); *Pringle*, 1884 (Y); *Wilcox 417*, 1894 (N); *Toumey 179*, 1892. *Lemmon 90*, 1880 (G). Sonora; *Thurber 977*, 1851 (type — G); *Palmer 25*, 1869 (G, N); *Schott*, 1855 (C); *Lumholtz 195*, 1880 (Y); *Palmer 1705*, 1891 (N, Y); *C. V. Hartman 195*, 1890 (G); *C. E. Lloyd 431*, 1890 (G); Sinaloa; *Goldman 250*, 1898 (N); Oaxaca; *L. C. Smith 242*, 1894 (G); *Conzatti & Gonzalez 792*, 1897 (G); Puebla, *E. W. Nelson 1995*, 1894 (N).

109. **Ipomœa divergens** House, Muhlenbergia **3**: 40. 1907.

Closely related to *I. leptotoma*; leaf-segments broader, sinuately toothed or lobed, obtuse; sepals acuminate, glabrous.

Type locality: Guaymas, Sonora, Mexico.

Distribution: Western Mexico.

Specimens examined: *Palmer 231*, 1887 (type — N, G).

110. **Ipomœa pedatisecta** Mart. & Gal. Bull. Acad. Brux. XII. **2**: 265. 1845.— Walp. Rep. **6**: 535. 1847.

Type locality: Near Oaxaca, Mexico.

Distribution; Canons and barrancas, western and southern Mexico.

Specimens examined: Colima; Acapulco, *Palmer 234*, 1894–5 (G, C); Jalisco; barranca of Tequila, *Pringle 4439*, 1893. Morelos; *Rose & Painter 6586*, 1903; *Rose, Painter & Rose 8550, 8569*, 1905. Guerrero; La Lagunilla, *E. W. Nelson*, 1903 (N); Iguala, *Rose, Painter & Rose 9293, 9341*, 1905. Puebla; Tehuacan, *Rose, Painter & Rose 9904*, 1905. Oaxaca; Tecomavara, *Seler 1339b*, 1895 (G); Domingiullo, *E. W. Nelson 1597*, 1894 (N); Oaxaca, *Conzatti & Gonzalez 1064*, 1900 (G).

111. **Ipomœa valida** House, Muhlenbergia 3: 40. *pl. 1. f. d.* 1907.

Type locality: Manzanillo, Mexico.

Distribution: Thickets, Colima, Mexico.

Specimens examined: *Palmer 1031*, 1890 (type — N).

112. **Ipomœa tenuiloba** Torr. Bot. Mex. Bound. 148. 1859.— A. Gray, Syn. Fl. N. Am. **2**: Suppl. 434. 1886.

TYPE LOCALITY: Near Puerto de Paysano, western Texas.

DISTRIBUTION: Hills and rocky places, western Texas to southern Arizona and adjacent Mexico.

SPECIMENS EXAMINED: Near Puerto de Paysano, *Bigelow* (type — C); *C. Wright 1617*, (G). Valley of the Rio Grande, below Donana, *Parry 989* (G).

113. **Ipomœa pilosissima** Mart. & Gal. Bull. in Acad. Brux. XII. **2**: 264. 1845.— Walp. Rep. **6**: 535. 1847.

Slender, twining, pilose or hirsute; leaf-blades 5- to 7-pedately parted, the segments ovate-oblong, 3–5 cm. long, acuminate or attenuate, densely sericeous-pilose; peduncles 5–7 cm. long, 1-flowered; sepals densely setaceous-hirsute, lanceolate, acute, equal; corolla campanulate-funnelform, purple, 4–5 cm. long.

TYPE LOCALITY: Sierra de Yavezia, and near Oaxaca, Mexico. Not known by any recent collections.

114. **Ipomæa leptosiphon** S. Wats. Proc. Am. Acad. **23**: 280. 1880.

Leaf-segments 5, filiform, 4–6 cm. long; peduncles 1-flowered; sepals unequal, oblong-lanceolate, acute, 8–10 mm. long, the outer ones muricate-keeled; corolla slender, 8–10 cm. long, white with a pink or rose-colored limb.

TYPE LOCALITY: Near Chihuahua, Mexico.

DISTRIBUTION: Thin gravelly soil, northern Mexico.

SPECIMENS EXAMINED: Chihuahua; *Pringle 1337*, 1887 (type — G, C, N); *Townsend & Barber 271*, 1889 (N, Y); *E. W. Nelson 4822*, 1898 (N); *E. W. Nelson 6159a*, 1899 (N).

115. **Ipomœa muricata** Cav. Ic. **5**: 52. *pl. 478. f. 2.* 1794. Not *I. muricata* Jacq. 1798.

Convolvulus capillaceous H. B. K. Nov. Gen. & Sp. **3**: 97. 1819.
Ipomœa armata Roem. & Schult. Syst. **4**: 214. 1819.
Cantua tuberosa Roem. & Schult. l. c. 893.
Ipomœa capillacea G. Don, Gen. Syst. **4**: 267. 1838.— Choisy in DC. Prodr. **9**: 353. 1845.— A. Gray, Syn. Fl. N. Am. **2**: Suppl. 434. 1886.
Leptocallis quinta G. Don, l. c. 260.
Leptocallis armata G. Don; Sweet, Hort. Brit. ed. 3, 482. 1839.
Quamoclit pedata Mart. & Gal. Bull. in Acad. Brux. XII. **2**: 270. 1845.

TYPE LOCALITY: "Habitat in Huanajuato."

Distribution: New Mexico and Arizona to northern South America.

Specimens examined: New Mexico; *Rusby 301*, 1881; Arizona; *Leiberg* 5898, 1901; *Rothrock 623*, 1874; *Wilcox 348*, 1894; *Lemmon 443*, 1881 and *2836*, 1882; *Neally 187*, 1891; *Griffiths 5432*, 1903. Lower California, *Brandegee*, 1899.

Sonora; *Thurber 964*, 1851 (G). Lower California; *Brandegee*, 1899 (N). Durango; *Palmer 302*, 1896 (N, G, Y); *E. W. Nelson, 4640*, 1898 (N). Chihuahua; *Pringle 580*, 1885 (G). Tepic; *Rose*, 1897 (N); Queretaro; *Rose, Painter & Rose 9540*, 1905 (N); Jalisco; *Barcena 562*, 1887 (M); *Pringle 11048*, 1902 (N, Y). Federal Dist. *Coulter 1036* (G); *Rose Painter & Rose 8515*, 1905 (N). Oaxaca; *Rev. Lucius C. Smith 472*, 1895 (G). Chiapas; *E. W. Nelson 2879, 2946*, 1895 (N).

116. **Ipomœa patens** (A. Gray) comb. nov.

Ipomœa muricata Roth. Bot. Wheeler 204. 1878. Not *I. muricata* Cav. 1794.
Ipomœa capillacea var. *patens* A. Gray, Syn. Fl. **2**: Suppl. 434. 1886.

Type locality: Southern Arizona.

Distribution: Southern New Mexico, Arizona and adjacent Mexico.

Specimens examined: New Mexico; *C. Wright 1616*, 1851 (type — G. C). *O. B. Metcalfe 271*, 1903 (G). Arizona; *Wilcox*, 1893 (N); Sonora; *Thurber 967*, 1851 (C); Chihuahua; *Pringle 841*, 1886 (C, N); *1340*, 1887 San Luis Potosi; *Parry & Palmer 626*, 1878 (G, N). Coahuila, *Palmer 910*, 1880 (N, G).

117. **Ipomœa plummeræ** A. Gray, Syn. Fl. N. Am. **2**: Suppl. 434. 1886.

Type locality: Southern Arizona.

Distribution: Gravelly slopes of the higher mountains of southern Arizona and New Mexico to Chihuahua, Mexico and in the Bolivian Andes.

Specimens examined: Arizona; *Lemmon 2839*, 1882 (type — G); *Toumey* 1894; *MacDougal 382*, 1898 (Y); *Dr. Lour 324*, 1873 (G); *Wright 1616* in part (G). New Mexico; *Earle 492*, 1900 (Y). Chihuahua; *Townsend & Barber 228*, 1899 (N); *E. W. Nelson 6085*, 1899 (N).

118. **Ipomœa lemmoni** A. Gray, Proc. Am. Acad. **19**: 90. 1883.— Syn. Fl. N. Am. **2**: Suppl. 434. 1886.

Type locality: Mountains near Ft. Huachuca, Arizona.

Distribution: Mountains and canons of southern Arizona.

Specimens examined: *Lemmon 2840*, 1882 (type — G, N).

119. **Ipomœa madrensis** S. Wats. Proc. Am. Acad. **23**: 281. 1888.

Peduncles 1-flowered, 1–2 cm. long, scabrous; sepals ovate, acute or obtuse 8–10 mm. long, muricate; corolla 3–4 cm. long.

TYPE LOCALITY: Base of the Sierra Madre, Chihuahua, Mexico.
DISTRIBUTION: Pine plains, northern Mexico.
SPECIMENS EXAMINED: *Pringle 1338*, 1887 (type — G, C, N).

120. **Ipomœa egregia** House, Torreya **6**: 124. 1906.

Ipomœa cuneifolia A. Gray, Proc. Am. Acad. **19**: 90. 1883.— Syn. Fl. N. Am. **2**: Suppl. 434. 1886. Not *I. cuneifolia* Meissn. 1869.

TYPE LOCALITY: Tanner's Canon, Ft. Huachuca, southern Arizona.
DISTRIBUTION: Mountains of southern Arizona.
SPECIMENS EXAMINED: *Lemmon 2837*, 1882 (type — G, N).

16. Microsepalæ. Slender, annual or perennial, twining vines, with herbaceous stems: sepals small, less than 5 mm. long, equal or nearly so, often acute: corollas small, narrowly funnelform, not ventricose at the base.

Corolla yellow.
  Leaf-blades sessile or very short petioled. 121. *I. amplexicaulis.*
  Leaf-blades relatively long-petioled. 122. *I. microsepala.*
Corolla white or purple.
  Corolla white, 10–15 mm. long; leaves pubescent above. 123. *I. filipes.*
  Corolla-limb blue, about 20 mm. long; leaves glabrous above. 124. *I. turckheimii.*

120. **Ipomœa amplexicaulis** Fernald, Bot. Gaz. **20**: 535. 1895.

Glabrous or sparingly hispid; leaf-blades ovate, deeply cordate, entire, clasping, 1.5–4 cm. long; peduncles 3–6 cm. long, 2- to 9-flowered; sepals 2–3 mm. long, lanceolate, acute; corolla 15–20 mm. long.

TYPE LOCALITY: Mountains near Zopelote, Tepic, Mexico.
DISTRIBUTION: Mountains of western Mexico.
SPECIMENS EXAMINED: Tepic; *Lamb 576*, 1895 (type — G, N, Y); Tuxtla, *Caec. et Ed. Seler 1900*, 1896 (G). Durango; Chacala, *Goldman 339*, 1899 (N). Between Valle Banderas and Colomo, Tepic, *E. W. Nelson 4154*, 1897 (N).

122. **Ipomœa microsepala** Benth. Bot. Voy. Sulph. 136. 1844.— Walp. Rep. **6**: 533. 1847.

Ipomœa nelsoni Rose, Contr. U. S. Nat. Herb. **1**: 343. 1895.

Stems densely hirsute with spreading hairs; petioles as long as the leaf-blades; leaf-blades ovate, cordate, acuminate or obtuse, 3–8 cm. long; peduncles 2- to 4-flowered; sepals 2 mm. long, obtuse; corolla 2–2.5 cm. long; capsules about 4 mm. high.

TYPE LOCALITY: Near Acapulco, Mexico.

DISTRIBUTION: western Mexico.

SPECIMENS EXAMINED: Oaxaca, *E. W. Nelson 318,* 1894 (N, Y, G); Manzanillo, *Palmer 1363,* 1891 (G).

123. **Ipomœa filipes** Benth.; Meissn. in Mart. Fl. Bras. **7**: 274. 1869.

Stems pubescent or glabrate; leaf-blades orbicular-ovate, 1–3 cm. long, acute, entire or angled, pubescent above, glabrous beneath; peduncles filiform, 5–8 cm. long, 1–3-flowered; pedicels recurved in fruit; sepals 2 mm. long; corolla 10–15 mm. long, white.

TYPE LOCALITY: About Santarem, on the Amazon River, Brazil.

DISTRIBUTION: Thickets, near the coast, western Mexico to Brazil.

SPECIMENS EXAMINED: Sinaloa; *Palmer 1647,* 1891 (N, Y). Guerrero; *Palmer 109,* 1894–5 (N, G, C). Guatemala: *W. C. Shannon (John Donnell Smith 4026),* 1892 (G). Among the South American specimens of this are *Herbert H. Smith 1589,* 1898; *Fendler 2089* and *Spruce 886.*

Doubtless identical with *Convolvulus minutiflorus* Mart. & Gal.

124. **Ipomœa turckheimii** Vatke; J. Donnell Smith, Bot. Gaz. **40**: 8. 1905.

Ipomœa concinna House, Muhlenbergia **3**: 42. *pl. 2. f. c.* 1907.

Leaf-blades ovate, acuminate, cordate-hastate, 1.5–5 cm. long; petioles 2-5 mm. long, rarely longer; peduncles 3–5 cm. long, 3- to 7-flowered; sepals equal, outer ones acute, inner obtuse, corolla about 2 cm. long.

TYPE LOCALITY: Coban, Guatemala.

DISTRIBUTION: Southern Mexico and Central America.

SPECIMENS EXAMINED: Jalisco, *Barcena 553,* 1887 (M). Morelos, near Cuernavaca, *Pringle 7232,* 1896 (G). Guatemala: *H. von Tuerckheim* (ex J. D. Smith, Pl. Guat. *386*), 1886 (co-type — G).

17. Emeticæ. Slender-stemmed vines, twining, stems herbaceous from perennial, tuber-like, thickened roots: leaf-blades entire, cordate or cordate-sagittate, usually glabrous: sepals very unequal, obtuse, membranaceous; corollas salverform or funnelform, usually purple.

Stamens and style exserted; corolla salverform.
  Corolla limb 5 cm. broad or more, tube 5–8 cm. long. 125. *I. purga.*

Corolla limb 2–3 cm. broad, tube 3–4 cm. long; leaf-blades strongly sagittate, long-caudate. 126. *I. emetica.*
Stamens and style included; corolla not salverform.
Leaf-blades ovate or orbicular-ovate, more than 3 cm. long.
Corolla funnelform.
Leaf-blades ovate; corolla 5–6 cm. long; sepals about 10 mm. long. 127. *I. seducta.*
Leaf-blades cordate-sagittate.
Corolla 4–5 cm. long; sepals 4–6 mm. long. 128. *I. simulans.*
Corolla 8–10 cm. long, sepals 8–10 mm. long. 129. *I. elongata.*
Corolla tubular, 5–6 cm. long and slightly bent; limb 15 mm. broad; leaf-blades 3–4 cm. long, cordate. 130. *I. urbinei.*
Leaf-blades small, reniform-ovate, 1–2 cm. long or less; corolla 6–8 cm. long, very slender. 131. *I. suffulta.*

125. **Ipomœa purga** (Wender.) Hayne, Arzn. Gew. **12**: *pls. 33, 34.* 1833. — Choisy in DC. Prodr. **9**: 374. 1845.— Willis, Prac. Fl. 184. 1894.

Convolvulus jalapa Schiede, in Linnaea **5**: 473. 1830. Not *C. jalapa* L. 1767.
Ipomœa jalapa Nutt. & Coxe, in Am. Journ. Med. Sci. **5**: 300–307. 1830.— Schiede & Deppe, in G. Don, Gen. Syst. **4**: 271. 1838. Not *I. jalapa* Pursh, 1814.
Convolvulus purga Wenderoth, in Pharm. Centralb. **1**: 457. 1830.— D. Dietr. Syn. Pl. **1**: 667. 1839.
Ipomœa scheideana Zuccar. in Flora **14**: 801. 1831.— Pl. Nov. vel Min. Cogn. 293. 1832.
Exogonium purga & dumosum Benth. Pl. Hartw. 46. 1840.
Convolvulus officinalis Pelletan; Steud. Nom. ed. 2, **1**: 410. 1841.
Calonyction galeotii Mart. & Gal. in Bull. Acad. Brux. XII. **2**: 268. 1845.

Type locality: Mexico.

Distribution: Mountain forests, central Mexico to Central America.

Illustrations: Hayne, l. c.; Nees Offic. Pfl. Suppl. **3**: *pl. 13.* Berg. & Schmidt, Offiz. Gew. **1**: *pl. 5.* Curt. Bot. Mag. *pl. 4280.* Am. Journ. Med. Sci. 1830. *pl. 7.* Bentl. & Trin. Med. Bot. *pl. 186.* Zuccar. l. c. *pl. 12.* Royle, Ill. Himal. *308.* Bot. Reg. *pl. 49.*

Specimens examined: Vera Cruz; *Muller 889,* 1853 (C). Jalapa, *Schiede 149,* 1839 (C); *A. Duges 3,* 1906 (G); *C. L. Smith 1930,* 1894 (G); Trinidad, *Pringle 8889,* 1904 (G). Valle de Cordova, *Borgeau 1730,* 1865 (G). Zucuapan, *Purpus 2212, 2392,* 1907 (G, Y). Jalisco; *Palmer 373,* 1886 (G, C); *E. W. Nelson 4022, 4085,* 1897 (N). Durango, near Chacola, *Goldman 331,* 1899 (N). Oaxaca; *Rev. L. C. Smith 666,* 1895 (G). Guatemala; *Deam 317,* 1905 (G, Y). *J. Donnell Smith 2014,* 1890 (G, Y, N). Costa Rica; *Tonduz 1771,* 1894 (K). Jamaica (introduced); *Britton 155,* 1906 (Y).

126. **Ipomœa emetica** Choisy in DC. Prodr. **9**: 376. 1845.

Ipomœa caudata Fernald in Proc. Am. Acad. **36**: 498. 1901.

Slender; leaf-blades thin, 3–5 cm. long, apex caudate-acuminate, base sagittate, basal lobes 1–2 cm. long, acuminate; corolla 5–6 cm. long, the limb 2–3 cm. broad.

TYPE LOCALITY: Tepelpæ circuitum Mexico.

DISTRIBUTION: Exposed places at high altitudes, central Mexico.

SPECIMENS EXAMINED; Sierra de Tepoxtlan, Morelos, *Pringle 8448*, 1900 (G, N, Y). *Pringle 13590* (G).

127. **Ipomœa seducta** sp. nov.

Closely resembling *I. purga*; glabrous, perennial from a tuberous root; leaf-blades orbicular-ovate, cordate, 6–10 cm. long, acuminate, basal sinus often closed, pale beneath; petioles short; peduncles as long as the petioles, usually 1-flowered; sepals unequal, outer ones lanceolate, 4–5 mm. long, acute, inner fully 10 mm. long, subacute or obtuse; corolla 5–6 cm. long, funnelform, the whitish tube expanding from the base, constricted within the calyx, limb purple, 5 cm. broad; stamens and style included.

GUATEMALA; Cubilquitz, Alta Verapaz, *Tuerckheim* (J. Donnell Smith distr. *7926*), 1901 (type — C). Coban, *Tuerckheim* (J. Donnell Smith distr. *101*), 1887 (C). MEXICO; Chiapas, Near Yajalon *E. W. Nelson 3403*, 1895 (252535 — N).

128. **Ipomœa simulans** Hanbury, Journ. Linn. Soc. **11**: 281. 1871.

Leaf-blades ovate-lanceolate, 5–8 cm. long, caudate-acuminate, base cordate-sagittate, basal lobes acute or rounded, 1 cm. long, glaucous beneath; sepals unequal, inner ones 4–6 mm. long; corolla 4–6 cm. long, purple with a white tube.

TYPE LOCALITY: Mexican Andes, Piedra Gorda district, Guanajuato; also the cold regions of Oaxaca.

DISTRIBUTION: High altitudes of central and southern Mexico.

SPECIMENS EXAMINED: Mechoacan, *Schiede* (G). Morelos, *Pringle 6565*, 1896 (G, N, C). Oaxaca; *E. W. Nelson 1184* (in part), 1894 (N, G).

129. **Ipomœa elongata** Choisy in DC. Prodr. **9**: 355. 1845.— Hallier f. in Bull. Herb. Boiss. **5**: 1052. 1895.

Calonyction dubium Mart. & Gal. Bull. in Acad. Brux. XII. **2**: 268. 1845.
Ipomœa dubia Hemsley, Biol. Cent.-Am. Bot. **2**: 386. 1882. Not *I. dubia* Roem. & Schult. 1819.
Ipomœa mestecensis House, Bot. Gaz. **43**: 411. 1907.

Glabrous or pubescent; leaf-blades ovate-lanceolate, sagittate or cordate-sagittate, acuminate, 3–5 cm. long, basal lobes produced, half as long as the blade, acute, divergent; peduncles 1-flowered; sepals lanceolate, acute; corolla rose-purple, limb deeply 5-lobed.

TYPE LOCALITY: Near Oaxaca, Mexico (*Andrieux 212*).

DISTRIBUTION: Mountains of Oaxaca.

SPECIMENS EXAMINED: *Pringle 4693*, 1894 (G, N, C). *C. L. Smith 910*, 1894 (Y, G); *Rev. Lucius C. Smith 334*, 1895 (G).

130. **Ipomœa urbinei** House, Muhlenbergia **3**: 41. *pl. 2, f. b.* 1907.

Resembling *I. simulans*; leaf-blades glaucous and densely pubescent beneath; peduncles 1–2-flowered, slightly longer than the petioles and somewhat confluent with them at the base; sepals unequal, the inner 8–10 mm. long and 2–3 times as long as the outer; corolla scarlet, tubular.

TYPE LOCALITY: Faldas del Volcan de Colima, Mexico.

DISTRIBUTION: Known only from the type locality (*Barcena 214*, 1881, type — M).

131. **Ipomœa suffulta** (H. B. K.) G. Don, Gen. Syst. **4**: 276. 1838. — Robinson & Greenm. Am. Journ. Sci. **50**: 160. 1895. — Hallier f. Bull. Herb. Boiss. **7**: 411. 1899.

Convolvulus suffultus H. B. K. Nov. Gen. & Sp. **3**: 102. 1819.

TYPE LOCALITY: On the volcanic mountain of Jorullo, Mexico.

DISTRIBUTION: Mountains of Oaxaca, Mexico.

ILLUSTRATIONS: H. B. K. l. c. *pl. 211*.

SPECIMENS EXAMINED: *Pringle 4755*, 1894 (G, N, C). *E. W. Nelson 1541*, 1894 (N, G); *3061*, 1895 (N); *2920*, 1895 (N G). *Rev. L. C. Smith 141*, 1894 (G).

18. **Anisomeræ.** Twining, annual or perennial vines of various habit; stems sometimes woody below, usually not densely pubescent; leaf-blades entire or 3-lobed or toothed, rarely somewhat 5-lobed; sepals coriaceous, very unequal.

Leaf-blades linear to broadly lanceolate; corolla small.
  Leaf-blades denticulate-hastate at base; corolla white. 132. *I. angustifolia.*
  Leaf-blades sagittate or cordate-sagittate.
    Corolla crimson or purplish. 133. *I. tenuissima.*
    Corolla white; leaf-blades subsessile. 134. *I. sagittula.*
Leaf-blades ovate in outline.
  Sepals obtuse or merely subacute, not cuspidate.
    Leaf-blades broadly hastate at the base; thick-textured, basal lobes acute. 135. *I. callida.*

Leaf-blades cordate or truncate at the base.		
Leaf-blades deeply 3-lobed or sub 5-lobed.		
Corolla white.		
Inner sepals 6 mm. long. Haytian.	136.	*I. buchii.*
Inner sepals 10–12 mm. long. Mexican.	137.	*I. rhomboidea.*
Corolla blue or purple; inner sepals 8–10 mm. long.	138.	*I. vulsa.*
Leaf-blades entire or merely toothed.		
Peduncles elongated, exceeding the leaves.		
Blades toothed near the base; sepals 8–10 mm. long.	139.	*I. splendor-sylvæ.*
Blades not toothed; sepals 8–12 mm. long.	140.	*I. phillomega.*
Peduncles not exceeding the leaves.		
Corolla yellow.	141.	*I. lindenii.*
Corolla purple or white.		
Peduncles many-flowered; corolla purple, slender-funnelform.	142.	*I. wilsoni.*
Peduncles 3–5-flowered.		
Corolla white, 4–5 cm. long.	143.	*I. anisomeres.*
Corolla blue, 2 cm. long; leaf-blades hastately lobed at base.	144.	*I. oligantha.*
Sepals cuspidate-acute.		
Stems and leaves densely pilose-pubescent; blades 3-lobed; sepals ciliate; corolla rose-purple.	145.	*I. purpusi.*
Stems and leaves glabrous or nearly so.		
Leaf-blades deeply 3–5-lobed; sepals 8–14 mm. long; corolla purple.	146.	*I. collina.*
Leaf-blades entire, toothed or slightly 3-lobed.		
Corolla purple or yellowish-purple.		
Inner sepals broadly obovate; corolla 3–3.5 cm. long.	147.	*I. gracilis.*
Inner sepals oblong-lanceolate.		
Sepals 10–14 mm. long; stems usually prostrate and blades usually lobed, glabrous.	158.	*I. babatas.*
Sepals 8–10 mm. long; the pilose or pubescent stems usually twining.	159.	*I. tiliacea.*
Corolla white, fading purple in drying; 6–8 cm. long; sepals about 15 mm. long.	148.	*I. jicama.*

132. **Ipomœa angustifolia** [1] Jacq. Coll. **2**: 367. 1788.

Convolvulus angustifolius Desr. in Lam. Encyc. **3**: 547. 1789.
Convolvulus filicaulis Vahl, Symb. Bot. **3**: 24. 1794.
Convolvulus simplex Pers. Syn. **1**: 178. 1805.

---

[1] **Ipomœa aprica** nom. nov.

Ipomœa angustifolia Choisy in DC. Prodr. 9: 367, 1845.— Meissn. in Mart. Fl. Bras. 7: 249. *pl. 89 f. 2.* 1869. Not *I. angustifolia* Jacq. 1788.
BRAZIL.

Convolvulus filiformis Thunb. Fl. Cap. **2**: 168. 1823. Not *C. filiformis* Desr. 1789.
Ipomœa denticulata R. Br. Prodr. 485. 1810.
Convolvulus sonneratii Rees, Cyclop. No. 29. 1819.
Convolvulus denticulatus Spreng. Syst. **1**: 603. 1825. Not *C. denticulatus* Desr. 1789.
Ipomœa filicaulis Willd. Sp. Pl. **1**: 848. 1798.—Choisy in DC. Prodr. **9**: 353. 1845.
Ipomœa filiformis Voigt. Hort. Suburb. Calc. 356. 1845. Not *I. filiformis* Jacq. 1763.
Ipomœa bidentata G. Don, Gen. Syst. **4**: 266. 1838.
Fraxima tridentata Raf. Fl. Tellur. **4**: 83. 1838.
Merremia angustifolia Hallier f. Bot. Jahrb. **16**: 552. 1893: **18**: 117. 1894.

Type locality: Guyana.

Distribution: Thickets and shores, circumtropical. Introduced on ballast about the seaports of the southern United States.

Illustrations: Rheed. Mal. **11**: *pl. 55.* Bot. Reg. *pl. 317.* Jacq. Ic. Rar. *pl. 317.* Bot. Mag. *pl. 5426.*

Specimens examined: On ballast, Brunswick, Georgia, *Harper 1523,* 1902 (G). Porto Rico: *Sintenis 6763,* 1887 (Y); *Heller 1276,* 1899; *6440,* 1903 (Y); *Underwood & Griggs 982,* 1901 (Y).

133. **Ipomœa tenuissima** Choisy in DC. Prodr. **9**: 376. 1845.—Small, Bull. N. Y. Bot. Gard. **3**: 434. 1905.

Slender and herbaceous above, from a perennial root; leaf-blades 2–5 cm. long; peduncles 4–6 cm. long, 1-flowered; sepals ovate-lanceolate, obtuse, mucronulate, 6–8 mm. long; corolla crimson, 3–4 cm. long.

Type locality: Desportes, Cuba.

Distribution: Cuba, Isle of Pines and subtropical Florida.

Specimens examined: Florida; Pinelands near Cutler, *Small & Carter 712, 750,* 1903; *1705, 1834, 1953,* 1904 (Y). Biscayne Bay, *Curtiss,* 1880 (Y). Dade Co. *Britton 163,* 1904 (Y). Cuba: "Open grassy places at Salvador and Savanas, Cayo del Rey," *C. Wright 1651,* Sept. 11, 1859 (G, C). Cieneguita, *Combs 238,* 1895 (Y). Madruga, *Britton & Shafer 680,* 1903 (Y). Pinar del Rio, *Shafer 558,* 1903 (Y). Matanzas, *Britton & Wilson 422,* 1903. Santa Clara, *Baker 2495,* 1904 (Y). Habana, *Van Hermann 980,* 1905 (Y). Isle of Pines, *Curtiss 495,* 1904 (G, Y).

134. **Ipomœa sagittula** sp. nov.

A slender, twining, perennial vine, with weak, woody stems, bark thin, whitish exfoliating; leaf-blades broadly lanceolate, acute and cuspidate, base sagittate, 4–7 cm. long, 1.5–3 cm. broad, the basal auricles 1 cm. long or less, obtuse and clasping the stem, glabrous above, minutely white-dotted beneath; petioles 2–6 mm.

long; peduncles 1.5–2 cm. long, 1- to 5-flowered, bracts minute; pedicels 1 cm. long; sepals unequal, obtuse, ovate-oblong, outer ones 3–5 mm. long, inner 5–7 mm. long; corolla white, funnelform, about 3 cm. long and as broad; capsules ovoid, 8–9 mm. long, 2-celled.

MEXICO: Jalisco; Between San Sebastian and Las Palmas, 3000–2500 ft. alt. *E. W. Nelson 4129*, Mar. 30, 1897 (type — N, G).

135. **Ipomœa callida** House, Muhlenbergia **3**: 42. *pl. 3*, Fig. *b*. 1907.

Perennial, woody below; leaf-blades 6–12 cm. long, 4–6 cm. broad at the base, glabrous and glossy above, paler beneath; peduncles 5–10 cm. long, 5- to 10-flowered in a rather dense cyme; sepals 5 mm. long in the outer to 10 mm. long in the inner, rounded; corolla purple, 4.5–5 cm. long.

TYPE LOCALITY: Near Puerto Sierra, Honduras.
DISTRIBUTION: Known only from the type locality.
SPECIMENS EXAMINED: *Percy Wilson 534*, 1903 (type — Y).

136. **Ipomœa buchii** Urban, Symb. Ant. **3**: 356. 1903.

Young stems minutely but sparingly pilose; leaf-blades 3-lobed or parted, 3.5–5 cm. long, 4–6 cm. broad, middle lobe ovate-elliptical, obtuse; peduncles 1-flowered, 6–12 cm. long; sepals pale-green, outer ones oval, 4.5 mm. long, rounded, inner 6 mm. long, subtruncate at apex; corolla white, 4–4.5 cm. long.

TYPE LOCALITY: Near Petite Coupe, mountains of Hayti, alt. 250 m.
DISTRIBUTION: Mountains of Hayti.

137. **Ipomœa rhomboidea** sp. nov.

A slender, twining vine from a perennial root; stems angled, minutely canescent; leaf-blades ovate, 3-lobed, shallowly cordate, 8–12 cm. long and as broad, lobes contracted below, suborbicular, obtuse, thin and submembranaceous, reticulate-veined, minutely pubescent; petioles 6–10 cm. long, very slender; peduncles 4–6 cm. long, 1- to 3-flowered; pedicels 1–3 cm. long, becoming 5 cm. long in fruit; sepals very unequal, outer oblong, obtuse, subcanescent, 7–9 mm. long, inner ones broader, rounded, 10–13 mm. long; corolla white, tinged with purple-mauve below, funnelform, constricted within the calyx, 6–7 cm. long, limb 5-lobed, 5–6 cm. broad, the plicæ ending in minute cusps at the margin; capsules ovoid.

MEXICO: Sinaloa; Topolobampo, *Palmer 227*, Sept. 1897 (type — 315548 — N).

138. **Ipomœa vulsa** House, Muhlenbergia **3**: 45. *pl. 1.* fig. *a, b.* 1907.

Glabrous, 1–2 m. long; leaf-blades 3- to 5-lobed, lobes oblong or obovate-lanceolate, blunt, 1.5–4 cm. long; peduncles 3–5 cm. long, 1–2-flowered; outer sepals obovate, 6 mm. long, inner ones broadly oblong, rounded and finely toothed, ciliate, 8–10 mm. long; corolla purplish, 3–4 cm. long.

Type locality: Orizaba, Mexico.
Distribution: Vicinity of Orizaba, Mexico.
Specimens examined: *Müller,* 1855 (type — *291646, 291644* — N, C).

139. **Ipomœa splendor-sylvæ** House, Muhlenbergia **3**: 43. *pl. 2. f. a.* 1907.

Leaf-blades ovate, cordate, acuminate, sinuate-toothed near the base, 5–9 cm. long; peduncles 10–18 cm. long, 1- to 3-flowered; sepals 8–10 mm. long; corolla 5–6 cm. long, scarlet (when dried), strongly constricted at the base, limb subentire, 4 cm. broad.

Type locality: Puerto Sierra, Honduras.
Distribution: Known only from the type locality.
Specimens examined: *Percy Wilson 286,* 1903 (type — Y).

140. **Ipomœa phillomega** (Vell.) comb. nov.

Convolvulus phillomega Vell. Fl. Flum. (text) 74. 1825. Icones **2**: *pl. 63.* 1827.
Ipomœa capparoides Choisy in Mém. Soc. Phys. Genèv. **8**: 59. 1839.— In DC. Prodr. **9**: 376. 1845.— Hallier f. in Jahrb. Hamb. Wiss. Anst. **16**: 52. 1898.
Ipomœa parænsis Peter in Engl. & Prantl. Nat. Pfl. IV. **3a**: 30. 1891.
Aniseia syringifolia Dammer; Bot. Jahrb. **23**: *Beibl.* **57**. 38. 1897.

Type locality: [Brazil.]

Distribution: Costa Rica to Colombia, Venezuela, Martinique and Guadeloupe.

Reported from Martinique (*Belanger 1116,* Hb. Del.) and Guadeloupe (L'Herminier, Hb. Boiss.) by Hallier, l. c.

141. **Ipomœa lindenii** Mart. & Gal. Bull. in Acad. Brux. XII. **2**: 264. 1845. Walp. Rep. **6**: 535. 1847.

Twining, woody, glabrous; leaf-blades ovate, shallowly cordate, acuminate, mucronate, 5–10 cm. long; peduncles shorter than the petioles, 1- to 3-flowered, 5–10 mm. long; pedicels longer, 25–30 mm. long; sepals oblong, obtuse; corolla campanulate-funnelform, yellow, 3–5 cm. long.

Type locality: Near Zucuapan, Vera Cruz, Mexico. Not known by any recent collections.

142. **Ipomœa wilsoni** House, Muhlenbergia **3**: 44. *pl. 1. f. c.* 1907.

Leaf-blades ovate, deeply cordate, acute, thick, basal lobes slightly angled; peduncles stout, as long as the petioles, cymosely many-flowered; inner sepals oblong, 8–10 mm. long, obtuse, outer ones suborbicular, smaller; corolla slender-funnelform, purple, 5.5–6 cm. long, limb about 4 cm. broad.

Type locality: Near Puerto Sierra, Honduras.
Distribution: Known only from the type locality.
Specimens examined: *Percy Wilson 530,* 1903 (type — Y).

143. **Ipomœa anisomeres** Robinson & Bartlett, Proc. Am. Acad. **43**: 57. 1907.

Perennial, glabrous; leaf-blades ovate, cordate, acute, 6–11 cm. long, paler beneath; petioles 3–5 cm. long; peduncles 3.5–6 cm. long, cymosely many-flowered; sepals glabrous, white-margined, outer ones 1–3 mm. long and suborbicular, inner about 10 mm. long; corolla 6.5–7 cm. long, white with a purple throat, limb 4–5 cm. broad; capsules ovoid, 10–12 mm. long.

Type locality: Gualan, Guatemala.
Distribution: Southern Mexico to Central America.
Specimens examined: Puebla; Near Metlaltoyuca, *Goldman 67,* 1898 (N). Guatemala: Gualan, *Deam 318, 319,* 1905 (type — G).

144. **Ipomœa oligantha** Choisy in DC. Prodr. **9**: 380. 1845.

Convolvulus pulchellus H. B. K. Nov. Gen. & Sp. **3**: 101. 1819.
Convolvulus pauciflorus Willd.; Roem. & Schult. Syst. **4**: 302. 1819.
Ipomœa pulchella G. Don, Gen. Syst. **4**: 276. 1838. Not. *I. pulchella* Roth, 1821.

Slender, twining, glabrous, perennial below; stems angled, puberulent; leaf-blades triangular-ovate, caudate-acuminate, cuspidate, deeply cordate, 5–10 cm. long, basal auricles laterally acute; petioles as long as blades, glandular-muricate at base; peduncles pubescent at base, 3- to 5-flowered; pedicels 1–2 cm. long; sepals subequal, ovate, acute or subobtuse, 5–6 mm. long; corolla about 2 cm. long, limb purple.

Type locality: Crescit in Regno Pereuviano.
Distribution: Southern Mexico to Bolivia and Brazil.
Specimens examined: Mexico: Oaxaca, *E. W. Nelson 1148,* 1894 (N, G).

145. **Ipomœa purpusi** sp. nov.

Stems stout, perennial below, 1-several m. long, densely pilose; leaf-blades broadly ovate, 5–8 cm. long, cordate, deeply 3-lobed, acuminate, densely appressed-hirsute and green above, paler and densely pubescent beneath with less appressed hairs; petioles shorter than the blades; peduncles longer than the petioles, 4–10 cm. long. lanate above, 1- to 5-flowered; sepals oblong-lanceolate, acute and apiculate, inner ones 8–10 mm. long, glabrous but ciliate near the apex, outer ones shorter, pubescent and ciliate; corolla broadly campanulate-funnelform, about 3 cm. long and the limb as broad.

MEXICO: Zucuapan, *Purpus 2213,* 1906 (type — Y, N).

146. **Ipomœa collina** House, Bot. Gaz. **43**: 412. *fig. 2.* 1907.

Petioles as long as the blades or shorter; peduncles stout, 1- to 5-flowered, 13–25 cm. long; sepals 8–14 mm. long, lanceolate, outer ones sparingly pubescent, inner cuspidate-acute, glabrous; corolla purple, 5–7 cm. long.

TYPE LOCALITY: Near Saltillo, Coahuila, Mexico.
DISTRIBUTION: Known only from the type locality.
SPECIMENS EXAMINED: *Palmer 396,* 1904 (type — N, Y).

147. **Ipomœa gracilis** R. Br. Prodr. 484. 1810. House, Torreya **7**: 37, 38. 1907.

Convolvulus denticulatus Desr. in Lam. Encyc. **3**: 540. 1789.
Convolvulus gracilis Spreng. Syst. **1**: 604. 1825.
Ipomœa denticulata Choisy in Mém. Soc. Phys. Genèv. **6**: 467. 1833.— G. Don, Gen. Syst. **4**: 276. 1838.— Choisy in DC. Prodr. **9**: 379. 1845. Not *I. denticulata* R. Br. 1810.
Ipomœa littoralis Blume, Bijdr. 713. 1826.— G. Don, l. c. 265.
Ipomœa cymosa Baker, Fl. Maurit. 208. 1877.
Ipomœa nicobarica Kurz, Jour. As. Soc. Beng. **45**: 141. 1876.
Ipomœa choisiana W. F. Wight, Contr. U. S. Nat. Herb. **9**: 298. 1905.
Ipomœa roseana House, Muhlembergia **3**: 43. 1907.

Perennial, glabrous, stems dark; leaf-blades ovate, cordate or cordate-hastate, obtuse or acute, mucronulate, 3–8 cm. long; peduncles 1- to 5-flowered, rarely many-flowered; sepals ovate, inner slightly longer, broad and rounded but minutely cuspidate at apex, outer ones narrower, lanceolate-oblong, acuminate-cuspidate, 6–8 mm. long; corolla purplish-pink, 4–5 cm. long.

TYPE LOCALITY: Cette espèce a été trouvée par Commerson dans les Isles Mahé, Sechelles & des trois Frères. (Desr.)
DISTRIBUTION: Circumtropical.
SPECIMENS EXAMINED: Mexico: Colima, *Palmer 978,* 1890 (N); Costa

Rica, *Tonduz 13675,* 1900 (Y). Cuba; *Pringle 57,* 1903 (G, Y). *Britton & Wilson 8, 271,* 1903 (Y). *Britton & Shafer 578, 269,* 1903 (Y). *Pollard, Palmer & Palmer 272,* 1902 (N, Y). *Underwood & Earle 112, 1638,* 1903 (Y). Isle of Pines, *Curtiss 249,* 1903 (G, Y, N). Bahamas: Great Bahama, *Brace 3646,* 1905 (Y). Jamaica; *Britton 973,* 1907 (Y). Hayti; *Nash 349,* 1903 (Y); *Nash & Taylor 1043,* 1905 (Y). Montserrat; *Shafer 167, 654,* 1907 (Y). Dominica; *Lloyd 354,* 1903 (Y). Porto Rico; *Heller 6341,* 1902 (Y); *Millspaugh 754,* 1899 (Y). Culebra, *Britton & Wheeler 127,* 1906.

Most of the so-called *I. fastigiata,* of the American tropics doubtless belongs here.

148. **Ipomœa jicama** Brandegee, Bull. Cal. Acad. II. **2**: 188. 1889.

Type locality: Magdalena Islands, Santa Margarita Island, San Jorge.

Distribution: Lower California and Islands off the coast.

Specimens examined: Magdalena Bay, Lower Calif. *Brandegee,* 1889 (N). Also fragment of type in Herb. Gray.

19. Aequisepalæ. Twining, perennial or annuals with entire or lobed leaf-blades and herbaceous or woody stems, glabrous or pubescent; sepals coriaceous, equal or nearly so, obtuse, acute or cuspidate; corolla purple, yellow or white.

Leaf-blades strongly sagittate; corolla purple.	149.	*I. sagittata.*
Leaf-blades ovate or cordate-sagittate (in *I. polyanthes*).		
Corolla yellow.		
Corolla 2–3 cm. long; inflorescence umbellately many-flowered; foliage glabrate or finely pubescent.	150.	*I. polyanthes.*
Corolla 4–5 cm. long; stems strongly hirsute.	151.	*I. longipes.*
Corolla purple, blue or white.	A.	
A. Sepals cuspidately pointed or acuminate.		
Sepals ciliate or pubescent; annuals.		
Corolla 3 cm. long, or longer.	152.	*I. trichocarpa.*
Corolla less than 3 cm. long.		
Peduncles longer than the petioles.		
Corolla narrowly funnelform, 15 mm. long or less,	153.	*I. triloba.*
Corolla broadly funnelform, about 20 mm. long.	154.	*I. ramoni.*
Peduncles shorter than the petioles; corolla-tube white, limb often pink.	155.	*I. lacunosa.*

Sepals glabrous; perennials.
Corolla 3 cm. long or less.
Corolla 2–3 cm. long; leaf-blades petioled, 3–5-lobed, rarely subentire. 156. *I. trifida.*
Corolla 15 mm. long; leaf-blades subsessile, entire. 157. *I. peninsularis.*
Corolla 4 cm. long or more.
Inner sepals broadly obovate, rounded, minutely cuspidate; outer ones lanceolate, cuspidate-acuminate. 147. *I. gracilis.*
Inner sepals oblong-lanceolate, cuspidate-acuminate.
Sepals 10–14 mm. long; stems usually glabrous and prostrate. 158. *I. batatas.*
Sepals 8–10 mm. long; stems usually pubescent and twining. 159. *I. tiliacea.*
Sepals obtuse, subacute or rarely awned. B.

B. Sepals aristately awned; foliage silvery-pubescent and sericeous. 160. *I. leucotricha.*
Sepals not awned.
Foliage densely pubescent.
Pubescence shaggy; stems retrorsely hispid, blades hirsute, entire; sepals glabrous. 161. *I. signata.*
Pubescence velvety or sericeous; blades entire or unequally 3-lobed; sepals sericeous. 162. *I. tuxtlensis.*
Foliage glabrous or at least not densely hirsute sericeous. C.

C. Stems stout and woody, often 2 cm. thick. West Indian. 163. *I. demerariana.*
Stems slender, less than 1 cm. thick.
Corolla salverform; blades subtriangular or ovate-lanceolate, more or less pilose. 164. *I. chenopodifolia.*
Corolla funnelform or campanulate-funnelform.
Corolla white or yellowish-white.
Leaf-blades oblong, rounded at the base. 166. *I. robinsonii.*
Leaf-blades ovate, cordate or subcordate.
Corolla 3.5 cm. long, yellowish-white with a magenta base, blades entire. 165. *I. curtissii.*
Corolla 6–8 cm. long, white; blades entire or 3-lobed. 167. *I. dimorphophylla.*
Corolla or corolla-limb blue or purple. D.

D. Corolla 2–3 cm. long; sepals 4–5 mm. long.
Foliage glabrous; sepals acute. 168. *I. cardiophylla.*
Foliage more or less pubescent at least when young.
Peduncles longer than the leaves.
Inflorescence 5 cm. long or less; corolla minutely pubescent without, white below. 169. *I. perlonga.*

Inflorescence 10 cm. long; corolla glabrous, entirely purple; blades often 3-lobed.	171. *I. umbraticola.*
Peduncles shorter than the leaves; sepals mucronulate; stems, petioles and peduncles finely pubescent, with weak tentacular-like outgrowths.	170. *I. parasitica.*
Corolla 4–6 cm. long or longer.	
Foliage thin and glabrous; pedicels hollow and wand-like.	
Pedicels 2–3 cm. long; corolla 5–6 cm. long.	172. *I. violacea.*
Pedicels 4–6 cm. long; corolla 8–10 cm. long.	173. *I. pedicellaris.*
Foliage firm-textured; pedicels not hollow or wand-like.	
Corolla white with a purple throat; peduncles 1–2-flowered.	174. *I. wallii.*
Corolla blue or purple; blades cordate-sagittate or cordate-hastate.	175. *I. morelii.*

149. **Ipomœa sagittata** Lam. Illus. **1**: 466. 1791.— Cav. Ic. **2**: 4. *pl. 107.* 1793.— Choisy in DC. Prodr. **9**: 372. 1845.— A. Gray, Syn. Fl. N. Am. **2**[1]: 212. 1878.

Convolvulus speciosus Walt. Fl. Car. 93. 1788. Not *C. speciosus* L. f. 1781.
Convolvulus wheeleri Vahl, Symb. Bot. **2**: 36. 1791.
Convolvulus formosus Gmel. Syst. **1**: 343. 1796.
Convolvulus sagittifolius Michx. Fl. Bor.-Am. **1**: 138. 1803.
Ipomœa sagittaefolia Ker. Bot. Reg. *pl. 436.* 1820.
Fraxima sagittifolia Raf. Fl. Tellur. **4**: 83. 1838.
Ipomœa heterophylla G. Don, Gen. Syst. **4**: 274. 1838.
Ipomœa diversifolia F. Dietr. in Kjoeb. Vidensk. Meddel. 221. 1854.
Ipomœa speciosa Hallier f. Bot. Jahrb. **18**: 143. 1894.— Small, Fl. 962. 1903. Not *I. speciosa* Pers. 1805.

Type locality: Carolina. (Walt.)

Distribution: Marshes and fields near the coast, North Carolina to northern Mexico, Bermuda, Bahamas, Cuba and the Mediterranean region.

150. **Ipomœa polyanthes** Roem. & Schult. Syst. **4**: 234. 1819.

Convolvulus americanus, vulgaris folio, capsulis triquetris numerosis, Pluk. Alm 114. *pl. 167.* f. *1.*

C. luteus polyanthos, Plum. Am. 88. *pl. 102.*

C. polyanthos, folio subrotundo, flore luteo, Sloan. Jam. 55.

Convolvulus umbellatus L. Sp. Pl. 155. 1753.— Desr. in Lam. Encyc. **3**: 555. 1789.
Convolvulus multiflorus Mill. Dict. No. 15. 1768.

Ipomœa umbellata G. F. W. Mey. Prim. Fl. Esseq. 99. 1819. Not *I. umbellata* L. 1759.
Convolvulus sagittifer H. B. K. Nov. Gen. & Sp. **3**: 100. 1819.
Ipomœa multiflora Roem. & Schult. l. c. Not *I. multiflora* Roxb. 1814.
Convolvulus caracasanus Roem. & Schult. l. c. 301.
Convolvulus millerianus Roem. & Schult. l. c. Index 821.
Ipomœa primulæfolia G. Don, Gen. Syst. **4**: 270. 1838.
Ipomœa sagittifer G. Don, l. c. 273.
Fraxima umbellata Raf. Fl. Tellur. **4**: 83. 1838.
Convolvulus densiflorus Hook. & Arn.-Bot. Voy. Beech. 303. 1841.
Convolvulus luteus Mart. & Gal. Bull. in Acad. Brux. XII. **2**: 260. 1845.
Ipomœa mollicoma Miq. Stirp. Surinam Select. 132. *pl. 37.* 1850.
Merremia umbellata Hallier f. Bot. Jahrb. **16**: 552. 1893;— **18**: 114. 1894.

Type locality: Martinique Domingo, Jamaica (Linn.).

Distribution: Florida Keys, West Indies, western and southern Mexico and Central America to Brazil, Bolivia and Paraguay.

151. **Ipomœa longipes** Garcke, in Linnaea **22**: 66. 1849.— Meissn. in Mart. Fl. Bras. **7**: 268. 1869.

Similar to *I. polyanthes*, but the stems densely hirsute; sepals unequal, ciliate, 7–10 mm. long; corolla 4–5 cm. long.

Type locality: Near Poelebantje, Brazil.

Distribution: Central America to Brazil.

Specimens examined: Guatemala; Coban, *H. von Tuerckheim* (J. Donnell Smith *1437*), 1888 (Y, N).

152. **Ipomœa trichocarpa**, Ell. Bot. S. C. & Ga. **1**: 258, 1817.[1]

Convolvulus folio hederaceo, arvensis, flore dilute purpureo, Dill. Hort. Elth. **100.** *pl. 84. f. 98.*

Convolvulus carolinus L. Sp. Pl. 154. 1753.
Ipomœa carolina Pursh, Fl. Am. Sept. **1**: 145. 1814. Not *I. carolina* L. 1753.
Ipomœa commutata Roem. & Schult. Syst. **4**: 228. 1819.— A. Gray, Syn. Fl. N. Am. **2**[1]: 213. 1878.
Ipomœa caroliniana Pursh; Small, Fl. Southeastern U. S. 963. 1903.

Type locality: Carolina.

Distribution: South Carolina to Florida, Kansas, Texas and Mexico. Reported throughout tropical America.

[1] J. H. Barnhart, Bull. Torrey Club **28**: 680. 1901, on the dates of Elliot's Flora.

153. **Ipomœa triloba** L. Sp. Pl. 161. 1753.— A. Gray, Syn. Fl. N. Am. 2[1]: 213. 1878.— Small, l. c. 963.

Ipomœa eustachiana Jacq. Obs. **2**: 12. 1767.
Convolvulus trilobus Desr. in Lam. Encyc. **3**: 564. 1789.
Ipomœa clausa Rudol.; Ledeb. in Schrad. Neues Jour. **2**: 292. 1807.
Ipomœa parviflora Vahl, Symb. **3**: 34. 1794.— Lunan, Hort. Jam. **1**: 402. 1814.
Convolvulus dentatus Blanco, Fl. Filip. 89. 1837.
Amphione lobata Raf. Fl. Tellur. **4**: 79. 1838.
Quamoclit triloba G. Don, Gen. Syst. **4**: 259. 1838.
Quamoclit eustachiana G. Don, l. c.
Convolvulus subquinquelobus Rees, Cyclop. No. 38. 1819.
Ipomœa galapagensis Anderss. in Vet. Akad. Handl. Stock. **1853**: 213. 1855.
Ipomœa blancoi Choisy in DC. Prodr. **9**: 389. 1845.
Ipomœa commutata Naves, in Fl. Filip. ed. 3. *pl. 31.* 1877.
Ipomœa leucantha Baker, Fl. Maurit. 208. 1877. Not *I. leucantha* Jacq. 1788.
Ipomœa batatas Usteri, Viertel. Naturf. Ges. Zurich **50**: 122. 1905.
Convolvulus heterophyllus Moc. & Sesse, Fl. Mex. in La. Naturaleza II. **2**: Append. 36. 1893.

Type locality: Jamaica (Sloane). America (Linn.).

Distribution: Dry or sandy thickets, peninsular Florida, Bahamas and West Indies, Arizona to Central America and Brazil and the Philippine Islands.

Illustrations: Sloane Jam. *pl. 97. f. 1.* Jacq. Obs. *pl. 36.*

154. **Ipmocea ramoni** Choisy in DC. Prodr. **9**: 380. 1845.

Closely resembling *I. triloba*; calyx broadly campanulate; sepals unequal, abruptly acuminate and setaceous, 4–7 mm. long, outer ones densely ciliate and pubescent; corolla broadly funnelform, 1.75–2 cm. long or longer, the limb as broad, pinkish-purple.

Type locality: Near Havana, Cuba.

Distribution: Cuba.

Specimens examined: Guanajay, *Curtiss 632,* 1905 (Y); Havana, *Hermann 3117, 3883,* 1905, (Y); *Baker 3680 3847, 3986,* 1904 (Y); *Wilson 3640,* 1904 (Y); *Baker & Wilson 3875,* 1904 (Y). Holquin, Bacajagua, *C. Wright 3085,* 1860–64 (G).

155. **Ipomœa lacunosa** L. Sp. Pl. 161. 1753.— A. Gray, Syn. Fl. N. Am. 2[1]: 213. 1878.— Britton, Manual 752. 1901.— Small, Fl. Southeastern U. S. 963. 1903.

Convolvulus stellatus, periplocae rotundioris folis, Dill. Hort. Elth. 103. *pl. 87. f. 103.*

Convolvulus lacunosus Spreng. Syst. **1**: 597. 1825.
Convolvulus micranthus Riddell, Syn. Fl. W. St. 70. 1835.

Type locality: Carolina.

Distribution: Moist thickets, Pennsylvania to South Carolina, west to Illinois, Mississippi and Texas.

156. **Ipomœa trifida** (H. B. K.) G. Don, Gen. Syst. **4**: 280. 1838.— A. Gray, Syn. Fl. N. Am. **2**[1]: 212. 1878.— Small, l. c. 963.

Convolvulus trifidus H. B. K. Nov. Gen. & Sp. **3**: 107. 1819.
Convolvulus hepaticifolius Willd.; Roem. & Schult. Syst. **4**: 303. 1819.

Type locality: In woods along the Orinoco river, between Carichana and San Borja, Venezuela.

Distribution: Southern Louisiana and Texas to Central and South America. Also in the West Indies.

Ipomœa trifida (var.) **torreyana** A. Gray, l. c.

Ipomœa commutata Torr. Bot. Mex. Bound. 149. 1859.

Western and southern Texas to western Mexico.

Ipomœa trifida (var.) **berlandieri** A. Gray, l. c.

Central and southern Texas.

Ipomœa trifida ymalensis var. nov.

Glabrous, twining; leaf-blades ovate, entire or shallowly 3-lobed or angled, cordate or cordate-hastate, acuminate, thin, pale-green beneath; peduncles elongated, stout, 3-many flowered; sepals oblong-lanceolate, 9–11 mm. long; corolla less than 2 cm. long.

Mexico: Ymala, *Palmer 1746*, 1891 (type — Y, N); *Palmer 1708*, 1891 (Y, N).

157. **Ipomœa peninsularis** Brandegee, Zoe, **5**: 168. 1903.

Slender, twining from a perennial, tuberous root, pubescent; leaf-blades ovate, acuminate, deeply cordate, basal sinus often closed and clasping the stem in young leaves, 5–6 cm. long; peduncles 3–6 cm. long, 1- to 3-flowered; sepals ovate, 4–5 mm. long, glandular-muricate; corolla about 15 mm. long, pale-violet.

Type locality: Western slopes of the Cape region, Lower California.

Distribution: Lower California and western Mexico.

Specimens examined: Lower California, *Brandegee,* 1902 (N). Jalisco; *Barcena 553,* 1887 (M).

158. **Ipomœa batatas** (L.) Lam. Encyc. **6**: 14. 1804.— Willis, Prac. Fl. 183. 1894.

Convolvulus batatas L. Sp. Pl. 154. 1753.
Convolvulus edulis Thunb. Fl. Jap. 84. 1784.
Ipomœa catesbatei G. F. W. Mey, Prim. Fl. Esseq. 113. 1818.
Convolvulus esculentus, batata and *varius* Vell. Fl. Flum. **2**: 73. 1827.
Batatas edulis Choisy in Mém. Soc. Phys. Genèv. **6**: 435. 1845.— In DC. Prodr. **9**: 1845.
Convolvulus chrysorhizus Forst.; Wien. Illustr. Gartenz. 288. 1888.

Type locality: Asia, Africa, America (Linn.).

Distribution: Circumtropical, chiefly as a cultivated plant. Arkansas to Texas, Florida and Mexico to South America. Sweet Potato.

Illustrations: Catesb. Car. *pl. 60.* Moris. Hist. 2: *pl. 3. f. 4.* Rumph. Amb. *pl. 130.* Rheed. Mal. **11**: *pl. 50.* Dill. Elth. *pl. 80. f. 91, 92*; *pl. 81, f. 93*; *pl. 82, f. 94*; *pl. 83, f. 95, 96.* Vell. Fl. Flum. **2**: *pl. 55, 58, 59, 61.*

Apparently derived by cultivation from the next species and doubtfully distinct from it.

159. **Ipomœa tiliacea** (Willd.) Choisy in DC. Prodr. **9**: 375. 1845.— Hallier f. Bull. Soc. Bot. Belg. **37**: 95. 1898.

? *Convolvulus platanifolius* Vahl, Symb. **3**: 26. 1794.
Convolvulus tiliaceus Willd. Enum. **1**: 203. 1809.— Schlecht. in Linnaea **6**: 739. 1831.
Convolvulus fastigiatus Roxb. Hort. Beng. 13. 1814.
Ipomœa cymosa G. F. W. Mey. Prim. Fl. Esseq. 99. 1818.
? *Ipomœa platanifolia* Roem. & Schult. Syst. **4**: 220. 1819.
Convolvulus essequebensis Spreng. Syst. **1**: 600. 1825.
Ipomœa fastigiata Sweet, Hort. Brit. 288. 1826. Choisy in DC. Prodr. **9**: 380. 1845.
Ipomœa hirsuticaulis C. H. Wright, Kew Bull. 162. 1896.

Type locality: Brazil.

Distribution: Florida Keys and West Indies, southern Mexico to Bolivia, Peru and Brazil.

160. **Ipomœa leucotricha** J. Donnell Smith, Bot. Gaz. **23**: 10. 1897.

Perennial; densely silvery-pubescent or sericeous; leaf-blades orbicular, 6–10 cm. broad, cordate, entire, acute, sparingly pilose above, silvery beneath; peduncles many-flowered, cymes 3–4 times dichotomous, corymbiform; sepals oblong-ovate, 6 mm. long, the awned apex recurved; corolla 5–6 cm. long, canescent in bud.

Type locality: Newton, Guatemala.

Distribution: Guatemala.

Specimens examined: Newton, *Nelson 3512*, 1895 (type — N).

161. **Ipomœa signata** House, Muhlenbergia **3**: 46. 1907.

Stout, perennial; stems and foliage densely pubescent or hirsute; stems retrorsely hirsute and terete; leaf-blades ovate, cordate, acute, 4–6 cm. long; peduncles 8–12 cm. long, 1- to 3-flowered; calyx glabrous; sepals ovate, 9–10 mm. long; corolla crimson, 6–7 cm. long, glabrous.

Type locality: Between Jacaltenango and San Martin, Guatemala.
Distribution: Known only from the type locality.
Specimens examined; *E. W. Nelson 3595*, 1895 (type — *252762* — N).

162. **Ipomœa tuxtlensis** sp. nov.

A slender, perennial, twining vine, 2–3 m. long, softly pubescent; leaf-blades ovate, cordate, acuminate, entire or more or less 3-lobed, 5–8 cm. long, nearly as broad, softly appressed-pubescent above, sericeous or silvery beneath; petioles shorter than the blades; inflorescence subsessile on peduncles 4–8 mm. long, 3- to 7-flowered; bracts linear-spatulate, 8–18 mm. long; pedicels 4–5 mm. long or less; sepals subequal, oblong-ovate, outer ones densely sericeous-pubescent, rounded at apex, inner ones glabrous or nearly so, submembranaceous, retuse at apex, 10–12 mm. long; corolla deep purple, 3.5–5 cm. long, the limb 3–4 cm. broad and 5-lobed.

Mexico: Chiapas, Tuxtla, 2400–2800 ft. alt. *E. W. Nelson 3094*, 1895 (type — *234042* — N); *3102*, 1895 (*233069* — N, G).

163. **Ipomœa demerariana** Choisy in DC. Prodr. **9**: 361. 1845.— Griseb. Fl. Br. W. Ind. 471. 1861.

Leaf-blades orbicular, deeply cordate, acute, 8–16 cm. broad; peduncles 10–20 cm. long, 3-several flowered; sepals 15–18 mm. long; corolla purple (yellow fide Choisy), 5–8 cm. long, funnelform; anthers contorted.

Type locality: Demerara.
Distribution: Lesser Antilles, Guiana and Brazil.
Specimens examined: Dominica; *Lloyd 241, 633, 982*, 1903 (Y). Guadeloupe; *Duss 4026*, 1899 (Y). Martinique; *Duss 4102, 4402*, 1899 (Y).

164. **Ipomœa chenopodiifolia** (Mart. & Gal.) Hensley, Biol. Cent.-Am. Bot. **2**: 385. 1882.

Calonyction chenopodiifolium Mart. & Gal. Bull. in Acad. Brux. XII. **2**: 269. 1845. — Walp. Rep. **6**: 531. 1847.

The perennial stems woody, muricate or tuberculate, hirsute with reflexed hairs; leaf-blades 8–12 cm. long, about 5 cm. broad, pilose beneath and on the veins above, the base hastate with a broad open sinus: petioles short; peduncles shorter than the petioles, pilose, 3–4 cm. long, 1-flowered; sepals ovate, obtuse, apiculate, glabrous; corolla purple, 5–8 cm. long.

TYPE LOCALITY: Oak woods, Juquila, Mexico (*Galeotti 1375*). Not known by any recent collections.

165. **Ipomœa curtissii** sp. nov.

Slender, twining, 1–2 m. long, finely and densely pubescent or canescent; leaf-blades ovate, entire, cordate, acute, 2–5 cm. long and as broad, or broader, glabrous or nearly so; petioles usually shorter; peduncles rarely longer than the petioles, 1- to 5-flowered; pedicels 15-20 mm. long and slightly thickened, recurved in fruit; sepals subequal, greenish, puberulent, scarious-margined, ovate, acute, 5–6 mm. long; corolla yellowish with a magenta base, funnelform, about 4 cm. long, the subentire limb as broad; capsules ovoid, acute, about 12 mm. long, 2-celled; seeds glabrous.

CUBA: Havana, *Curtiss 562*, 1904 (type — Y, G). PANAMA; Santa Rita Trail, *Cowell 166*, 1905 (Y).

Apparently differing from *I. obscura* Ker. only by its larger sepals and larger corolla of a more decided yellow.

166. **Ipomœa robinsonii** sp. nov.

A slender, glabrous, twining vine with zig-zag leafy branches; leaf-blades elliptical-oblong, rounded at base, apex obtuse or subacute, 6–8 cm. long, 2–4.5 cm. broad, punctate; petioles 1–2 cm. long; peduncles 1-flowered, less than 2 cm. long, the two large yellowish-green bracts elliptical-lanceolate and acute, tapering to the base; sepals orbicular-ovate, rounded at apex, 7–9 mm. long; corolla slender funnelform, 6–8 cm. long, white, the limb 3.5–4 cm. broad, with 5 rounded lobes; stamens nearly as long as the corolla; capsules ovoid, 1 cm. long, apiculate.

MEXICO: Morelos; Lava beds near Cuernavaca, *Pringle 7338*, 1896 (type — G).

Named in honor of Dr. B. L. Robinson, curator of the Gray Herbarium of Harvard University.

167. **Ipomœa dimorphophylla** Greenm. in Proc. Am. Acad. **33**: 482. 1898.

Slender, perennial below, more or less pubescent with fine hairs; leaf-blades ovate-oblong, 4–10 cm. long, 3–8 cm. broad, shallowly cordate, acuminate, entire or variously 3-lobed, more or less pubescent beneath; peduncles shorter than the petioles, 1-several flowered; sepals thick and coriaceous, obtuse, 6–7 mm. long; corolla white, 6–8 cm. long.

TYPE LOCALITY: Near Cuernavaca, Morelos, Mexico.
DISTRIBUTION: Morelos and Oaxaca, Mexico.
SPECIMENS EXAMINED: Cuernavaca, *Pringle 6658*, 1897 (type — G, N,

Y); *7241*, 1896 (G); *13779*, 1906 (G). *Deam 59*, 1900 (G). Oaxaca: *Conzatti & Gonzalez 505*, 1897; *968*, 1895 (G); *Pringle 5677*, 1894 (G).

168. **Ipomœa cardiophylla** A. Gray, Syn. Fl. N. Am. **2**[1]: 213. 1878.

Glabrous; leaf-blades ovate, hastate-cordate, 5–8 cm. long, thin; sepals ovate, acute, green with white scarious margins, 4–5 mm. long; corolla blue with a white tube 2–3 cm. long; capsules ovoid.

Type locality: Near El Paso, Texas.

Distribution: Rocky places, western Texas to Arizona and northern Mexico, south to Oaxaca.

Specimens examined: Texas; *C. Wright 511* (type — G). Chihuahua; *Pringle 617*, 1885 (G). Coahuila; *Palmer 904*, 1880, (G, N). Oaxaca; *Rev. L. C. Smith 847*, 1895 (G); *Gonzalez & Conzatti 898*, 1898 (G).

169. **Ipomœa perlonga** Robinson, Proc. Am. Acad. **29**: 319. 1894.

Young foliage minutely silvery-pubescent, stems with or without prickles; leaf-blades orbicular-ovate, cordate, acute, 3–10 cm. broad, more or less strigillose-pubescent, paler beneath; peduncles 15–30 cm. long, 5- to 15-flowered; pedicels slightly thickened and deflexed in fruit, 6–15 mm. long; sepals 4 mm. long, obtuse; corolla 4 cm. long, minutely pubescent without on the plicæ.

Type locality: Tequila, Mexico.

Distribution: Lower California and western Mexico to Central America.

Specimens examined: Tequila, *Palmer 4519*, 1893 (type — G, N, C).

170. **Ipomœa parasitica** (H. B. K.) G. Don, Gen. Syst. **4**: 275. 1838.

Convolvulus parasiticus H. B. K. Nov. Gen. & Sp. **3**: 103. 1819.
Convolvulus circinnatus Willd.; Roem. & Schult. Syst. **4**: 302. 1819.

Stems glabrous or finely pubescent in lines, with a few weak recurved prickles; leaf-blades orbicular-ovate, 6–8 cm. long, the apex often acuminate, minutely pubescent above, less so beneath; peduncles shorter than the petioles 5- to 9-flowered; sepals 4–5 mm. long, outer ones subacute and minutely cuspidate, pubescent, inner ones rounded; corolla silvery-canescent in bud, about 3 cm. long, pubescent without on the tube.

Type locality: Near Caracas, Venezuela.

Distribution: Southern Mexico to Venezuela.

Specimens examined: Costa Rica; Nicoya, *Tonduz 13679*, 1900 (Y). San Jose, *Tonduz 1561*, 1893 (G). Guatemala; Santa Rosa, *Heyde & Lux.* (J. Donnell Smith *4024*), 1892 (G).

171. **Ipomœa umbraticola** sp. nov.

Perennial; stems furrowed, twisted below, glabrous; leaf-blades ovate, entire or usually 3-lobed, cordate, 6–10 cm. long, nearly as broad, with some minute hispidulous pubescence above, glabrous or nearly so beneath, middle lobe oblong, acuminate, lateral lobes spreading, acute, subtriangular; petioles filiform, shorter than the blades; peduncles stout, longer than the leaves, angled, 10–15 cm. long, cymosely many-flowered; pedicels 1–2 cm. long; sepals glabrous, flavescent, subequal, 4.5–5 mm. long, suborbicular, imbricated, retuse and mucronulate; corolla funnelform, 4 cm. long; capsules ovate, obtuse, 7–8 mm. long, 2-celled; seeds glabrous.

COSTA RICA: Nicoya, *Tonduz 13677* (ex Herb. *H. Pittier*), 1900 (type — Y).

172. **Ipomœa violacea** L. Sp. Pl. 161. 1753.

Ipomœa foliis cordatis integerrimis, floribus confertis, corallis indivisis, Sauv. Monsp. 114.

Quamoclit foliis amplissimis cordiformibus, Plum. Sp. 3; Am. *pl. 93. f. 1.* Sloan. Jam. 55. Hist. **1**: 155. *pl. 98. f. 1.*

Convolvulus indicus Mill. Dict. No. 5. 1768.
Ipomœa tricolor Cav. Ic. Pl. Rar. **3**: 5. *pl. 208.* 1794.
Convolvulus violaceus Spreng. Syst. **1**: 399. 1825.
Convolvulus venustus Spreng. l. c.
Ipomœa rubrocœrulea Hook. Bot. Mag. *pl. 3297.* 1834.
Pharbitis violacea Bojer, Hort. Maurit. 227. 1837.— Choisy in DC. Prodr. **9**: 344. 1845.
Tereietra violacea Raf. Fl. Tellur. **4**: 124. 1838.
Ipomœa hookeri G. Don, Gen. Syst. **4**: 274. 1838.
Pharbitis rubrocœruleus Planch. Fl. des Serres **9**: 281. *pl. 966.* 1854.
Convolvulus rubrocœruleus D. Dietr. Syn. Pl. **1**: 670. 1839.
Ipomœa puncticulata Benth. Bot. Voy. Sulph. 136. 1845.— S. Wats. in Proc. Am. Acad. **22**: 440. 1887.

Peduncles hollow and wand-like, longer than the petioles; leaf-blades ovate, cordate, often early deciduous; pedicels 2–3 cm. long; sepals 5–6 mm. long, greenish with white, scarious margins; corolla 5–6 cm. long, violet-blue or purple with a white tube.

TYPE LOCALITY: Habitat in America meridionali.

DISTRIBUTION: Western Mexico to Central America, Antilles and tropical South America.

SPECIMENS EXAMINED: Guanajuato, *A. Duges 4, 23,* 1904 (G). Oaxaca; *E. W. Nelson 1311,* 1894 (N, G); *L. C. Smith 300,* 1894 (G); *Mrs. D. H. Sheldon,* 1893 (G); Morelos; Cuernavaca, *Borgeau 1405,* 1865 (G). Costa Rica; San Jose, *Tonduz 7181,* 1892 (G). Jalisco; Chapala, *Palmer 702,* 1886 (N, C); Puebla; Near Tehuacan, *Rose & Rose 11441,* 1906 (N, Y); Yucatan; *Gaumer 329* (Y).

Guadeloupe; *Duss 3591*, 1894 (Y); Antigua; *Duss 3*, 1902.

Guatemala; Santa Rosa, *Heyde & Lux.* (ex J. Donnell Smith, *4352*), 1892 (G).

173. **Ipomœa pedicellaris** Benth. Bot. Voy. Sulph. 135. 1844.— Walp. Rep. **6**: 533. 1847.

Ipomœa rubrocœrulea A. Gray, Proc. Am. Acad. **21**: 434. 1886. Not *I. rubrocœrulea* Hook. 1834.

Ipomœa grayi Rose, Contr. U. S. Nat. Herb. **1**: 107. 1891.

Leaf-blades broadly ovate, 6–10 cm. long, shallowly cordate or subtruncate, entire, acuminate; peduncles 4–6 cm. long, 1-several flowered; pedicels as long as the peduncle, thickened, curved; sepals oblong-ovate, unequal, obtuse, 6–8 mm. long; corolla purple.

Type locality: Acapulco, Mexico, and Tiger Island, Gulf of Fonseca.

Distribution: Western Mexico.

Specimens examined: Sonora; *Schott*, 1855 (C). Ymala, *Palmer 1704*, 1891; *1997a*, 1902; *710*, 1890. Tepic, *Palmer 1997*, 1892. Chihuahua, *Palmer 102*, 1885 (N, C, G). Sinaloa; *Lamb 359*, 1894 (G); *Brandegee*, 1904 (G). Guerrero; Acapulco, *Palmer 154*, 1894–96 (N, G, C).

174. **Ipomœa wallii** (Morren) Hemsley, Biol. Cent.-Am. Bot. **2**: 396. 1882.

Batatas wallii Morren, in Ann. Soc. d'Argic. Bot. Gand. **2**: 285. 1846. Walp. Rep. **6**: 530. 1847.

Perennial from a tuberous root; glabrous, swollen at the nodes and bearing tentacular outgrowths on both sides of the node; petioles stout, leaf-blades ovate, cordate, acute, 7–15 cm. long; sepals ovate, acute; peduncles shorter than the petioles.

Type locality: Guatemala. Not known by any recent collections in American herbaria. Exact relationship doubtful.

175. **Ipomœa morelii** Duchass. & Walp. Linnaea **23**: 752. 1850.— Walp. Ann. Bot. Syst. **3**: 109. 1852–53.

Perennial, glabrous, twining 1–4 m. long; leaf-blades narrowly ovate, deeply cordate, long acuminate, 6–9 cm. long, 3–6 cm. broad, hastately lobed at the base or entire, lobes laterally acute, basally rounded, pale beneath; petioles shorter than the blades; peduncles as long as the petioles or longer, 3–7 cm. long, 1- to 5-flowered; pedicels slightly thickened, 1–2 cm. long; sepals subequal, glabrous, oblong-ovate, 5–8 mm. long, the outer slightly the shortest, obtuse; corolla 5–6 cm. long, white below, the tube constricted within the calyx, the limb deep-blue, 4–5 cm. broad, 5-lobed.

Type locality: Panama.

Distribution: Southern Mexico to Colombia.

Specimens examined: Chiapas: Between Hacienda Juncana and San Vicente, 4200–6000 ft. alt. E. W. Nelson 3499, 1895 (252747 — N); Between San Cristobal and Teopisca, 6700–8500 ft. alt. E. W. Nelson 3479, 1895 (N). Referred to *I. morelii* by description only. The above description applies to the specimens here cited which may not be *I. morelii.*

Species Inquirendæ.

Ipomœa apiculata Mart. & Gal. in Bull. in Acad. Brux. XII. **2**: 262 1845.—Walp. Rep. **6**: 534. 1847.

aristulata Mart. & Gal. l. c. 263. Walp. l. c. 535.

costaricensis Kuntze, Rev. Gen. 443. 1891.

nematoloba Urban, Sym. Ant. **3**: 349. 1902.

karwinskiana Regal, Ind. Sem. Hort. Petrop. **1857**: 46. 1858.

lactescens Beuth. Pl. Hartw. 120. 1843.

pauciflora Mart. & Gal. l. c. 266.

proximum (Mart. & Gal.) Hemsley, Biol. Cent.-Am. Bot. **2**: 392. 1882. (*Calonyction proximum* Mart. & Gal. l. c. 268.)

schiedeana Ham. in Lindl. Bot. Reg. Misc. 19. 1838.

sericophylla Peter, in Engl. & Prantl. Nat. Pflanzenfam. IV. **3a**: 31. 1891.

triflora Maria & Velasco, in La Naturaleza **2**: 338. 1870.

truncata Lem. Hort. Univ. **2**: 33. Pl. 49.

walpersiana Duchass.; Urb. l. c. 345.

Species excludendæ.

Ipomœa ægyptia L. Sp. Pl. 162. 1753.= **Operculina ægyptia** House.

alata Rose, Contr. U. S. Nat. Herb. **1**: 108. 1891.= **Operculina rubicunda** House.

alatipes Hook. Bot. Mag. *pl.* 5330. 1862.= **Operculina alatipes** House.

alba L. Sp. Pl. 161. 1753.= **Calonyction album** (L.) House.

altissima (Spreng.) Bert.; G. Don, Gen. Syst. **4**: 273. 1838.= **Exogonium racemosum** Choisy.

alulata Miq. Linnaea **18**: 599. 1844.= **Operculina alata** (Ham.) Urban.

ampliata Choisy, DC. Prodr. **9**: 361. 1845.= **Operculina ampliata** House.

antilliana Millsp. Field. Col. Mus. Bot. **2**: 84. 1900.= **Turbina corymbosa** (L.) Raf.

arenaria Steud. Nom. ed. 2. **1**: 815. 1841.= **Exogonium arenarium** Choisy.

argentifolium A. Rich. in Sagra Fl. Cub. **2**: 131. 1850.= **Exogonium.**

aurea Kellogg; Curran, Bull. Cal. Acad. **1**: 143. 1885.= **Operculina.**

bona-nox L. Sp. Pl. ed. 2. 228. 1762.= **Calonyction aculeatum** (L) House.

bracteata Cav. Ic. 5: 51. 1799.= **Exogonium bracteatum** Choisy; G. Don.

bracteata Rud.; Ledeb. in Schrad. Neues Jour. Bot. **2**: 292. 1807.= **Exogonium.**

Ipomœa cincta Roem. & Schult. Syst. **4**: 254. 1819.= **Exogonium bracteatum** Choisy.

coccinea L. Sp. Pl. 160. 1753.= **Quamoclit coccinea** Moench.

conzatti Greenm. Field. Col. Mus. Bot. **2**: 258. 1907.= **Exogonium.**

corraliensis Choisy, DC. Prodr. **9**: 361. 1845.= **Operculina.**

corymbosa G. Don, Gen. Syst. **4**: 274. 1838.= **Turbina corymbosa** Raf.

desrousseauxii Steud. Nom. Ed. 2, **1**: 816. 1841.= **Exogonium eriospermum** Choisy.

dissecta Pursh, Fl. Am. Sept. **1**: 145. 1814.= **Operculina dissecta** House.

domingensis (Desr.) House, Muhlenbergia **3**: 38. 1907.= **Turbina corymbosa** (L.) Raf.

eriosperma Raf. Fl. Tellur. **4**: 74. 1838.— Urb. Symb. Ant. **3**: 350. 1902.= **Exogonium eriospermum** Choisy.

filiformis Jacq. Enum. Pl. Carib. 13. 1760.= **Exogonium filiforme** Choisy.

fuchsioides Griseb. Cat. Pl. Cub. 205. 1866.= **Exogonium.**

funis Cham. & Schlecht. Linnaea **5**: 118. 1830.= **Quamoclit.**

glaberrima Boj. Hook. Jour. Bot. **1**: 357. 1834.= **Calonyction album** (L.) House.

globosa Meissn. Mart. Fl. Bras. **7**: 220. 1869.= **Quamoclit.**

grandiflora Roem. & Schult. Syst. **4**: 240. 1819.= **Calonyction aculeatum** (L.) House.

grandiflora Hallier f. Bot. Jahrb. **18**: 153. 1894.= **Calonyction album** (L.) House.

hamiltoni G. Don, Gen. Syst. **4**: 268. 1838.= **Operculina alata** (Ham.) Urb.

hastigera H. B. K. Nov. Gen. & Sp. **3**: 111. 1819.= **Quamoclit coccinea hederifolia** (L.) House.

havanensis Choisy, DC. Prodr. **9**: 368. 1845.= **Jacquemontia havanensis** Urb.

hederifolia L. Syst. ed. 10. 925. 1759.= **Quamoclit coccinea hederifolia** (L.) House.

jalapoides Griseb. Cat. Pl. Cub. 202. 1866.= **Exogonium.**

latiflora Lindl. Bot. Reg. *pl. 889.* 1825.= **Calonyction aculeatum** (L.) House.

leuconeura Urb. Symb. Ant. **3**: 350. 1902.= **Exogonium.**

llaveana Meissn. l. c. 219.= **Quamoclit.**

longiflora Humb. & Bonpl.; Willd. Enum. 207. 1809.= **Calonyction aculeatum** (L.) House.

luteola Jacq. Ic. Rar. **1**: *pl. 35.* 1781–86.= **Quamoclit coccinea** var. **luteola** Meissn. (*Quamoclit. lutea* Hemsley).

megacarpa Brandegee, Zoe **5**: 218. 1905.= **Operculina ornithopoda** (Robinson) House.

melanosticta (Schlecht.) G. Don, l. c. 271.= **Rivia tiliæfolia** Choisy.

microdactyla Griseb. l. c. 204.= **Exogonium.**

muricata (L.) Jacq. Hort. Schoenb. **3**: 40. 1798.= **Calonyction muricatum** G. Don.

nuda Peter; Engl. & Prantl. Nat. Pfl. VI. **3a**: 31. 1891.= **Operculina tuberosa** (L.) Meissn.

operculata Mart.; in Spix. & Mart. Reise Bras. **2**: 547. 1828.= **Operculina macrocarpa** (L.) Urban.

Ipomœa ornithopoda Robinson, Proc. Am. Acad. **27**: 183. 1892.= **Operculina ornithopoda** House.

palmeri S. Wats. Proc. Am. Acad. **24**: 63. 1889.= **Operculina palmeri** House.

peduncularis Bert. Fl. Guatem. 8. 1840.= **Quamoclit vitifolia** (Cav.) G. Don.

pentaphylla (L.) Jacq. Coll. **2**: 297. 1788.= **Operculina ægyptia** (L.) House.

perryana Duch. & Walp. in Linnaea **23**: 751. 1850.= **Thyella lactescens** (Seem.) House.

præcox Wright; in Sauv. Fl. Cub. 107. 1868.= **Exogonium.**

pterodes Choisy, DC. Prodr. **9**: 361. 1845.— Griseb. Fl. Br. W. Ind. 313. 1861.= **Operculina alata** (Ham.) Urban.

pterodes Seem. Bot. Voy. Herald 171. 1857.= **Operculina alatipes** House.

Quamoclit L. Sp. Pl. 159. 1753.= **Quamoclit quamoclit** (L.) Britton.

racemosa Poir. Encyc. Suppl. **4**: 633. 1816.= **Exogonium racemosum** Choisy.

repanda Jacq. Enum. Pl. Carib. 13. 1760.= **Exogonium repandum** Choisy.

rhodocalyx A. Gray, Proc. Am. Acad. **22**: 439. 1887.= **Operculina rhodocalyx** House.

rudolphii Roem. & Schult, Syst. **4**: 222. 1819.= **Exogonium.**

serpyllifolia (H. B. K.) G. Don, l. c. 267.= **Jacquemontia serpyllifolia** Urban.

sidæfolia Choisy, Mém. Soc. Phys. Genèv. **6**: 459. 1833.= **Turbina corymbosa** (L.) Raf.

sinuata Ort. Hort. Matr. Dec. 84. 1798.= **Operculina dissecta** (Jacq.) House.

spicata H. B. K. Nov. Gen. & Sp. **3**: 112. 1819.= **Exogonium bracteatum** (Cav.) Choisy.

spinulosa Brandegee, l. c. 169.= **Calonyction muricatum** (L.) G. Don.

steudeli Millsp. l. c. 86.= **Exogonium arenarium** Choisy.

tamnifolia L. Sp. Pl. 161. 1753.= **Thyella tamnifolia** Raf.

tastensis Brandegee, l. c. 168.= **Calonyction tastense** House.

tiliæfolia (Lam.) Roem. & Schult. Syst. **4**: 229. 1819.= **Rivia tiliæfolia** Choisy.

triquetra Roem. & Schult. l. c. 231.= **Operculina triquetra** (Vahl) Hallier.

tuba (Schlecht.) G. Don, l. c. 271.= **Calonyction album** (L.) House.

tuberosa L. Sp. Pl. 160. 1753.= **Operculina tuberosa** Meissn.

ventricosa (Bert.) G. Don, l. c. 274.= **Operculina ventricosa** Peter.

versicolor Meissn. Mart. Fl. Bras. **7**: 220. 1869.= **Quamoclit,** (*Mina lobata* Llav. & Lax.; *Quamoclit mina* G. Don.).

[Annals N. Y. Acad. Sci., Vol. XVIII, No. 7, Part II, pp. 265–311. May, 1908.]

RECORD OF MEETINGS

OF THE

NEW YORK ACADEMY OF SCIENCES.

January, 1906, to December, 1906.

By W. M. Wheeler, *Recording Secretary.*

BUSINESS MEETING.

January 8, 1906.

The Academy met at 8:15 P. M., at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following names were then presented for election to Active Membership, having been approved by the Council:

Cleveland Abbe,	2017 I St., Washington, D. C.,
H. F. De Puy,	Care of H. F. Raymond, 466 Dunham Ave., Cleveland, O.,
George E. Dimock,	907 No. Broad St., Elizabeth, N. J.,
Milton Franklin, M. D.,	112 West 47th Street,
W. K. Gregory,	American Museum of Natural History,
Charles S. Hirsch,	259 West 72nd Street,
Mrs. E. A. Hoffman,	135 East 21st Street,
T. D. Hurlbut,	104 Hicks St., Brooklyn,
Titus B. Meigs,	16 East 65th Street,
Dr. Alexander Petrunkewitch,	Short Hills, N. J.,
Jesse W. Reno,	684 St. Nicholas Ave.,

Frederick A. Richardson,	15 West 67th Street,
C. Sidney Shepard,	New Haven, N. Y.,
Richard L. Walsh,	188 Eighth Ave., Brooklyn.

The Candidates were unanimously elected by vote of the Academy.
The meeting then adjourned.

W. M. WHEELER,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

JANUARY 8, 1906.

Section met at 8:30 P. M., Vice-President Hovey presiding.
The minutes of the last meeting of the Section were read and approved.
The following program was then offered:

E. O. Hovey, NOTES ON THE GEOLOGY AND GEOGRAPHY OF THE WESTERN SIERRA MADRE. (With lantern illustrations.)
A. W. Grabau, DISCOVERY OF THE SCHOHARIE FAUNA IN MICHIGAN.
Geo. F. Kunz, PRELIMINARY NOTE ON SPORADIC OCCURRENCE OF DIAMONDS IN NORTH AMERICA.

Dr. **Kunz** then exhibited and described the volumes illustrating the Bishop collection of Jades.

SUMMARY OF PAPERS.

Dr. **Hovey** gave a concise résumé with the aid of lantern slides of his observations during an expedition made for the American Museum of Natural History in February, March and April, 1905. The route traversed lay southwestward and southward from Ciudad Juarez to Ocampo, thence to the railroad again at Miñaca. The development of bolson deserts in arid regions and the similar bolson basins in the less arid regions was described. These bolsons have normally no external drainage, but in many cases they have been invaded by streams from without. The Aros River has cut through several such inclosed basins, as is shown by the remains of local conglomerates and sandstones. The section exposed in the deep canyon of the Aros shows that a foundation of Cretaceous (?) limestone has been covered by old andesitic eruptives; that continental movements have raised, tilted, faulted and metamorphosed the limestone, producing schists from clayey beds; that granite has been intruded under and into the limestone; that later and more acid lavas (rhyolites) and tuffs have been poured out or deposited over the region; that the latest outflows were of basaltic lavas; that the local conglomerates and sandstones have been formed in constructional basins by the disintegration of the mountain slopes. Many other points of geologic interest were brought out in the photographs.

Professor **Grabau** said that recent examination of the limestones of the Mackinaw region for the Michigan Geologic Survey, showed the existence of the Schoharie fauna in the basal portion of the Dundee formation, in a number of localities in the northern part of lower Michigan; notably at Mill Creek, near Mackinaw City, and on Mackinaw Island. Such typical species as *Trochoceras clio*, *Atrypa impressa*, *Rhipidomella alea*, *Conocardeum cuneus*, *Phacops cristatus*, etc., characterize this fauna. The strata containing it rest directly upon beds with *Leperditia opscalaris*, and, therefore, of lower Manlius (Greenfield limestone, Cobleskill) age, from which they are separated by a pronounced disconformity. The finding of this fauna fixes the date of the great mid-Devonic transgression.

Dr. **Kunz** pointed out the general features of the occurrence of diamonds in North America, reserving more complete discussion for the next meeting.

The meeting then adjourned.

A. W. Grabau,
Secetary.

SECTION OF BIOLOGY.

January 15, 1906.

Section met at 8: 15 P. M., at the American Museum of Natural History, Vice-President Crampton presiding.

The minutes of the preceding meeting were read and approved.

The following program was then offered.

William Beutenmüller, The South American Species of Moths Belonging to the Genus *Attacus*.

R. C. Osburn, Some Experiments on Dragon Flies in Brackish Water.

Henry F. Osborn, **G. N. Calkins,** **F. E. Lloyd** and other members. NOTES ON THE LEADING PAPERS READ AT THE MEETINGS AT NEW ORLEANS AND ANN ARBOR.

The meeting then adjourned.

M. A. BIGELOW,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

JANUARY 22, 1906.

Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Trowbridge presiding.

The minutes of the preceding meeting were read and approved.

Dr. Milton Franklin was unanimously elected Secretary of the Section for 1906.

The following program was then offered:

C. C. Trowbridge, (1) RESEMBLANCES BETWEEN THE METEOR TRAIN AND THE AFTER-GLOW PRODUCED BY THE ELECTRODELESS DISCHARGE.

(2) PLAN FOR A GENERAL OBSERVATION OF METEOR TRAINS.

The meeting then adjourned.

MILTON FRANKLIN,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

JANUARY 29, 1906.

Section met in conjunction with the American Ethnological Society, at 8:15 P. M., at the American Museum of Natural History.

The minutes of the last meeting were read and approved.

The following program was then offered:

George F. Kunz, THE GREAT ILLUSTRATED CATALOGUE OF THE HEBER R. BISHOP COLLECTION OF JADE, NOW ON EXHIBITION AT THE METROPOLITAN MUSEUM OF ART.

C. V. Hartman, USE AND ORNAMENTATION OF THE TREE CALABASH IN TROPICAL AMERICA.

The meeting then adjourned.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

FEBRUARY 5, 1906.

The Academy met at 8:15 P. M., at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following candidates for Active Membership were then presented for election having been recommended by the Council:

Francis S. Bangs,	161 West 73 Street,
Miss Cora F. Barnes,	6 East 65 Street,
Miss M. L. Baugh,	15 West 67 Street,
Frederick Billings,	279 Madison Aveuue,
Mrs. W. R. Birdsall,	Wellsville, N. Y.,
Emil L. Boas,	128 West 74 Street,
William H. Brisley,	104 West 70 Street,
William H. Burr,	151 West 74 Street,
Charles L. Case,	343 West 87 Street,
George W. Collord,	884 Fifth Avenue,
David S. Cowles,	Rye, Westchester, Co., N. Y.,
Henry Willard Bean,	15 William Street,
Carl Eickemeyer,	Yonkers, N. Y.,
Francisco Escobar,	1269 Bergen Street, Brooklyn,
Anton C. Hodenpyl,	7 Wall Street,
Charles E. Hughes,	570 West End Avenue,
James N. Jarvie,	Montclair, N. J.,
Clark Wissler,	Amer. Museum of Nat. Hist.

The Candidates were unanimously elected.

The Academy then adjourned.

W. M. WHEELER,
Recording Secretary.

SECTION OF BIOLOGY.

February 5, 1906.

The Section met at 8:30 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the preceding meeting were read and approved.

The following program was then presented:

F. S. Lee, Acid and Fatigue. (Illustrated by stereopticon.)

B. T. Terry, The Spirochæte of Relapsing Fever. (With demonstrations.)

C. W. Hahn, Proposed Biological Survey of New York State.

Summary of Papers.

Professor **Lee** presented the results of his recent studies on "Acid and Fatigue." In previous communications to the academy, the author discussed the physical phenomena of fatigue and the relation to them of lack of carbohydrate. The present paper presents the results of further researches on the causation of fatigue. The physiological action on muscle of sarcolactic acid, potassium sarco-lactate, mono-potassium phosphate and carbon dioxide has been studied in detail. All of these substances are markedly fatiguing, their action consisting in general of a diminution of lifting power and a slowing of contraction. These substances, which are produced during muscular activity, are rightly named fatigue substances. The author believes, moreover, that fatigue in many pathological states, such as diabetes mellitus, fevers, carcinoma, anæmia, various disorders of digestion and inanition, is largely due to the pathological acids that are present and produce the so-called acid intoxication of these diseases. He finds, for example, B-oxy-butyric acid, and its salts, which are characteristic of diabetes mellitus, to be fatiguing, like the physiological acid fatigue substances. Not unfrequently in pathological, as in normal states both lack of carbohydrate and accumulation of acid are present as factors in the causation of fatigue. This is notably so in diabetes, fevers and inanition.

Dr. **Terry** gave a résumé of recent work on the spirochæte of relapsing fever.

Dr. **Hahn** called attention to the proposed biological survey for the state of New York.

The Section then adjourned.

M. A. Bigelow,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

FEBRUARY 12, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Hovey presiding.

The minutes of the preceding meeting of the Section were read and approved.

The following program was then offered:

J. H. Wilson, DISCOVERY OF FOSSIL SHELLS IN MANHATTAN ISLAND.

Geo. F. Kunz, DIAMONDS IN AMERICA.

G. M. Richards, GEOLOGY OF THE COUNTRY TRAVERSED BY THE WALLACE EXPEDITION TO LABRADOR IN 1905.

J. F. Kemp, THE TRAP DYKE IN FAYETTE COUNTY, PENN.

All the papers were followed by discussions.

The Section then adjourned.

A. W. GRABAU,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

FEBRUARY 19, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Trowbridge presiding.

The program of the evening consisted of a public lecture:

S. A. Mitchell, "THE TOTAL ECLIPSE OF THE SUN OF AUGUST, 1905."

The lecture was illustrated by a fine series of steropticon views made from photographs taken during the eclipse, and was well attended by members and their friends.

MILTON FRANKLIN,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

February 26, 1906.

The Section met in conjunction with the New York Section of the American Psychological Association in Dodge Hall, Princeton University, Princeton, N. J. Two sessions were held, one in the afternoon at 4 o'clock, the other in the evening at 7: 30 o'clock.

The following program was offered:

Afternoon Session.

A. L. Jones,	METHOD IN ÆSTHETICS.
W. M. Urban,	SOME NEW POINTS OF VIEW IN THE PSYCHOLOGY OF VALUATION.
Irving King,	A PSYCHOLOGICAL THEORY OF THE ORIGIN OF RELIGION.
Vivian A. C. Henmon,	THE DETECTION OF COLOR BLINDNESS.
R. S. Woodworth,	COLOR SENSATIONS AND COLOR NAMES.
J. McK. Cattell,	THE PRACTICE CURVE AS AN EDUCATIONAL METHOD.

Evening Session.

H. C. Warren,	A NEW VIEW OF "MENTAL FUNCTIONS."
D. S. Miller,	"THE FOUR POWERS OF LIFE."
W. H. Sheldon,	THE NATURE OF JUDGMENT.
M. Philips Mason,	REALITY AS POSSIBLE EXPERIENCE.
W. P. Montague,	MISCONCEPTIONS OF REALISM.

The Section then adjourned.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

March 5, 1906.

The Academy met at 8:15 o'clock, at the American Museum of Natural History, Vice-President Hovey presiding.

The minutes of the last meeting were read and approved.

The Assistant Secretary reported from the Council that the following resolution regarding the use of the metric system had been adopted by the Council and referred to the Academy with recommendation for adoption:

To the HONORABLE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES in CONGRESS Assembled,

The New York Academy of Sciences of New York City in the State of New York, respectfully submits the following resolution advocating the substitution in the United States of the metric system of weights and measures for the diverse and cumbersome standards now in use.

Whereas the metric system has already been adopted by all civilized countries with the exception of the United States and the British Empire.

Whereas it is a simple, uniform, exact and widely known system of weights and measures based on a decimal ratio harmonizing with our decimal system of currency.

Whereas our foreign commercial relations will be greatly benefited by the adoption of the system which is in use in many other nations, and

Whereas the metric system of weights and measures has been universally adopted for scientific work in other nations as well as our own. Be it

RESOLVED that the New York Academy of Sciences respectfully urges that a law be enacted making the metric system of weights and measures compulsory in all departments of the Government of the United States in which the transaction of business requires the use of weight and measurement.

It was voted to approve the report of the Council, and to adopt the resolution.

A memorial notice of the late John H. Hinton, prepared by the committee appointed by the Academy for the purpose, was then read as follows:

Doctor John Henry Hinton, born New York city, January 1, 1827, died New York city, 1905. After completing a course of study in elementary schools, he became clerk in his father's drug store, beginning, at the same time, preparation for practice of dentistry. He was successful in this practice for several years, but, in fulfilment of a promise to his mother, he entered the College of Physicians and Surgeons and was graduated in medicine in 1852. He served as assistant in the New York Hospital for two years, after which he continued his studies in Paris. On returning to this country he became resident surgeon to the New York Hospital and associated himself with Doctor Cornelius R. Agnew in the New York Eye and Ear Infirmary. Throughout life, he was connected actively with hospitals and infirmaries, devoting a great part of his time to practice which brought no pecuniary reward.

Doctor Hinton was treasurer of this Academy for twenty years. For a long period he attended the meetings with great regularity, though he rarely took part in the discussions; latterly, however, he seldom appeared at evening gatherings, so that he ceased to be a familiar figure to the majority of our members; but those of the older group will always remember him as a man of extraordinary good common sense, a wise adviser and a delightful companion.

D. S. MARTIN,
J. J. STEVENSON,
Committee.

The following applications for Active Membership, having been approved by the Council, were then presented.

Miss Anna E. Collins,	St. Agatha's School, 559 West End Av.,
William Forster,	59 Wall Street,
Emil V. Helferrich,	Cincinnati, O.

It was voted that the applicants be elected.

Announcement of the death of W. W. Jefferis, mineralogist, late of this city, on the 23d of February, was then made.

The Chairman suggested that Mr. L. P. Gratacap be requested to prepare a memorial notice of Dr. Jefferis. Voted.

The Academy then adjourned,

W. M. Wheeler,
Recording Secretary.

SECTION OF BIOLOGY.

March 5, 1906.

The Section met at 8:40 P. M. at the American Museum of Natural History.

The minutes of the preceding meeting were read and approved.

The following program was then presented:

C. W. Hahn,	Embryology of the Horned Toad.
A. M. Fernandez de Ybarra,	The First Written Document about the Flora, the Fauna, the Ethnology and the Anthropology of America.
R. C. Osburn,	Notes on the Functions of Fins of Fishes.

Summary of Papers.

Mr. **Hahn** stated that in the horned toad, the blastoderm is in the form of a cap-like elevation at a very early stage. Even before the mesoblast sac has advanced far in its development, the whole space under the cap-like elevation is filled with a network of mesoblast cells. A distinct lateral pouch from the lateral region of the mesoblast sac on each side is conspicuous. In subsequent stages, the elevated cap disappears, the mesoblast sac with its lateral pouches is compressed and the three cavities thus obliterated, persist as clefts between the layers of mesoblast. These are comparable in part to the somatic and splauchnic mesoblast observed in other reptiles. In the horned toad four cell masses are thus to be distinguished, first, one from the roof of the mesoblast sac, second, one from the roof of the two lateral pouches, third, one from the floor of the lateral pouches, fourth, one from the floor of the median mesoblast sac. The last extends but a short distance in front of the ventral opening of the blastopore, in a position lateral to it.

These facts may be regarded as added evidence that the yolk-cleavage theory of Wenckebach and Weldon is applicable to the reptilian egg. In the egg of the horned toad there is far less interference of yolk and more cellular differentiation, the blastoderm is less compressed because of this and because of the pinching off of the germ from the yolk. The processes attending the formation of the chorda and mesoblast are not obscured by compression as in most other forms. The behavior is much like that in the upper half of a frog's egg.

Dr. **de Ybarra** said that the author of this invaluable scientific and historical document was Dr. Diego Alvarez Chanca, of Seville, Spain, who wrote it with his own hands in the form of a letter addressed to the Municipal Council of his native city, and dated at the port of Isabella, in the island of Hispaniola or Santo Domingo, West Indies, at the end of January, 1494. The author was a distinguished practitioner of much learning and professional skill, who held the position of Physician-in-Ordinary to the King and Queen of Castile and Aragon, and had attended their first-born child, Princess Isabella (who afterward became Queen of Portugal) during a serious illness the year before. He was especially appointed by the Spanish monarch to accompany Columbus on his second voyage of discovery to America, came over in the same ship with him, and saved his life, as well as the lives of many high dignitaries and young gentlemen belonging to the Spanish nobility, who were very sick during their stay at the island of Hispaniola.

On his return to Spain, Dr. Chanca published in Spanish, in the year 1506, a treatise on the treatment of pleurisy (*Para curar el mal de costado*), and a few years after, in 1514, a commentatorial work in Latin, criticising the book, entitled "*De conservanda juventute et retardanda senectute,*" whose author was another distinguished Spanish physician named Dr. Arnaldo de Villanova. The title of the second work of Dr. Chanca is "*Commentum novum in parabolis divi Arnaldo de Villanova.*"

This historical first document about the flora, the fauna, the ethnology and the anthropology of America has been only once before translated into the English language, from its Spanish original, by Mr. R. H. Major, of the British Museum, and published in London for the Hakluyt Society in 1847; but as it was penned by its author in the old Spanish language of the fifteenth century, that translation into English, having been done by a foreigner who lived in the nineteenth century, naturally contains several almost unavoidable inaccuracies, and lacks the necessary appreciation of the many fine and subtle meanings in phraseology, deviating from the rules of grammar, which the original document possesses.

It begins by giving a detailed account of the second voyage of Christopher Columbus to America, from the very moment of starting from the port of Cadiz, Spain, on the 25th day of September, 1493, their temporary stop at three of the Canary Islands, and when arriving at the Cannibal islands of Dominica, Marie Galante, Guadeloupe, Martinique, etc., he describes in a most instructive and interesting way the customs and habits of the aborigines. Continuing his vivid and graceful narrative, he speaks of the various trees, flowers and fruits found there, in Porto Rico and Santo Domingo, also of the animals and minerals and several important points connected with the ethnology and the anthropology of that group of the West Indian islands which Columbus visited.

Dr. de Ybarra, who is the author of the only existing Medical History of Christopher Columbus, has made this quaint historical document more interesting and instructive by adding a large number of explanatory notes and geographical and historical remarks.

The Section then adjourned.

M. A. Bigelow,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

March 12, 1906.

Section met at 8:15 P. M., Professor Kemp presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

A. E. Stevenson, The Water Supply of Bermuda. (Illustrated by lantern.)

J. Howard Wilson, Was there a Newfoundland Ice Sheet?

Robert T. Hill, The Broader Geological Structure of the Mexican Plateau. (Illustrated by lantern.)

A discussion followed each paper.

Summary of Papers.

Mr. **Wilson** claimed as a probability that Newfoundland had been the region of another great center of ice dispersion able to send its lobes and glaciers to the edge of the continental shelf and what is more important, southwesterly even so far as Cape Cod and Nantucket, forming the glacial deposits in those regions.

The evidence in favor of this hypothesis was grouped under four heads: 1) The availability of the region for an ice-sheet of such magnitude with indications of great glaciation, 2) The direction of motion of the ice along the Atlantic coast from Newfoundland to Nantucket, 3) The interlobate region, 4) The nature of the transported material.

It was shown that all the facts obtainable were best in accord with this hypothesis, while even some heretofore unexplainable phenomena were apparently made clear.

Two maps were shown representing the relation of this ice-sheet to the other glaciated regions, with its extent and the probable direction of motion of its glaciers.

The Section then adjourned.

A. W. Grabau,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

March 19, 1906.

No meeting.

Milton Franklin,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

March 2, 1906.

Section met in conjunction with the American Ethnological Society at 8:15 P. M. at the American Museum of Natural History.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

A. B. Lewis, Notes on the Ethnography of the Columbian Valley.
Clark Wissler, Notes on the Ethnography of Montana and Alberta.

The meeting then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

April 2, 1906.

The Academy met at 8:15 o'clock, at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

It was reported from the Council that Professors Kemp, Osborn and Hovey had been appointed delegates to the International Congress of Geologists at Mexico to be held in September and that it was suggested by the Council that the Academy inscribe itself as a member of the Congress.

A memorial notice of the late Dr. Augustus Choate Hamlin, prepared by the Committee appointed for the purpose, was then read as follows:

In the death of Dr. Augustus Choate Hamlin, of Bangor, Maine, American mineralogy has suffered the loss of a very interesting and able student and promoter, especially in relation to our native gem-stones. Dr. Hamlin has long been known as the chief authority upon the tourmalines and associated minerals of Oxford County, Maine; and it is largely due to his enthusiastic studies and active practical interest, that the localities in that region have been opened and worked for the past thirty years, their treasures made known to the public, and their finest specimens gathered and preserved in important public collections.

The famous old locality of colored lithia tourmalines, at Paris Hill, was first discovered in 1820 by Dr. Hamlin's father, Hon. Elijah L. Hamlin, and his uncle, Hon. Hannibal Hamlin, who forty years later was elected Vice-President of the United States, on the ticket with Abraham Lincoln. It was natural that Dr. Hamlin, who was a man of cultivated tastes, should feel a deep interest in the further development of this locality and its remarkable minerals, and this he accomplished in important ways in the later years of his life. Dr. Hamlin's tall, commanding figure, with great heavy eyebrows, moustache and hair, combined with a deep, impressive voice, and clear sharp eyes, made him a strong personality one rarely meets.

Augustus Choate Hamlin was born in 1829, at Columbia, Maine. He graduated at Bowdoin College in 1851, and at the Medical School of Harvard University in 1855. After further study in Europe, he began medical practice at Bangor, Maine; but in four years the Civil War broke out and he at once entered the army as assistant surgeon of the Second Maine Regiment. He served with distinction through the entire war, rising successively to higher grades and more important responsibilities, until he was mustered out in 1865, with the rank of lieutenant-colonel. On returning to Bangor, which was ever afterward his home, he soon gave up the regular practice of medicine, to devote himself to literary pursuits and public activities. He was twice elected mayor of the city of Bangor, by large popular majorities, and made an able and honorable record. He wrote and published quite extensively, on medical subjects, on certain portions of the history of the war, and on the gem-minerals of Oxford County. Among the latter was his well-known work "The Tourmaline," published in 1873. This book created the greatest interest and was the inspiration of Saxe Holmes's "My Tourmaline," a dainty love story of American art. Others were "Leisure Hours with the Gems," 1884, and "The History of Mount Mica," 1895. All of these attracted much attention from gem-lovers and mineralogists, and made him widely known.

Dr. Hamlin made extensive collections of the tourmalines and associated minerals of the country, and especially those of the mines at Paris Hill. The majority of his colored tourmalines were purchased some years ago for the museum of Harvard University, by the late James H. Garland, Esq., and are one of the choicest features of the mineralogical cabinet there, under the name of the Hamlin-Garland Collection. The entire proceeds of this sale were expended in the "History of Mount Mica," a memorial to his only son. In 1900 he presented another collection illustrating the minerals of the county, to the Oxford Cabinet and Hamlin Memorial Library, at Paris Hill. The history of this very valuable local museum is worthy of notice. There was at Paris Hill an old, very plain, and very substantial granite building which had long been used as the county jail. It was decided finally to give up this building and place the jail elsewhere, upon which action, by the terms of the deed, the property reverted to the original owners, the Cummings family. Dr. Hamlin then proposed that if the ladies of Oxford County would purchase the building from the heirs, he would remodel it at his own expense into a fire-proof library and museum. The heirs were many and widely dispersed; but all were well disposed, and in time the transaction was accomplished. Dr. Hamlin then, in 1900, had the building entirely refitted and made suitable for a library and a repository of both historical and scientific material relating to Oxford County. He himself presented a large number of books for the public library, and the fine collection of minerals above noted, which is installed there together with two other choice local collections given by the late Samuel R. Carter and Jarvis L. Carter, of Paris, the whole making an exceedingly fine representation.

Dr. Hamlin took much interest also in the introduction of the Paris tourmaline into jewelry. To his granddaughter, Miss Elinor C. Hamlin, of Boston, he gave the famous Hamlin tourmaline necklace, which is probably unique. It consists of 17 large tourmalines, from 3 to 30 carats each, hung by a chain of Maine gold work, to a general connecting chain, and so adjusted that they can be removed and replaced by others of different colors. With these there are also a cross and ear-drops of variously colored tourmalines, set with colorless beryls from the same locality. Thirty years ago tourmalines were unfamiliar in jewelry, but now the public taste has been educated to know and appreciate them, and this change has been largely, though not indeed wholly, due to the interest and activity of Dr. Hamlin.

In other fields, too, Dr. Hamlin exerted important influence and did valuable service. He wrote much on the history of the Civil War, especially with regard to the sufferings of the Union prisoners at Andersonville and other points. Almost his last literary work was a history of the Eleventh Army Corps of the Army of the Potomac, of which he had been medical director. This was published in 1896. In this work, he reviewed minutely and ably the events connected with the battle of Chancellorsville, May, 1863, and clearly proved the fallacy of certain charges made against that corps in some of the accounts. For this important service to history and to the honor of the corps, he was presented by the surviving members with an appropriate and unique silver gilded vase, at a banquet held in New York, November 17th, 1904. The cup is of gold, set with 20 Maine tourmalines and beryls.

Dr. Hamlin had two children, a son and a daughter, neither of whom is living. The former died in the flower of his youth at the age of 18 years. The daughter Helen was the Fair Helen of Maine of Longfellow's poem. The loss of his wife, coming closely after the death of his children, affected him deeply, and for two or three years past his health was much broken. He died at his home in Bangor on November 18th, 1905, greatly honored and mourned not only in that community, but also by a wide circle of friends, acquaintances and correspondents.

GEORGE F. KUNZ,
Committee.

The following names of applicants for Active Membership, having been approved by the Council, were then presented to the Academy, and it was unanimously voted that they be elected:

B. E. Dahlgren,	American Museum of Natural History,
John Belknap Marcou,	Princeton, Mass.,
Adolph Obrig,	1 West 72 Street,
W. W. Owens,	93–99 Nassau Street,
George H. Proctor,	Hotel San Remo,
Thomas Fitch Rowland,	329 Madison Avenue,
Joel W. Thorne,	995 Madison Avenue,
Artemas Ward,	32 West 11 Street,
John Gilbert Ward,	117 West 58 Street,
M. F. Westover,	Schenectady, N. Y.,
Leonard D. White,	45 West 75 Street.

A letter to the Council, announcing the death of Professor C. Ogden Doremus was read to the Academy.

The meeting then adjourned.

W. M. WHEELER,
Recording Secretary.

SECTION OF BIOLOGY.

APRIL 2, 1906.

Section met at 8:15 P. M., President Britton presiding. In the absence of the secretary, Mr. Roy W. Miner was appointed secretary *pro tem.*

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

C. Stuart Gager, A NEW FACTOR IN PLANT ENVIRONMENT.
Bashford Dean, ZOÖLOGICAL NOTES COLLECTED IN JAPAN AND INDIA.

SUMMARY OF PAPERS.

Dr. **Gager** gave a brief historical résumé of the discovery and nature of radioactivity, and reviewed the researches which indicate that radioactivity is very widely distributed in nature, and is very probably a general property of matter, and therefore a factor in the normal environment of plants. Various radioactive substances, and preparations for growing plants under the influence of the radium emanation, and of the three types of rays were exhibited. In conclusion several lantern slides were shown illustrating experiments made by the speaker on the effect of radioactivity on various physiological processes of plants.

The meeting then adjourned.

ROY W. MINER,
Secretary pro tem.

SECTION OF GEOLOGY AND MINERALOGY.

APRIL 9, 1906.

Section met at 8:15 P. M., Dr. Julien, presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Walter Granger, THE STRATIGRAPHY OF THE BRIDGER BASIN, WYOMING. (Illustrated with charts and lantern slides.)
W. D. Matthew, NOTES ON THE PALÆONTOLOGY OF THE BRIDGER BASIN, WYOMING. (Illustrated with specimens and diagrams.)
F. J. Peck, NOTE ON *Eocystides,* A PRIMITIVE CYSTOID.

Dr. **George F. Kunz** exhibited a transparent diamond crystal in the form of an elongated trigonal octahedron weighing $1\frac{21}{32}$ carats, 327 mg, found on Gold Creek, 10 miles from Ramelton, Brown County, Indiana, in 1900. He also gave notice of the discovery of a new locality for gem sapphires, in a placer mine 100 miles from Boisé, Idaho.

The meeting then adjourned.

Roy W. Miner,
Secretary pro tem.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

April 16, 1906.

Section met at 8:15 P. M., Vice-President Trowbridge presiding.

The minutes of the previous meeting of the Section were read and approved.

The following program was then offered:

D. W. Hering, The Distortion and Oscillations of Helical Springs.

Charles Lane Poor, Possible Changes in the Shape of the Sun.

The meeting then adjourned.

Milton Franklin,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY

April 23, 1906.

The Section met in conjunction with the New York Section of the American Psychological Association for two sessions at 4:00 at Schermerhorn Hall, Columbia University and 8:15 P. M. at the American Museum of Natural History.

The minutes of the preceding meeting of the Section were read and approved.

The following program was offered:

Afternoon Session.

W. B. Pitkin, A Study in the Psychology of Evidence.

E. E. Jones, A Comparison of Mental Processes in the Horizontal and Vertical Positions of the Body.

G. Fernald,	COLORED AFTER-IMAGES OF UNPERCEIVED PERIPHERAL COLOR-STIMULI. (Communicated by J. H. Leuba.)
Mildred Focht,	ON SIMULTANEOUS COLOR CONTRAST.
F. Lyman Wells,	STATISTICAL METHOD AND LITERARY VALUES.

Evening Session.

Clark Wissler,	THE TYPE IN PSYCHO-PHYSICAL DATA.
J. E. Lough,	AN EXPERIMENT IN HABIT FORMATION.
H. Heath Bawden,	THE FUNCTIONAL PSYCHOLOGY OF SENSATION AND IMAGE.
Brother Chrysostom,	CONSCIOUSNESS FROM A METAPHYSICAL STANDPOINT.
D. S. Miller,	THE DISTINCTION BETWEEN HEART AND HEAD.

The Section then adjourned.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

MAY 7, 1906.

The Academy met at 8: 15 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The Assistant Secretary then read the following report from the Council:

The following proposals have been adopted by the Societies composing the Scientific Alliance, to take effect in the fall of 1906:

In order to encourage the further unification of scientific organization and the development of science in the City of New York, the following arrangements have been proposed, made possible by the present concentration of interest in natural science at the American Museum of Natural History, and the increased resources of the New York Academy of Sciences:

1. Societies organized for the study of any branch of science may become affiliated with the New York Academy of Sciences, by consent of the Council of the Academy, without surrendering their own name, or losing their identity or autonomy.

2. Members of the affiliated societies may become members of the Academy by paying the Academy's annual fee, but as members of the Affiliated societies they shall be Associate Members of the Academy, with the rights and privileges of such Associate Members, except the receipt of its publications, without paying an additional fee.

3. In order to obtain the right to vote or hold office in any of the associate societies thus affiliated, or to receive their publications, members of the Academy must be elected by such society and pay its annual dues as well as those of the Academy, but all other privileges of membership would be included in the Academy's annual dues.

4. The New York Academy of Sciences to encourage the work of societies thus affiliated with it by furnishing means for paying distinguished lecturers, by awarding grants to aid scientific investigation by their members, by providing facilities for their meetings at the present place of the Academy and in other ways that may become practicable.

5. Each society thus affiliated with the New York Academy of Sciences to have the right to delegate one of its members to the Council of the Academy, this delegate being selected from such members of the society as are also members of the Academy, or made so by his society's paying his dues while a delegate.

6. Societies thus affiliated may, at their option, indicate on their publications their affiliation with the New York Academy of Sciences.

7. Notices of all meetings or other functions of the Academy and of its sections and of the affiliated societies to be mailed weekly by the Secretary of the Academy to all members and associate members without charge to any affiliated society.

8. Lists of members and associate members of the Academy and of its affiliated societies to be printed annually by the Academy and distributed to all members and associate members without charge to any affiliated society.

9. Any affiliated society may withdraw from this affiliation, by a majority vote of its members, at a meeting called for this purpose, to take effect three months after official notice of such action has been filed with the Secretary of the New York Academy of Sciences.

10. Such an alliance would render the Council of the Scientific Alliance an unnecessary organization, and its powers and functions might be merged in the Council of the New York Academy of Sciences under existing laws.

It was voted that the report be approved.

The memorial notice of the late William Walter Jefferis, prepared by Mr. L. P. Gratacap, was then read as follows:

William Walter Jefferis was born at West Chester, Chester Co., Pa., on the twelfth of January, 1820. He was a son of Horatio Townsend, and Hannah Paul Jefferis. He received his education in the West Chester Academy under Jonathan Ganse, a teacher distinguished in his day for erudition and discipline. He evinced at a very early age an unusual interest in minerals and as a boy gathered crystals as they were occasionally dislodged from the paving blocks of West Chester. This curiosity ripened into a confirmed attachment to mineralogy which, however, was shared by an enthusiastic admiration for flowers and botany. In both of these branches of science he became a diligent collector, though his name is universally identified with the former.

The lectures in 1835 of Professor Josiah Holbrook communicated a new ardor to the young student; his enthusiasm became contagious; and soon a group of young people, among whom Jefferis and William D. Hartman, afterwards known as an excellent conchologist, were the leaders, were engaged in scouring the surrounding countries for specimens. Mines, now abandoned, were then being opened, and every promising gulch was explored, the glades yielded flowers and the ponds snails, and amongst surroundings so congenial to his tastes, the young Jefferis grew to manhood imbued with an abiding affection for the wonders of the mineral world.

At a very early age, under the tutelage of his father, Mr. Jefferis entered the Bank of Chester County, which afterwards became the National Bank of Chester County. He rose in the service of the bank until in 1857 he succeeded to the cashiership, which position he retained until his resignation in 1883.

Throughout his life he was an omnivorous collector, and the accumulation of mineral material which formed the Jefferis Collection represented the results of over half a century of personal efforts, exchanges and purchases. He became well known to the mineralogists of the world; and in America, Dana, Shepard, Genth, Clarke, J. Lawrence Smith and Cooke were indebted to him for material and information, and especially Genth's "Mineralogy of Pennsylvania" owes to Mr. Jefferis many of its facts and localities. He has himself thus recounted his efforts in the field: "In the days when I first began collecting minerals, Chester, Delaware and Lancaster Counties were fine fields for collectors. The country was comparatively new, and at that time very little of it was under cultivation. Seventy years ago I used to go over the hills south of West Chester, to hunt for amethysts, and it well repaid me, for some of my best specimens came from there. I found garnets in the serpentine range north of West Chester; zircons on the Brandywine, a mile west of the town; from the south west came orthite and aquacreptite, a very interesting mineral, named by Professor Shepard.

"Chester County at that time, was rich in mica crystals in many colors. At Birmingham Serpentine Quarries, I found a new species, which Professor Brush decided was a new mineral and he named it after the discoverer, now known as Jefferisite."

It is this latter circumstance that has signally made his name a mineralogical possession, but his name is also associated with the discovery or extension of knowledge of aquacreptite, euphyllite, zaratite, melanosiderite, roseite and painterite.

After his resignation from the National Bank of Chester he lived in Philadelphia, where he soon participated with Leidy, Vaux, Wilcox, Dixon and Rand in mineralogical conferences. In Philadelphia he was made Curator of the Vaux Collection of Minerals which had been bequeathed to the Philadelphia Academy of Sciences. About 1900 he came to New York, which was his residence to the time of his death.

His large collection has become the property of the Carnegie Museum at Pittsburgh. Mr. Jefferis has thus described it: "It contained over 12,000 catalogued specimens, in the general collection, not including the cut gems, the microscopic mounted specimens and 150 boxes of choice and rare specimens of minerals consisting of 3,500, each not over 1½ inches in size, selected and put up similar to the original Smithsonian Collection."

Mr. Jefferis was a member of the American Association for the Advancement of Science; the Academy of Natural Sciences of Philadelphia; the American Philosophical Society; the Department of Archæology, University of Pennsylvania; Buffalo Society of Natural History, and an honorary member of the New York Mineralogical Club.

Mr. Jefferis was enamored of flowers, and it may surprise those who only regarded him as a mineralogist that he sent over 3,000 specimens of plants to Paris, and also prepared a collection for the Smithsonian Institution.

Mr. Jefferis was three times married, his widow, formerly Mrs. Anna Elmore, survives him. By his first wife he had four children of whom Mrs. Emma Bogart and Mrs. Ellis Noyes alone are now living, his two sons dying (one by accident) some years ago. He was a man of charming simplicity, earnestness and disinterested attachment to his friends. His passion for minerals was remarkable, and his tenacity of memory of single, extraordinary or rarely beautiful or odd specimens quite wonderful. It is a matter for general congratulation, apart from the extreme satisfaction to his family, that his collection, symptomatic of a very early period in American mineralogical science, is now permanently preserved as his memorial in the great Museum of Pittsburgh.

L. P. Gratacap,
Chairman.

It was voted that the following names, having been approved by the Council, be entered on the roll of Active Members:

James Lane Allen,	66 Fifth Avenue,
John H. Emanuel, Jr.,	304 Clinton Avenue, Brooklyn,
W. D. Mann,	309 West 72 Street,
H. McM. Painter,	62 West 55 Street,
Eugene H. Porter,	181 West 73 Street,
Allen Merrill Rogers,	14 West 72 Street,
Elliott C. Smith,	33 Wall Street,
John Weir,	The Waldorf,
William Pennington,	Paterson, N. J.,
Simon Flexner, M. D.	Rockefeller Institute, 66 Street & Av. A.

President Britton then submitted in writing, as prescribed by the Constitution and By-laws, certain amendments to the Constitution and By-laws, to be voted upon at the next Business Meeting. The proposed changes are as follows:

Amendments to the Constitution.

Article II. First sentence to read:

"The Academy shall consist of *five* classes of members: namely Active Members, Fellows, *Associate Members*, Corresponding Members and Honorary Members."

Article IV. First sentence to read:

"The officers of the Academy shall be a President, as many Vice-Presidents as there are Sections of the Academy, a Corresponding Secretary, a Recording Secretary, a Treasurer, a Librarian, an Editor, six *elected* Councilors *and one additional Councilor for each allied society or association.*"

Article VI. A new Article to be inserted as "Article VI," to read as follows:

"Societies organized for the study of any branch of science may become allied with the New York Academy of Sciences by consent of the Council. Members of allied societies may become Active Members of the Academy by paying the Academy's annual fee, but as members of an allied society they shall be Associate Members of the Academy with the rights and privileges of other Associate Members except the receipt of its publications. Each allied society shall have the right to delegate one of its members, who is an Active Member of the Academy, to the Council of the Academy, and such delegate shall have all the rights and privileges of other Councilors."

ARTICLE VII. "Article VI" to read "Article VII." The third sentence to read "The term of office of *elected* Councilors shall be three years, etc.," instead of "The term of office of Councilors shall be three years, etc."

ARTICLE VIII. "Article VII" to read "Article VIII".

ARTICLE IX. "Article VIII" to read "Article IX".

ARTICLE X. "Article IX" to read "Article X".

ARTICLE XI. "Article X" to read "Article XI".

Amendments to the By-laws.

CHAPTER IV, SECTION 2. A new Section to be inserted as "Section 2," and to read as follows:—

"Associate Members. Workers in science may be elected to Associate Membership, for a period of two years, in the manner prescribed for Active Members. They shall not have the power to vote and shall not be eligible to election as Fellows, but they may receive the publications. At any time subsequent to their election they may assume the full privileges of Active Members by paying the fee of such Members."

CHAPTER IV, SECTION 3. Change number of Section 2 to "3".

CHAPTER IV, SECTION 4. Change number of Section 3 to "4".

CHAPTER V, SECTION 1. To read as follows:

"The annual dues of Active Members and Fellows shall be $10, payable in advance at the time of the Annual Meeting; but new members elected after May 1 shall pay $5 for the remainder of the fiscal year.

"*The annual dues of elected Associate Members shall be $3, payable in advance at the time of the Annual Meeting.*

"Non-resident Members shall be exempt from dues, so long as they shall relinquish the privileges of Active Membership (Vide Chapter X)."

CHAPTER VI,— Title to read "PATRONS, DONORS AND LIFE MEMBERS."

SECTION 2. A new Section, to read as follows:

"Donors. Any person contributing $50 or more annually to the general funds of the Academy shall be termed a Donor, and on election by the Council, shall enjoy all the privileges of Active Membership."

SECTION 3. Original number of Section to be changed to "3".

CHAPTER XI, SECTION 3. To read as follows:

"Investments. All the permanent funds of the Academy shall be invested in United States, or New York State securities, or in first mortgages on real estate, provided they shall not exceed sixty-five per cent. of the value of the property, or in first mortgage bonds of corporations which have paid dividends continuously on their common stock for a period of not less than five years. All income from patrons' fees and life membership fees shall be added to the permanent fund."

The Meeting then adjourned.

W. M. WHEELER,
Recording Secretary.

At a meeting of the Council of the New York Academy of Sciences held on Monday, May 7th, 1906, the following resolutions were adopted:

RESOLVED:—That the Council of the New York Academy of Sciences desires to extend its sympathy to the family of the late Professor ROBERT OGDEN DOREMUS, LL. D., for the great loss which it has sustained by his death on March 22, 1906, and to express on behalf of the Fellows and Members of the Academy, their appreciation of his untiring activity and zeal in scientific work and progress.

RESOLVED that in the death of Professor Doremus, science has lost an exceptional man in ability and merit, and that a brilliant and scholarly career has come to an end.

RESOLVED that the citizens of New York are deeply indebted to the late Professor Doremus for his work in connection with the general educational progress in this city, particularly the advancement of medical education, with which he was closely identified.

RESOLVED that a copy of these resolutions be engrossed and sent to the family of the late Professor Doremus, and that the resolutions be spread upon the minutes of this Council and published in the Annals of the Academy.

N. L. BRITTON, *President*,
W. M. WHEELER, *Recording Secretary*.

SECTION OF BIOLOGY.

MAY 7, 1906.

The Section met at 8:15 at the American Museum of Natural History, Vice-President Crampton presiding.

The minutes of the preceding meeting of the Section were read and approved.

The following program was then offered:

N. L. Britton, W. M. Wheeler and **M. A. Howe.** THE BIOLOGY OF THE BAHAMAS. (Illustrated with lantern slides.)

Henry E. Crampton, BRIEF REPORT ON A RECENT TRIP TO THE SOCIETY ISLANDS.

The meeting then adjourned.

M. A. BIGELOW,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

May 14, 1906.

Section met at 8:30 P. M., Vice-President Hovey presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

William Campbell and **C. W. Knight,**	The Microscopic Examination of the Silver Deposits of Temiskaming, Ont. (By title.)
Henry S. Washington,	A Petrographic Study of the Lavas of Vesuvius. (Illustrated with lantern slides.)
E. Otis Hovey,	Comparison of Vesuvius and Mont Pelé, with Special Reference to Recent Eruptions. (Illustrated with lantern slides.)
James F. Kemp,	The Volcanic and Seismic Disturbances in North America; The California Earthquake of 1906. (Illustrated with lantern slides.)
Wm. Hallock,	Instrumental Detection and Record of Earthquakes. (Illustrated with lantern slides.)

Summary of Papers.

In reference to their paper Messrs. **Campbell** and **Knight** said in brief: The work consists of a metallographic examination of specimens from the recently discovered cobalt-nickel arsenides and silver deposits of Temiskaming. The paper contains a series of photographs which show that the minerals were deposited in the following order: smaltite, niccolite, calcite, argentite, native silver. The method of examination of opaque minerals along metallographic lines is fully explained.

All the other papers were discussed at length.

Mr. **Eddy** announced the existence of two seismographs in Bayonne, N. J., which had given an average record of 30 shocks annually for the two years during which they were in operation.

Dr. **Kunz** suggested as a possible explanation of the occurrence of the San Francisco earthquake, the overflow and breaking down of the banks of the Colorado River and the consequent filling of the basin at Salton in southern California, where there formerly was an arid, heated depression several hundred feet below sea-level, and there now is an inland sea covering 250 square miles of the lowest point of the sink. Possibly the weight of this body of water and its penetration through the surface may have directly or indirectly been the cause, or a partial cause, of the seismic disturbance.

The Section then adjourned.

A. W. Grabau,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

May 21, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Trowbridge presiding.

The minutes of the preceding meeting of the Section were read and approved.

The following program was then offered:

J. C. Hubbard, The Spark Discharge; How it Occurs.

The meeting then adjourned.

Milton Franklin,
Secretary.

BUSINESS MEETING.

October 1, 1906.

The Academy met at 8:15 o'clock, at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following name was then presented for election to Active Membership, having been approved by action of the Council:

Edward J. Voratka, 1123 Hewitt Place, Bronx, N. Y. City.

On motion, elected by ballot cast by secretary.

The Amendments to the By-laws, as placed on file with the minutes of the meeting held May 7, 1906, were then presented for the action of the

Academy. It was voted that the following sections be inserted or be amended as read:

Chapter IV, Section 2. (A new section)
Chapter IV, Section 3.
Chapter IV, Section 4.
Chapter V, Section 1.
Chapter VI, (Change in title of Chapter)
Chapter VI, Section 2. (A new section)
Chapter VI, Section 3.

It was voted that the Amendment to Chapter XI, Section 3, regarding investments, be laid on the table until the next meeting of the Academy.

The meeting then adjourned.

W. M. Wheeler,
Recording Secretary.

SECTION OF BIOLOGY.

October 1, 1906.

The Section met at 8:30 P. M., at the American Museum of Natural History. Vice-President Crampton presiding.

The minutes of the preceding meeting of the Section were read and approved.

The evening was then devoted to hearing the reports of summer work by members of the Section.

Professor **Britton** described his trip to Jamaica to study the flora of the island, in continuation of the work carried on by the New York Botanical Garden in the West Indies for several years. The explorations in Jamaica for the past three years have been carried on through the coöperation of the Department of Gardens and Plantations of the Island, and are not yet by any means complete. The little known regions are dangerous, especially "the Cockpit," a place where Mr. Harris of the Department of Gardens and Plantations obtained most of his 50 or 60 new species. The hills are conical in shape, of limestone roughened by erosion. The rock edges are covered with a great mass of luxuriant vegetation which is often slippery and dangerous. This rough character of the country has prevented cultivation of this part of the island.

A subtropical laboratory for the use of students of tropical flora has been established here, and is now in effective coöperation with the Jamaican government.

Dr. Britton visited all the xerophytic portions of the island in order to study Cactuses in nature. He succeeded in making observations on all the recorded species except one. Grisebach has defined Jamaica as a floral region by itself. The flora is more nearly like that of Central and South America, than of any other of the Antilles.

Professor **Wilson** reported that he had spent the summer collecting insects over a great part of the United States to procure material for his studies on chromosomes. He was very successful, procuring a large series of species, and many insects of each species, especially Hemiptera, Neuroptera and Coleoptera.

He found especially interesting his trip across the southern belt from the Atlantic to the Pacific. Specimens of the insects collected were exhibited in connection with Prof. Wilson's talk.

Professor **Wheeler** gave an account of his expedition to Florissant, Colorado, with Professor T. D. A. Cockerell of the University of Colorado, for fossil insects, which are found more abundantly here than anywhere else in the world. Florissant is situated near West Park, Colorado, and the insects are found in the bed of a Tertiary Lake Basin, which in ancient times probably drained into the Arkansas. There is now very little water left in it. The altitude is 8150 feet and the climate is now sub-boreal. Consequently the flora resembles that of Greenland and Siberia. The remains of insects found in the shale, however, show that in Tertiary times the climate was more like that of Georgia or Alabama.

The ancient lake was probably covered from time to time by volcanic ashes which imbedded any insects or plant remains that fell into the lake. The fossil-bearing strata are very thick and exposed only at certain points. Leaves of such trees as sequoia, cottonwood, etc., are abundant, while ants are the most abundant of the insects.

Professor Wheeler remained at Florissant about a month and obtained about 2000 specimens, mostly ants and plants, many of which are in a fine state of preservation. The investigation of the forms thus far shows that these Tertiary insects were very similar to those now living there, showing the remarkable stability of insect types from Miocene times.

Mr. **Beebe** reported an interesting series of experiments on the effect of subjecting different species of birds to intense humidity. For example, Inca Doves were kept in an intensely humid atmosphere through two molts, with the result that the birds' plumage changed in such a way as to cause them apparently to pass through two subspecies. The plumage in general was darkened while the wing-feathers were whitened. Experiments on the White-throated Sparrow produced no change after the first molt, but after the second molt there was a remarkable change to a dark mahogany color, unknown to any birds of this species in a wild state. Other experiments showed that food and light were not factors in causing the changes, which were apparently due therefore solely to changes in humidity.

The Section then had the pleasure of listening to an interesting address by Sir **William Henry Perkin**, the discoverer of the color mauve, who spoke of the great advances made in the knowledge of natural colors, such as indigo, etc., in the last fifty years. The development of our knowledge of the coal-tar products, to which even the coloring matter in plants is nearly all related, has been especially important.

Professor **Crampton** then spoke of the progress of the work at Cold Spring Harbor, the Carnegie Laboratory and Woods Holl, and gave a brief account of the progress made in his experiments on inheritance in the Cynthia moth, and of his studies on variation in connection with the land-snail, *Partula*, in Taluti.

The meeting then adjourned.

Roy W. Miner,
Secretary pro tem.

SECTION OF GEOLOGY AND MINERALOGY.

October 8, 1906.

The Section met at 8:15 P. M., at the American Museum of Natural History, Mr. Alfred W. Tuttle presiding.

The minutes of the preceding meeting of the Section were read and approved.

A communication from Dr. Kunz, relative to the death of the following members was read by Mr. Miner:

Professor Samuel L. Penfield of Yale,
Professor I. C. Russell of Michigan University,
Dr. Henry A. Ward of Chicago.

On motion of Professor A. W. Grabau the following committee was appointed to draw up resolutions to be presented at the annual Meeting:

Dr. George F. Kunz,
Professor J. F. Kemp,
Dr. E. O. Hovey.

The following program was then presented:

William Campbell, Notes on the Microscopic Examination of the Opaque Constituents of Ore Bodies.
C. P. Berkey, Notes on the Preglacial Channels of the Lower Hudson Valley as Revealed by Recent Borings.
A. W. Grabau, Notes on the Character and Origin of the Pottsville Formation of the Appalachian Region.
D. S. Martin, A Beryl from Haddam Neck, Connecticut.

Brief discussions followed several of the papers.

Summary of Papers.

Dr. **Campbell's** paper dealt with the preparation of the specimen for examination; of the various types of microscopes used; and the means of obtaining illumination by reflected light. Next the paragenesis of the constituents of certain alloys was shown by microphotographs. Lastly the methods were applied to the opaque constituents of ores from Butte; the Cochise district of Arizona; Ducktown, Tenn.; Rossland, B. C.; Sudbury, Ont.; southeast Missouri, etc.

Dr. **Berkey** said that borings made by the Board of Water Supply of New York City, in connection with the project of bringing water from the Catskill Mountains, had shown the existence of numerous deeply buried channels representing preglacial stream courses. Many of them indicate channels cut far below present sea level at considerable distances back from the Hudson River. From engineering records it appears that the depth to bed-rock in the Hudson River has never been determined at any point in its lower course. Profiles of supposed rock-bottom based upon wash-borings have been proven by the recent work to represent simply the bottom of the finer silt filling. The results show that more than 200 feet of more compact material lies below this silt at the point now being tested, and that the rock-bottom of the ancient Hudson lies more than 450 feet below the present river level throughout a large part of its lower course.

Dr. **Grabau** discussed the character of the overlap of the several divisions of the Pottsville, and the material and type of cross-bedding and reached the conclusion that the formation is of the nature of an alluvial cone — or several confluent ones, with occasional marine intercalations.

Professor **Martin** exhibited a large crystal of pink beryl, which he had lately obtained at Haddam Neck, Conn. The old quarry in the albite pegmatite at this locality, long famous for its colored tourmalines, is not now being worked, but a new one has been opened closely adjacent, and apparently on a continuation of the same vein or dike. This one has yielded less tourmaline than the former, but much more beryl, and particularly the heretofore very rare pink variety. Of these, a number of fine large crystals have been obtained, comparable with those lately developed from the gem-tourmaline mines in San Diego County, California.

The present specimen measures about four inches in both length and diameter; it is a fine termination, of the type characteristic of this variety. It has been recently shown by Ford (*Am. J. Sci.*, Sept., 1906) that these pink beryls, from whatever locality, present a peculiar type of crystallization. Instead of the long hexagonal prism with flat basal termination, usually seen in the green beryls of New England, the pink ones tend to a strong development of pyramidal planes, especially the pyramid of the second order (*s*), while the prismatic faces are short. It is very interesting to see how perfectly this crystal, from a new locality, conforms to this statement. It shows three very short and partly broken prismatic faces, and a large and perfect hexagonal pyramid of the second order; the basal plane is reduced to a small irregular face about one inch in its longest diameter, and bears several shallow pits or depressions, of which the inclined sides conform to the pyramid of the first order. Altogether, the specimen is one of unusual interest.

The Section then adjourned.

A. W. Grabau,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

October 15, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Trowbridge presiding.

The minutes of the previous meeting of the Section were read and approved.

The Section then proceeded to the election of Sectional Officers for 1907. Professor C. C. Trowbridge was elected Chairman of the Section and nominated to the Council for election as Vice-President of the Academy.

The election of Secretary was postponed to a later meeting.

The Section then listened to brief reports of summer work by its members.

The Section then adjourned.

Milton Franklin,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

October 22, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, in conjunction with the American Ethnological Society.

The present officers of the Section were reëlected for the ensuing year.

The following program was then presented:

Frederick S. Dellenbaugh, The Navajo Loom; Is It Indigenous?

George Grant MacCurdy, Conventionalism in the Ancient Art of Chiriqui.

The Section then adjourned.

R. S. Woodworth,
Secretary.

PUBLIC LECTURE.

October 29, 1906.

The members of the Academy and their friends met in the large lecture hall of the American Museum of Natural History, at 8:15 P. M. to listen to an extremely interesting lecture by Mr. **F. A. Lucas,** Director of the Brooklyn Museum of Arts and Sciences, entitled "The Collection of Extinct Elephants in the American Museum." The lecture was illustrated with stereopticon views.

W. M. Wheeler,
Recording Secretary.

BUSINESS MEETING.

November 5, 1906.

The Academy met at 8:15 P. M., at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following name was then presented for election to Associate Active Membership, having been approved by action of the Council:

James Howard McGregor, Barnard College.

On motion, elected by ballot cast by the secretary.

The Amendment to Chapter XI, Section 3, of the By-laws, regarding investments, as placed on file with the minutes of the meeting held May 7, 1906, and laid on the table at the meeting of October 1, 1906, was then presented for the action of the Academy. It was unanimously voted that the section be amended as read.

The Amendments to the Constitution, as presented with the minutes for May 7, 1906, were then presented for the action of the Academy and were unanimously adopted as read.

The meeting then adjourned.

W. M. Wheeler,
Recording Secretary.

SECTION OF BIOLOGY.

November 5, 1906.

The Section met at 8:15 P. M., at the American Museum of Natural History, Vice-President Crampton presiding.

The minutes of the previous meeting of the Section were read and approved.

The Section then proceeded to the election of its officers for 1907.

Prof. Henry E. Crampton was reëlected Chairman of the Section and nominated to the Council for reëlection as Vice-President of the Academy.

Prof. M. A. Bigelow was reëlected Secretary of the Section.

The following program was then offered:

Clinton G. Abbott, Expression of Emotion in Birds as Shown by Photography.

Henry E. Crampton, A Case of Mutation in Pulmonate Gastropods.

Summary of Papers.

Mr. **Abbott** said that as expression of emotion in the human being and in many animals is evidenced largely by the lines of the mouth and face, it would seem at first thought that birds, handicapped by an unrelaxable bill and feathered face, would be largely incapable of the mute expression of emotion. But a large series of photographs, taken of living wild birds under varying conditions show fear, expectation, satisfaction, bewilderment, curiosity, worry and many other emotions expressed merely by the position of the body, and the raising or depressing of the feathers. The mental attitude of birds of different temperaments under the same conditions is especially well illustrated.

The paper was illustrated with a fine series of lantern-slides.

The Section then adjourned.

M. A. Bigelow,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

November 12, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Hovey presiding.

The minutes of the last meeting of the Section were read and approved.

On motion of Dr. G. F. Kunz the following Sectional Officers were nominated for 1907:

For Chairman and Vice-president, subject to election by the Academy at the Annual Meeting, ... Prof. A. W. Grabau.
For Secretary . . . . Dr. A. A. Julien.

By unanimous vote of the Section the Secretary was instructed to cast a ballot for the above nominees, which was done.

The following program was then offered:

A. A. Julien, On a Buried Kitchen-midden at South Harwich, Cape Cod, Mass.

James F. Kemp and **E. O. Hovey**, The Mexico Meeting of the International Congress of Geology.

Summary of Papers.

The interesting paper by Dr. **Julien** was illustrated with lantern views and discussed by Mr. F. Wilton James, Professor A. W. Grabau, and Dr. Julien.

Professor **Kemp** presented an outline of the work of the Tenth International Geological Congress which was held in September in the City of Mexico. The Congress was opened at eleven o'clock in the morning of September 6 by President Diaz of the Republic of Mexico, and in the great assembly hall of the historic School of Mines. In the afternoon the regular sessions began in the fine new building of the Mexican National Geological Survey. On the alternate days of the business sessions, excursions were offered to points near the City of Mexico. The first great topic discussed was Past Geological Climates, and occupied two days. The second related to the Origin of Ore Deposits and occupied a day and a half. Subjects of general interest filled the remaining days, including especially Earthquakes and Volcanoes. The speaker briefly outlined the more important communications. Excursions were given to the great lava flow near the city, called the Pedregal, to Cuernavaca, to Pachuca, and to the Pyramids of San Juan Teotihuacan. In the evenings banquets were tendered by various officials, of which the chief was by President Diaz at Chapultepec.

Dr. **Hovey** spoke briefly of the excursions to some of the volcanoes in the southern part of the Republic and of the trip across the Isthmus of Tehuantepec.

The Section then adjourned.

A. W. Grabau,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

November 19, 1906.

The Section met at 8:15 P. M. at the American Museum of Natural History, Vice-President Trowbridge presiding.

The minutes of the previous meeting were omitted on account of the absence of the Secretary.

A public lecture was then delivered by Professor **Charles Lane Poor,** entitled "The Proposed New Astronomical Observatory and Nautical Museum for New York City."

The lecture was illustrated with stereopticon views.

Roy W. Miner,
Secretary pro tem.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

November 26, 1906.

The Section met in conjunction with the New York Section of the American Psychological Association at 4 P. M. at the Psychological Laboratory, Columbia University, and at 8:15 P. M. at the American Museum of Natural History.

The minutes of the previous meeting of the Section were read and approved.

The following program was presented:

Afternoon session.

F. Lyman Wells, Linguistic Ability and Intellectual Efficiency.
Kate Gordon, Esthetics of Simple Color-Arrangements.
A. H. Pierce, Gustatory Audition.
Harvey Carr, The Pendular Whip-lash Illusion of Motion.

Evening session.

Robert MacDougall, Imaginative Thought as Adaptive Response.
Brother Chrysostom, Psychology and Spelling.
John Dewey, Knowledge and Judgment.

Summary of Papers.

The paper by Dr. **Wells** was published in full in the Journal of Philosophy for December 6, 1906.

Dr. **Gordon** presented the results of experiments on the esthetics of simple color arrangements. She sought to arrange colors in a field in a manner somewhat similar to the usual massing of colors in a painting. Her figures were composed of large and small triangles of color arranged symmetrically about a point, and with bases turned toward each other. Red, yellow, green and blue were the colors used, and these and the triangles were arranged in all possible ways within the limits indicated. These colors differed greatly in brightness, and the results so far seem to show that preferences depend almost entirely on the arrangements of brightness. Small bright triangles surrounded by large dark ones were uniformly preferred. By control experiments it was found that this result depended partly on a preference for small masses in the centre surrounded by large masses, and partly on a preference for brightness surrounded by darkness. The results could, however, be reversed by certain accessory figures. The preference for a certain arrangement of colors did not depend on a preference for single colors; the latter preference was also studied, with the result that different colors were preferred according as the background was light or dark; on the whole the order of preference was red, blue, green and yellow. The preferred combinations were red and green, yellow and blue.

Professor **Pierce,** in his paper described an interesting case of a new form of synesthesia. The subject is a young lady, now a college senior, and it is important to note that she has a slight and variable deafness and apparently complete anosmia. She experiences gustatory and other mouth qualities on the hearing of words. Each word feels as if some article of food were in the mouth and giving the complex of buccal sensations which its actual presence would arouse. The gustatory equivalents are permanent, being found the same after a lapse of six months. It has been impossible to detect any system in the equivalencies, as the same sound, such as a labial, produces very different gustatory feelings. There is more agreement in regard to the vowels. Inarticulate sounds, excepting the high notes of the piano, do not give gustatory experiences. Some facts which point to the case being one of true synesthesia rather than of associated imagery, are: that the experience comes unsought; that it often precedes the name of the substance tasted, the name being found only after search; that some of the experiences are sharply located and located right, according to the position of the corresponding end organs; and that when in doubt the subject often presses the cheeks inward to strengthen the impression. The case and its interpretation were discussed at some length at the meeting.

Dr. **Carr** presented the results of experimental work on the pendular whip-lash illusion of movement. This illusion has been interpreted by Dodge as depending on the non-perception of movement in an object which is perfectly followed by the eyes, and consequently as indicating that the feelings of eye movement do not furnish the basis for the perception of movement. Dr. Carr's measurements show that the object followed by the eyes is seen to move till nearly the end of its swing, and that the illusory appearance of motion in the swinging object which is not regarded, after the object which is regarded has apparently come to rest, is due to the progressive disappearance of the after-image streak. An opposite and very curious illusion can be produced by placing both objects on the same arm of the pendulum and regarding the object whose swing is the longest.

The after-image streak of the other object then disappears progressively in the direction opposite to its real movement, and gives the appearance of an object moving in one direction while covering distance in the other direction if at all.

Professor **MacDougall** said in abstract: The adaptive responses of organisms differ in complexity, immediacy and persistence. The lower form makes simple, direct responses involving few determinants; the higher are characterized by sustained and complex reactions based upon intricate processes of apprehension. The introduction of a system of ideas between stimulus and reaction serves the furtherance of adaptation in two ways; it supplements the nature of the presented stimulus by a representation of its significant associates, and it increases selective discrimination in the choice of reactions. Representative thought is thus, from the biological point of view, a device by which economy of action is attained through the elimination of unfit alternatives at the level of imagination instead of at that of movement. When divorced from association with immediate practical results, thought still preserves this function in the economy of life. The plastic imagination is occupied with the representation of events and situations for which it constructs a series of ideal solutions. Adaptive reaction is rendered more efficient by the organic exercise which imagination thus provides. Through the freeing of thought from its practical relations an independent value is secured to all its manifestations. This element of absolute worth is embodied in each of the two forms of thought to which the primitive discriminative reaction has given origin, namely, to productive imagination and to analytic reflection. The former is a free treatment of the concrete situations of life according to principles prescribed by esthetic motives, and gives rise to the system of arts; the latter is a thoroughgoing exploration of the stimuli to action under a logical motive, and gives rise to the system of sciences.

Brother **Chrysostom**, in his paper, emphasized particularly the great difference between the mistakes in spelling of good and of bad spellers, and the consequent need of treating the two classes differently in teaching. This led him to urge the importance to education of organized and authoritative promulgation by psychological associations of the facts and laws of psychology that bear on the problems of teaching.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

December 3, 1906.

The Academy met at 8:15 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

It was reported from the Council that the following nominations for 1907 had been made:

For President,	Nathaniel L. Britton,
For Vice-Presidents:	
Section of Biology,	Henry E. Crampton,
Section of Geology and Mineralogy,	A. W. Grabau,
Section of Astronomy, Physics and Chemistry,	C. C. Trowbridge,
Section of Anthropology and Psychology,	Robert MacDougall,
For Corresponding Secretary,	Richard E. Dodge
For Recording Secretary,	E. O. Hovey,
For Treasurer,	Emerson McMillin,
For Librarian,	Ralph W. Tower,
For Editor,	Charles Lane Poor,
For Councilors (to serve three years)	W. M. Wheeler,
	Charles Baskerville,
For Councilor (to serve one year)	H. H. Rusby,
For Finance Committee,	John H. Caswell,
	Frederick S. Lee,
	George F. Kunz.

It was voted that the report of the Council be accepted.

The President then announced that the Annual Meeting would be of a similar nature to those of the past two years, that is, it would consist of a business meeting to be followed by a dinner, after which the President's Address would be given; that it would take place on the evening of Monday, December 17th, and that full details would be sent to each member in the course of a few days.

The meeting then adjourned.

W. M. Wheeler,
Recording Secretary.

SECTION OF BIOLOGY.

DECEMBER 3, 1906.

The Section met at 8:30 P. M. at the American Museum of Natural History, Vice-President Crampton presiding.

The minutes of the previous meeting of the Section were read and approved.

The following program was then offered.

R. H. Johnson, AN EVOLUTIONARY STUDY OF COCCINELLIDS.
C. B. Davenport, INHERITANCE IN CANARY BIRDS.

SUMMARY OF PAPERS.

Mr. **Johnson's** studies, pursued at the Laboratory of the Carnegie Institution for Experimental Research, gave these results: The species of the larger lady-beetles exhibit a great variety of color markings. Many of the varieties are connected by a series of intergrades, but generally the intergrades are less abundant than the varieties. These constitute "positions of organic stability." Typical *Hippodamia convergens* is found associated with and inter-breeding with its several varieties. In crossing varieties with the parent species, there was either perfect dominance or there were present, in various proportions, the parental forms, intergrades, and some individuals more aberrant than the parent. These facts show the existence of alternative inheritance in various degrees and therefore probably some evolution by mutation. Modifications appeared in response to temperature experiments in some species. In the evolution of these markings the chief fact has not been natural selection but orthogenesis.

The Section then adjourned.

M. A. BIGELOW,
Secretary.

PUBLIC LECTURE.

DECEMBER 5, 1906.

The members of the Academy and their friends, to the number of over 900, met in the large auditorium of the American Museum of Natural

History at 8:15 P. M. to listen to a lecture by Mr. **Charles Truax** of Chicago on "The Yellowstone National Park" illustrated by more than 200 excellent colored lantern views of the natural wonders of that region.

W. M. Wheeler,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

December 10, 1906.

The Section met at 8:15 P. M., at the American Museum of Natural History, Vice-President Hovey presiding.

The minutes of the previous meeting of the Section were read and approved.

The following program was then offered.

A. A. Julien, Present Structural Character and Probable Former Extent of the Palisade Trap.

G. E. Anderson, Development of the Inner Wall in the Palæozoic Corals.

A. W. Grabau, The Geographical Classification of Marine Life Districts.

The meeting then adjourned.

A. W. Grabau,
Secretary.

ANNUAL MEETING.

December 17, 1906.

The Academy met for the Annual Meeting on Monday, December 17, 1906, at 7:30 P. M., at the Hotel Endicott, President Britton in the Chair. A formal session for the transaction of regular business was held, followed by a dinner, at which Members of the Academy, and their friends, to the number of 71 were present.

The accompanying reports of the Corresponding Secretary, Recording

Secretary, Treasurer and Librarian were read and approved, and the Treasurer's Report was referred to the Finance Committee for auditing. The Editor not being present no report was presented by him.

The following Members were elected Fellows of the Academy:

Cleveland Abbe,	W. H. Burr,
W. K. Gregory,	Simon Flexner, M. D.
Roy W. Miner,	Thomas Hunt Morgan,
J. E. Parsons,	Alexander Petrunkewitch,

Clark Wissler.

The Academy then proceeded to the election of Officers for the year 1907. Dr. L. T. Chamberlain and Mr. W. G. Levison were appointed tellers; ballots prepared by the Council according to the By-laws were distributed, and the votes were counted. The following officers were declared elected:

President, Nathaniel L. Britton.

Vice-Presidents,

H. E. Crampton (Section of Biology), A. W. Grabau (Section of Geology and Mineralogy), C. C. Trowbridge (Section of Astronomy, Physics and Chemistry), R. MacDougall (Section of Anthropology and Psychology).

Corresponding Secretary, R. E. Dodge.
Recording Secretary, E. O. Hovey.
Treasurer, Emerson MacMillin.
Librarian, R. W. Tower.
Editor, C. L. Poor.

Councilors (to serve three years), William M. Wheeler, Charles Baskerville.

Finance Committee, John H. Caswell, George F. Kunz, Frederick S. Lee.

The President announced that the 200th anniversary of the birth of Linnæus would occurr in May, 1907, and that it seemed fitting that the Academy should take the lead in commemorating the event. Upon motion by Dr. Chamberlain, it was voted to commend the proposition and refer it to the Council for action.

The President of the Academy, Professor Nathaniel L. Britton, then delivered his address upon "Some Considerations and Illustrations of Color in Plants."

The Academy then adjourned.

W. M. Wheeler,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

According to our corrected lists there are now 49 Honorary Members and 161 Corresponding Members.

Of the Honorary Members 40 replied to the Biennial Circulars sent in 1905; six have not been heard from since 1903, and two have not answered since 1901. During the last year one Honorary Member, Prof. Samuel Pierpont Langley, and two Corresponding Members, Professor Ludwig Boltzmann and Professor Henry Augustus Ward, have died.

Respectfully submitted,

Richard E. Dodge,
Corresponding Secretary.

REPORT OF THE RECORDING SECRETARY.

During the year 1906 the Academy held 8 Business Meetings, and 29 Sectional Meetings, at which 86 stated papers and lectures were presented, on the following subjects:

Astronomy,	2 papers and 2 lectures
Physics,	3 papers
Palæontology,	5 "
Zoölogy,	6 "
Geology,	14 "
Mineralogy,	4 "
Anthropology & Archæology,	3 "
Psychology,	21 "
Philosophy,	6 "
Physiology,	1 "
Botany,	2 "
Embryology,	1 "
General Biology,	6 "
Bacteriology,	1 "
Ethnology,	4 "
Reviews,	5 "

At the present time, the membership of the Academy includes 441

Active Members, 19 of whom are Associate Active Members and 122 are Fellows. The election of 9 Fellows is pending. During the year there have been ten deaths and 24 resignations, while 7 Members have been dropped for non-payment of dues. The new Members elected during the year number 58. As the Membership of the Academy a year ago was 424, there has been a net gain of 17 during 1906.

The most noteworthy event during the past year has been the affiliation with the Academy of the other Societies formerly composing the Scientific Alliance of New York, and the vesting of the functions of the Alliance in the Academy. By the terms of the agreement the Members of the Affiliated Societies become, in addition, Associate Members of the Academy and are to be represented in the Council of the Academy by a Councilor for each Affiliated Society. The Academy agrees to encourage the work of these Societies by maintaining lecture courses, by awarding grants for scientific investigation, by providing facilities for the meetings of the Societies, by announcing in a weekly Bulletin their meetings and other functions and by annually printing and distributing corrected lists of their members. The object of the affiliation is to unify scientific effort and activity in this City.

Another new development is the establishment of a new class of Membership,— that of Donors. This class is to be composed of persons contributing $50.00 or more annually to the general fund of the Academy.

It is with great regret the Academy records the loss by death of the following Members:

Miss Harriet Brown Bailey,	(Member	for	1	year).
R. Ogden Doremus (Fellow),	("	"	39	years).
Samuel Keyser,	("	"	9	").
S. Nicholson Kane,	("	"	11	").
James McNaughton,	("	"	7	").
Henry E. Taylor,	("	"	4	months).
Philip Schuyler,	("	"	30	years).
Walter S. Logan,	("	"	2	")
Walter Bryan,	("	"	3	").

Respectfully submitted,

W. M. Wheeler,
Recording Secretary.

REPORT OF THE LIBRARIAN.

The accessions to the library during the past year have been 300 volumes, 63 pamphlets and 1697 numbers. These have been duly acknowledged and made accessible for reference.

Special acknowledgment is herewith made to the Academies, Societies and Institutions who have made gifts of many volumes necessary to complete broken sets in the library.

It is desired that Members of the Academy assist in extending the use of its library to the public.

Respectfully submitted,

R. W. Tower,
Librarian.

CONDENSED REPORT OF THE TREASURER FOR THE YEAR ENDING DECEMBER 17th, 1906.

To the New York Academy of Sciences:

As required by the By-laws, I herewith submit a statement of receipts and disbursements since the last Annual Meeting, and a balance-sheet from my ledger as of this date.

Respectfully yours,

Emerson McMillin,
Treasurer.

Cash in bank at beginning of fiscal year	$3,959.61	
Cash received during fiscal year	9,923.97	
Total cash on hand and received		$13,883.58
Paid out on vouchers during the year		8,389.47
Balance (cash in banks this date)		$ 5,494.11

Deposits.

The cash balance is deposited as follows:		
With Guaranty Trust Company	$1,158.37	
" Emerson McMillin & Co., Bankers	4,335.74	
Total cash in banks		$5,494.11

Emerson McMillin,
Treasurer.

In this Condensed Report is included a collection of interest on deposits, amounting to $74.91, which is not included in the following statement, which has been made up by the Assistant Secretary, under a recent arrangement of book-keeping.

E. McM.

December 17, 1906.

RECEIPTS.[1]

Balance on hand, December 18, 1905		$3,959.61
One year's interest at $4\frac{1}{2}\%$ on Lampe Mortgage (St. Ann's Avenue) for $12,000		540.00
One year's interest at 5 % on Brennan Mortgage (East 135th St.) for $5,200		260.00
Interest on Bond Investment		14.31
Life Membership Fees		1,050.00
Active Membership Dues, 1903	$50.00	
" " " 1904	70.00	
" " " 1905	140.00	
" " " 1906	3,180.00	$3,440.00
Associate Membership Dues, 1906		36.00
Interest on Deposits in Bank		65.69
Surplus from Annual Dinner, 1905		19.70
From Sales of Publications (volumes, reprints and plates)		243.06
		$9,628.37

DISBURSEMENTS[1]

Publications	$1,576.39	
Expense of General Office	997.65	
Salary of Assistant Secretary	799.92	
Expenses of Exhibition to date	36.63	
Expenses of Treasurer	.34	
Expenses of Librarian	29.60	
General Expenses	230.40	
Amount on Deposit with Assistant Secretary for office Expenses	174.87	
Amount on Deposit with Assistant Secretary for Expenses of Exhibition	363.37	$4,209.17
Balance on hand		$5,419.20

[1] Summary prepared by the Assistant Secretary.

THE NEW YORK ACADEMY OF SCIENCES.

BALANCE SHEET, DECEMBER 17, 1906.[1]

Investments	$17,200.00	Permanent Fund	$16,152.75
Cash on hand with Treasurer	5,419.20	Publication Fund	3,000.00
		Audubon Fund	1,897.25
		Income of Audubon Fund	318.49
		Income of Publication Fund	466.27
		Income of Permanent Fund	505.00
		General Income	279.44
	$22,619.20		$22,619.20

[1] Prepared by the Assistant Secretary.

Examined and approved

Henry F. Osborn,
John H. Caswell,
Charles A. Post,
} *Auditing Committee.*

[ANNALS N. Y. ACAD. SCI., Vol. XVIII, No. 8, Part II, pp. 313-383. May, 1908.]

RECORD OF MEETINGS

OF THE

NEW YORK ACADEMY OF SCIENCES.

January, 1907, to December, 1907.

BY EDMUND OTIS HOVEY, *Recording Secretary.*

BUSINESS MEETING.

JANUARY 7, 1907.

The Academy met at 8:15 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following candidates for election as Active Members, recommended by the Council, were duly elected:

L. P. Gratacap, American Museum of Natural History,
C. H. Roberts, 10 Washington Place.

The Academy then adjourned.

EDMUND OTIS HOVEY,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

JANUARY 7, 1907.

Section met at 8:30 P. M., Vice-President Grabau presiding.

Thirty persons were present.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Edmund Otis Hovey, NOTES ON THE VOLCANOES OF TOLUCA, COLIMA AND POPOCATEPETL.

SUMMARY OF PAPERS.

Dr. **Hovey** said in abstract: Toluca is the oldest of the three volcanoes. A feature of greatest interest in the crater is the dome of vitreous andesite which welled up in the crater as the latest phase of the activity of the volcano and shows a certain resemblance to the cone of Mt. Pelé. The volcano of Popocatepetl shows its composite character as a strato-volcano with great clearness in the walls of the crater, and streams of lava have been among the features of the most recent eruptions. The volcano of Colima is still sending up a vigorous column of steam from its central summit crater. From this summit crater there poured out, in the latest eruption (1903), streams of very frothy lava which present a strange appearance on account of the porous character of the surface blocks. The same feature characterizes the streams of the earlier eruptions and has led some observers to the erroneous conclusion that flows of lava have not occurred at the volcano of Colima.

The paper was illustrated with stereopticon views from photographs taken by the author.

The Section then adjourned to an examination, in an adjoining room, of the exhibits of Geology, Paleontology and Mineralogy in the New York Academy of Sciences' Exhibition, under the guidance of the committeemen in charge of those exhibits.

A. A. JULIEN,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

JANUARY 21, 1907.

Section met at 8:15 P. M., Vice-President Trowbridge presiding. William Campbell was appointed Secretary of Section *pro tem.*

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

William Campbell, THE RELATION BETWEEN THE MICROSTRUCTURE AND THE HEAT AND MECHANICAL TREATMENT OF IRON AND STEEL.

SUMMARY OF PAPERS.

Professor **Campbell's** paper was illustrated by lantern slides and photographs showing the gradual changes brought about by increase of carbon contents and by variation in thermal and mechanical treatment.

An interesting discussion followed.

The chairman announced that through permission of Council there would be no meetings of the Section in February and April.

The Section then adjourned.

WILLIAM CAMPBELL,
Secretary pro tem.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

JANUARY 28, 1907.

Section met at 8:15 P. M. in conjunction with the American Ethnological Society, at the American Museum of Natural History, General J. G. Wilson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Marshall H. Saville, THE INDIANS OF MANHATTAN ISLAND AND VICINITY IN THE SEVENTEENTH CENTURY.

M. Raymond Harrington, ROCK SHELTERS AND SHELL HEAPS NEAR NEW YORK CITY.

W. S. Calver, RECENT DISCOVERY OF ABORIGINAL REMAINS ON MANHATTAN ISLAND.

Max Schrabisch, INDIANS OF BERGEN, PASSAIC AND MORRIS COUNTIES, NEW JERSEY.

Alanson Skinner, SOME RECENT DISCOVERIES IN A PREHISTORIC VILLAGE SITE AT MARINER'S HARBOR, STATEN ISLAND.

Reginald Pelham Bolton, RECENT DISCOVERIES IN THE ABORIGINAL, COLONIAL AND REVOLUTIONARY REMAINS ON MANHATTAN ISLAND.

The Section then adjourned.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

FEBRUARY 4, 1907.

The Academy met at 8:15 P. M., at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following candidates for election to the Academy, recommended by Council, were duly elected:

For Active Membership:
Dr. John B. Smith, State Entomologist, New Brunswick, N. J.,
Dr. William Campbell, Columbia University;
For Non-resident Membership:
Professor Francis B. Sumner, Woods Holl, Mass.,
Professor George I. Finlay, Colorado Springs, Colo.;
For Associate Membership:
Mr. Dwight Northrup, 26 Court St., Brooklyn, N. Y.

Council recommended the reëlection of the Associate Members carried over from last year. Council reported that the list of delegates to the Council of the Academy from the Affiliated Societies had been completed, and that a committee representing the Academy and Affiliated Societies had reported an attractive program for the celebration of the two hundredth anniversary of the Swedish naturalist, Carolus Linnæus, 25 May, 1907. On motion, the report of Council was accepted.

The committee consisting of Messrs. Britton, Kemp, Grabau and Hovey, which was elected at the last meeting of the Academy to prepare resolutions expressing to Mr. W. P. Letchworth the Academy's appreciation of his gift of the Glen Iris Estate to the State of New York, presented its report that the resolutions had been prepared and forwarded to Mr. Letchworth. The Academy voted to accept the report and place a copy of the resolutions on file. The resolutions are as follows:

WHEREAS the New York Academy of Sciences has learned of the generous gift to the State of New York, of a public park known as Glen Iris at Portage, by Mr. William Pryor Letchworth, and its acceptance by the State legislature, under the condition prescribed by Mr. Letchworth that this beautiful reservation be placed in charge of the American Scenic and Historical Preservation Society;

RESOLVED that the Academy of Sciences expresses its recognition of the value to science of this reservation, which, in addition to its exceptional interest from the point of view of scenery, botany and glacial geology, contains an important part of the standard section of the Upper Devonic formations of North America;

RESOLVED that the Academy hereby expresses its sincere appreciation of this gift, which will give pleasure and be of important educational value for all time to the people of the State of New York and to visitors from other states and countries, and

RESOLVED that the thanks of the New York Academy of Sciences be and hereby are tendered to the distinguished and public-spirited donor.

The Academy then adjourned.

EDMUND OTIS HOVEY,
Recording Secretary.

SECTION OF BIOLOGY.

FEBRUARY 4, 1907.

Section met at 8:15 P. M., Vice-President Crampton presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

"THE NATURAL HISTORY OF BERMUDA."

C. L. Bristol, GENERAL CONSIDERATIONS AND ZOÖLOGY.
J. J. Stevenson, GEOLOGY AND GEOGRAPHY.
N. L. Britton, LAND BOTANY.
M. A. Howe, MARINE BOTANY.

The section then adjourned.

M. A. BIGELOW,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

FEBRUARY 11, 1907.

Section met at 8:15 P. M., Vice-President Grabau presiding.

Twenty-two persons were present.

The minutes of the last meeting of the Section were read and approved.
The following program was then offered:

John M. Clarke, The Geography of the Atlantic Devonian.
James F. Kemp, Notes on Mineral Localities visited during the Summer of 1906 in Canada and Mexico.

The section then adjourned.

A. A. Julien,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

February 18, 1907.

By permission of Council no meeting was held.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

February 25, 1907.

Section met in conjunction with the New York Branch of the American Psychological Association at 4:00 P. M., at the Psychological Laboratory, Schermerhorn Hall, Columbia University, and at 8:15 P. M. at the American Museum of Natural History, Vice-President MacDougall, presiding.

The minutes of the last meeting of the Section were read and approved.
The following program was then offered:

Afternoon Session.

S. Fröberg, Reaction Time as Affected by the Intensity, Area and Duration of the Stimulus.
Harvey Carr, A Case of Incipient Hysterical Trance.
W. C. Rüdiger, Individual Variations in the Area of Distinct Vision.

Evening Session.

Brother Chrysostom, SPACE.
Dickinson S. Miller, IMAGELESS THOUGHT.
C. B. Bliss, AN INQUIRY AFTER THE POSSIBLE RELATIONS BETWEEN THE TRINITIES OF PSYCHOLOGY AND THEOLOGY.
Cassius J. Keyser, SOME RELATIONS OF GEOMETRY TO PSYCHOLOGY AND PHILOSOPHY.

SUMMARY OF PAPERS.

Mr. **Fröberg** gave the results of an experimental study of reaction time as affected by the intensity, area and duration of the stimulus. He used chiefly light stimuli, and found the reaction time to decrease as the intensity, area or duration increased; as the magnitude of the stimulus increases in a geometrical series, the time of reaction decreases in arithmetical progression. A given ratio of increase of intensity produces about twice as much decrease in reaction time as does the same ratio of increase of area or duration. In case of sound, also, increase of intensity brings decrease of reaction time.

Dr. **Carr** reported a case of incipient hysterical trance. The subject was a young woman who, since the age of six years, following an attack of typhoid fever, had been subject to recurring attacks of partial trance, in which, though no unconsciousness, amnesia or alternation of personality occurred, there was motor paralysis (without rigidity) and the following peculiar visual experience. Objects appeared to move away, while remaining, at first, clear-cut and real; next they either remained in the distance or disappeared in a haze, or sometimes the whole visual field became blank. Her feet, as she lay, seemed far away, and this visual illusion was accompanied by the tactile illusion of being indefinitely long. Auditorily, the experience was one of great quiet. The experience was terrifying, but she was unable to struggle or cry out. The subject presented some further symptoms of hysteria, and a comparison of her case with that of Helène Smith leads to the view that only circumstances making the subject antagonistic to her trances and to occultism prevented her from developing into a trance medium.

Mr. **Rüdiger** said in his paper that he has explored an area near the center of clear vision by the tachistoscopic method, and determined the limits within which the letters 'u' and 'n,' of a certain type, can be distinguished 90 per cent. and also 75 per cent. of the time. There were found to be individual differences in the area of distinct vision, comparable in magnitude to the differences found in most other traits. Slight if any correlation could be detected between the size of the area of distinct vision and the speed of reading or the number of fixation pauses per line of print. The amount read during one fixation pause is, in most persons, much less than the amount covered by the area of distinct vision.

Brother **Chrysostum**, in discussing 'Space,' noted two sources of confusion in treating it. The first consists in a failure to distinguish between real and ideal space. Real space may be defined as the real extension of a given body considered as contained within the surfaces that bound it. This concept is complex, containing an objective element — a real extension, and a subjective element — a logical relation. Real space, viewed concretely, is neither infinitely divisible nor infinite, as current physical and astronomical discussions illustrate. Confusion also arises from an implied identification of space and place. As real space is primarily real extension and therefore solid contents as bounded, so place is primarily the bounding surface referred to the enclosed or bounded body. The two concepts are complementary, not identical.

Professor **Miller** traced the doctrine of 'Imageless Thought' back to Descartes, Spinoza and Schopenhauer. The argument for it has been that since the work of thought, the conclusion reached, can not be attributed to sensation or to images of sensation — since, indeed, the work of thought may be accomplished in the absence of imagery — therefore there must be some other agent in thought, and consciousness must contain something besides sensation and imagery. To this argument the answer is that there need be nothing there. Nothing capable of doing the work of thought need show in consciousness. Thought as a function must be distinguished from conscious content. As a function, thought is essentially unconscious. It makes no difference how impotent and irrelevant the images in consciousness may appear, if only by good luck their associations are such as to lead to the right conclusion. What those who testify to experience of imageless thought really experience is probably a bodily feeling, which, left unanalyzed, appears as a feeling of satisfaction or of being on the right track, but which, when carefully attended to, is found to be of sensory quality, like all other conscious content.

Dr. **Bliss** said in abstract: Theologians have usually sought to derive the concept of the Trinity from quite other than psychological sources. Yet the existence of a psychological trinity is certainly a suggestive fact in this connection; it seems possible that the concept of God as threefold has arisen from conceiving the fundamental tendencies of the human mind as indefinitely expanded. Expansion of the intellectual tendency would give God as the world ground; expanding the emotional tendency would give God as universal love; and expanding the active tendency would give God as universal action.

Professor **Keyser** discussed certain questions connected with the bases of geometry. In Hilbert's 'Foundations of Geometry' culminate the efforts of western thinkers from pre-Euclidean times so to analyze the space intuition as to provide a simple and complete set of independent axioms for the science of space, in particular for what is now distinguished as Euclidean geometry. For Hilbert as for Euclid, the elements of space fall into three classes or systems, points, planes, lines. Hilbert's axioms are statements of certain relations that shall be the fundamental relations satisfied by the elements, but — and this is very important — the elements are not further defined. Accordingly, if one asks, What are points, planes and lines? the answer is, They are any three systems of entities that satisfy the axioms and require no others. Are there other entity systems than those of points, planes and lines, that satisfy the Hilbert axioms? There are infinitely many such other triplets of systems of entities. One of the most obvious of such triplets consists of the system of points of space except a single specified point, say *P*, the system of all the spheres containing *P* regarded as bereft of *P* and so called pseudo-spheres, and the system of all the circles containing *P* regarded as bereft of *P* and so called pseudo or pathological circles. These three systems perfectly satisfy the Hilbert axioms, and the description of the 'space' composed of these systems of entities regarded as elements is logically identical with Euclidean geometry, though psychologically the geometries are as different as fire and water or as red and bitter. Euclidean geometry is, therefore, one; psychologically many — infinitely many.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

March 4, 1907.

The Academy met at 8:15 P. M. at the American Museum of Natural History, Vice-President Grabau presiding.

The minutes of the last meeting were read and approved.

Council reported that arrangements were being made for suitable commemorative exercises of the two hundredth anniversary of the birth of Linnæus, and the Secretary gave a summary of the proposed program.

Dr. G. F. Kunz informed the Academy of the death of Henri Moissan, Honorary Member, and a Committee was elected, consisting of Messrs. G. F. Kunz, R. S. Woodworth, C. F. Chandler, J. F. Kemp and E. O. Hovey, to draw up suitable resolutions.

The Academy then adjourned.

EDMUND OTIS HOVEY,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

MARCH 4, 1907.

Section met at 8:30 P. M., Vice-President Grabau presiding.

The minutes of the last meeting of the Section were read and approved.

The session was devoted to a description of Letchworth Park (Glen Iris), the new State Reservation on the Genesee River, New York, recently presented to the State of New York by Mr. William Pryor Letchworth, and the following papers were presented:

A. W. Grabau, THE SCENERY AND GEOLOGY OF THE GORGES AND FALLS.
George F. Kunz, THE PLAN OF DEVELOPMENT OF THE PARK AS A MEANS FOR SCIENTIFIC EDUCATION.

SUMMARY OF PAPERS.

In the first part of his paper, Professor **Grabau** discussed studies made by him for some years on the drainage systems of central New York in preglacial time. It was pointed out that all the characteristics of the ancient valleys indicate a southward drainage in late Tertiary time. In all cases where the valleys are traceable they unite southward into trunk streams, a condition wholly inexplicable on the supposition that these valleys were formed by northward-flowing streams. This is readily seen by an inspection of the topographic sheets as well as of the magnificent geologic sheets of this section recently published by the state survey. Where the connection is broken, this can generally be shown to be due to drift deposits.

The following drainage systems were tentatively outlined, the outline being presented as a report of progress rather than as a final settlement in any one case:

On the west, the Wyoming (Warsaw) valley probably had the Dale valley, now occupied in part by the Little Tonawanda, as a western branch, joining it north of Warsaw. The Warsaw valley is still believed to have been continuous with the Upper Genesee valley, above Portageville, by way of Glen Iris, as outlined by the speaker in 1894 and earlier. The valley of Silver Lake joined the Warsaw valley somewhere near Silver Springs. A narrower valley, now occupied by the Genesee from Gibsonville to St. Helena, is continued by a buried gorge from that place to Portageville, where it joins with the Warsaw-Glen Iris valley and another valley from the northwest, to continue southward in the large valley now occupied by the Upper Genesee.

The Canasseraga valley, now occupied in part by the Genesee, was cut by an independent stream. This is the largest valley of the region and was that of the master stream. The Nunda-Cashaqua valley, generally held to have been the former path of the Genesee, is probably only an inner-lowland type of valley, carved on the contact between Portage shales and Chemung sandstones. It may have been in part a tributary of the Genesee at Portageville. The Canasseraga, above the junction of the Cashaqua, is as broad and flat-bottomed as below that point, and was certainly continuous throughout, being carved by a single stream, the Tertiary Canasseraga, as suggested nearly fifteen years ago by the speaker. This river, flowing southward, received as a tributary the Conesus, the valley of which is broad and open to Scottsburg. Hemlock and Canadice rivers joined southward, receiving another branch near Springwater, the united series joining the Canasseraga by way of Wayland. Honeoye and Canandaigua rivers joined near Naples having another eastern branch in West River. Originally this series may have drained southward by way of Cohocton, but may later have been captured by a branch of the Canasseraga. This proposition, however, needs careful study. Another branch of this system seems to have been the Flint, the valley of which, traceable for twenty miles or more, points toward the Cohocton outlet. Another system is represented by the two branches of Keuka Lake, which have other branches uniting with them southward.

Other systems are represented by the valleys of the more eastern lakes. So far as the study has proceeded, these valleys could only have been formed by a southward drainage, as outlined in Bulletin 45, New York State Museum.

The remainder of the paper consisted of a description of the gorges and falls about Portage, illustrated with lantern slides. The successive stages in the development of the lower falls received special attention.

Dr. **Kunz** then presented a plan of development of the park as a means for scientific education.

Both papers were illustrated with beautiful lantern slides.
The Section then adjourned.

ALEXIS A. JULIEN,
Secretary.

SECTION OF BIOLOGY.

MARCH 11, 1907.

By permission of Council no meeting was held.

M. A. BIGELOW,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

MARCH 22, 1907.

Section met at 8:15 P. M., in conjunction with the Physics Club of New York City, Mr. Robert H. Cornish presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Demonstrations.

F. J. Arnold,	FINDING THE WEIGHT OF AN IRREGULAR BODY BY MEANS OF ITS CENTER OF GRAVITY.
R. H. Cornish,	METHOD OF PROJECTION ON SCREEN OF LINES OF FORCE SURROUNDING A CONDUCTOR CARRYING A CURRENT.
R. H. Cornish,	MECHANICAL ILLUSTRATION OF BEATS IN SOUND.
J. Stewart Gibson,	NEW PIECE OF APPARATUS FOR SHOWING THE RELATION BETWEEN INTENSITY OF ILLUMINATION AND DISTANCE.
W. R. Pyle,	(*a*) DIP NEEDLE DEMONSTRATION.
	(*b*) MAGNETIZER FOR MAGNETS.
E. R. Von Nardroff,	AN APPARATUS FOR DETERMINING THE MOMENT OF INERTIA IN GM-CEN^2 UNITS.
Charles Forbes,	(*a*) THE OSMOSESCOPE.
	(*b*) THE CENTRIFUGAL RAILWAY.

Papers.

William M. Campbell, The Effect of Pressure on Magnetization of Iron.

J. Stewart Gibson, Results of a Series of Experiments on the Critical Angle; Its Effect on Vision from Underneath the surface of Water.

Summary of Papers.

Professor **Campbell's** paper referred briefly to the Kirchoff theory on the effects of stress deduced from the strains due to magnetization, to the experimental work done by Wassmuth, Tomlinson, Nagaoka and Honda and Miss Frisbie, and the contradictory results they obtained. Then followed a description of the apparatus used by the writer, the method of conducting the experiment and the results. Higher pressures were used in magnetizing fields stronger than those used by other investigators. Keeping the pressure constant and changing the field, the results showed an increase in intensity up to about eighteen units of field, then a decrease with a change of sign at about $H = 90$ units, and a continual decrease with increase of field.

The Section then adjourned.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

March 25, 1907.

Section met at 8:15 P. M., in conjunction with the American Ethnological Society, General J. G. Wilson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Frederick S. Dellenbaugh, Some Notes on the Disintegration of the Tribes of Oklahoma.

Franz Boas, Notes on the Pawnee Language.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

April 1, 1907.

The Academy met at 8:15 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

Through the President, the Council reported that a plan had been formulated by the Committee consisting of Messrs. Addison Brown, N. L. Britton, A. C. Weeks and C. F. Cox for the legal transfer of the funds of the Council of the Scientific Alliance of New York City to the keeping of the Council of the New York Academy of Sciences, and an enabling resolution accepting the care of the funds was presented. On motion by Professor James F. Kemp, seconded by Professor R. T. Hill, a quorum being present, the foregoing report was adopted, the enabling resolution passed and the contract and resolutions just mentioned were made a part of the minutes of the meeting. They are as follows:

Agreement made this first day of April, 1907, between the New York Academy of Sciences, of the first part, and the Council of the Scientific Alliance in the City of New York, of the second part, both Corporations created by and existing under the laws of the State of New York.

Whereas the party of the first part is empowered by the provisions of chapter 181 of the Laws of 1902 of the State of New York, to consolidate, or to unite, with any other society or association in the City of New York organized for the promotion of the knowledge of the study of any science or research therein; and

Whereas the party of the second part is, and for many years past has been, a society in the City of New York, organized for the purposes abovementioned; and

Whereas the said parties are desirous of uniting and effecting a consolidation upon the terms hereinafter stated, the same having been already approved and ratified by the votes of the respective parties

Now therefore, in consideration of one dollar and of their mutual covenants, it is hereby agreed by and between the parties aforesaid, as follows:

(1) That the said two societies or corporations, known as the said parties of the first and second parts, respectively, do hereby unite together and become one consolidated society or corporation, by the name of the New York Academy of Sciences, under, and according to the charter of the said

party of the first part and the amendments thereof, which shall remain in all respects unaffected by this Agreement.

(2) That the constitution, rules, by-laws, regulations and membership of the present New York Academy of Sciences shall be the constitution, rules, by-laws, regulations and membership of the united or consolidated society or corporation.

(3) That the said consolidated corporation shall have, hold and enjoy all the property, rights, franchises and privileges belonging or appertaining to the said constituent societies or corporations, and be subject to, and discharge all the trusts and liabilities of either, in the manner now imposed upon and required of the constituent societies.

IN WITNESS WHEREOF, the said parties hereto have caused these presents to be signed in their names by the respective presidents thereof, the day and year first above written.

NEW YORK ACADEMY OF SCIENCES,
By N. L. BRITTON *President.*
COUNCIL OF THE SCIENTIFIC ALLIANCE IN THE CITY OF NEW YORK,
By CHARLES F. COX, *President.*

The Council further reported the death of Professor John K. Rees, former president of the Academy, and of Professor Marcel Bertrand of Paris, a Corresponding Member. On motion, the Academy appointed Professors N. L. Britton and C. L. Poor a Committee to prepare a suitable memorial of Professor Rees.

Council further reported receipt of a gift of $500.00 from an unnamed donor to be used for the interests of the Academy as the Council might direct. On motion, a vote of thanks to the donor of this gift to be transmitted through Attorney John L. Bissell, 50 Broadway, was passed.

The Recording Secretary then presented the nomination by the Council for Active Membership in the Academy of

R. C. Birkhahn, 60 East 93rd St.

On motion, Mr. Birkhahn was duly elected.

The Academy then adjourned.

EDMUND OTIS HOVEY,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

APRIL 1, 1907.

Section met at 8:30 P. M., Vice-President Grabau presiding.

Twenty-two persons were present.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Robert T. Hill, The Geology of the Sierra Almaloya, Mexico.

Alexis A. Julien, Evidence of the Stability of the Rock Foundations of New York City.

Summary of Papers.

Professor **Hill** gave a discussion of the tectonic structure of the northern part of the Mexican Plateau introduced by a detailed description, with topographic maps and lantern illustrations, of the geology of the Sierra Almoloya, a small mountain of Comanche Cretaceous limestone, situated between Jimenez and Parral, in the southern part of the State of Chihuahua, Mexico.

He described the Mexican Plateau as having stood several thousand feet nearer sea level at some late geologic epoch, and stated that it, together with the Colorado Plateau, and probably the whole Rocky Mountain region, had participated in a great epeirogenic uplift, as measured by the similarity of depth of the canyons of the Colorado, the Rio Grande, the Rio Lerma and the Balsas. The summit of the plateau of Western Sierra Madre in Chihauhua, and other tops, save the more modern constructional volcanic piles, were described as remnants of the older peneplain before its uplift.

The mountains of Chihuahua, east of the Western Sierra, were described as necks and stubs representing the survival of the hardest in the degradation and lowering by desert denudation of the old plateau level which once occupied it, and the stripping away of two thousand feet or more of ejecta down to the once buried limestone basement.

The structure of the Almoloya mountain was shown to consist of most complicated recumbent folds, thrown over from the west, and of the Alpine type. The mountain was also of interest inasmuch as its structural axis was in a northeast direction.

Professor Hill's paper was discussed by Professor J. F. Kemp, Dr. E. O. Hovey and others.

Dr. **Julien** then spoke on the "Evidence of the Stability of the Rock Foundations of New York City." The general facts were reviewed which might justify the confidence of builders in the operations of extensive construction now in progress. Two former periods of enormous seismic activity in this region were considered, as recorded by the violent faulting produced at each time. The one, connected with the foldings, slips and shattering during the great Appalachian uplift, and now revealed by the numerous pegmatite intrusions cutting irregularly across the stratum of crystalline schists, probably effected during Cambrian time. The other, after the close of the Mesozoic, during the thrust of lava sheets between the sandstones and shales of the Newark series of New Jersey, now indicated by many faults across Manhattan Island and the adjacent Palisade Ridge. The long period of cessation of uplift, of ensuing subsidence and extensive surface erosion, offers the conditions in this region which promise long stability, notwithstanding the slight tremors noted at intervals of thirty or forty years. In the absence of disturbance from the glacial striæ, everywhere abundant, which serve as natural benchmarks to record changes of level or faulting, we obtain therefore direct testimony to the established absence of tremor during the long and approximately definite period which has elapsed since the passage and withdrawal of the continental glacier. In the upper portion of the Hudson River valley, however, some evidences of post-glacial faulting have been observed.

The Section then adjourned.

Alexis A. Julien,
Secretary.

SECTION OF BIOLOGY.

April 8, 1907.

Section met at 8:15 P. M., Vice-President Crampton presiding.

The minutes of the last meeting were read and approved.

The following program was then offered.

C. L. Bristol and
S. W. Bartelmez, Skin Glands of *Bufo aqua*.
George G. Scott, Regeneration in *Fundulus*.
Maurice A. Bigelow, The Difference Between Nature Study and Biology.

Summary of Papers.

Messrs. **Bristol** and **Bartelmez** said in abstract: *Bufo aqua* is a South American toad which is distinguished chiefly by its relatively large size and by the characteristic poison secreted by glands in its skin. This toad was introduced into Bermuda about 1885, where it has thriven to such an extent as to become a nuisance. Owing to the facilities of investigation upon this largest living Anuran and because of the economic aspects of its poisonous character, it has been an object of especial attention to the New York University Biological Expeditions at the station on White's Island, Bermuda. Experiments have shown that the poison is very like "curari" in its effects. A subcutaneous injection of moderate doses into a dog causes convulsions followed by death in about an hour.

The skin of the dorsal side of *Bufo aqua* is characterized by large warts and the parotoid gland is enormously developed. The poison is exuded from these warts, and most abundantly from the parotoid when the animal is irritated. Besides the poison, which is thick and milky, a colorless, non-poisonous mucous common to all amphibians is exuded from all parts of the skin. These secretions are elaborated in simple alveolar skin-glands of which there are two types. The glands of the first type — small clear mucous glands — are distributed throughout all regions of the skin; those of the second type — the larger granular poison glands — occur only on the dorsal aspect of the head, trunk and limbs, and are grouped in the parotoid and the warts.

The physiological processes that take place within the cells forming the epithelium of the mucous glands (first type mentioned above) are those typical of ordinary glandular epithelium. In *Bufo aqua* these glandular cells after a period of activity certainly go to the ground. The glands themselves, after a period of activity, degenerate and are resorbed.

The processes involved in the formation of the poison, and the method of regeneration of poison glands has been investigated in various Urodeles, but we have been able to find few, if any, references to investigations on the glands in toads, in which the poison function has become most highly developed. The poison glands of *Bufo aqua* are ovoid in shape and in the parotoid region attain a size of 7 mm., whereas the mucous glands are microscopic in size. A poison gland consists of an outer membrana propria, a layer of smooth muscle fibers and an inner simple columnar epithelium. The neck of the gland in *Bufo aqua* gradually merges into a wide duct passing out perpendicularly to the surface of the skin. Around the mouth of fully grown poison glands there is a group of from three to six small glands which have arisen by invaginations of the Malpighian layer of the epidermis. The epithelial cells of the poison glands, which develop large characteristic granules within the cytoplasm, grow to a large size and finally disintegrate. The substance of the cells thus becomes the poisonous secretion which comes to fill the lumen of the gland. Now the muscular layer develops greatly and the glands are gradually emptied. At this point one of the smaller glands around the mouth of the old gland begins to grow rapidly and takes its place, the old gland being eventually resorbed. Thus the poison gland is regenerated from a type of gland which in its early stages shows the characteristics of a mucous gland. The poison gland is in fact a highly modified and specialized form of mucous gland which has been differentiated for the performance of a special function.

The Section then adjourned.

M. A. Bigelow,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

April 22, 1907.

Section met at 3:30 and 8 P. M., in conjunction with the New York Branch of the American Psychological Association at the Psychological Laboratory, Yale University, New Haven, Conn.

The following program was offered:

Afternoon Session.

R. S. Woodworth, A Method of Measuring Differences in Order and its Use in Studying Correlation.
F. N. Freeman, Preliminary Studies in Writing Reactions.
F. Lyman Wells, On the Validity of Individual Judgment as Measured by its Departure from an Average.
W. C. Rüdiger, The Period of Mental Reconstruction.

Evening Session.

Edward L. Thorndike, Experiments in Memory for Paired Associations.
H. N. Loomis, Reactions to Weights of Unequal Size.
J. McK. Cattell, Perceptions, Images and Illusions.
W. P. Montague, Truth as Compossibility.

Summary of Papers.

Professor **Woodworth** said in abstract: The method differs from the Spearman method of counting up differences of rank in that only the relative positions of the terms are considered. The unit of change in order is the transposition of two terms, and the difference between two orders of the same terms is measured by the number of transpositions necessary to pass from one order to the other. This number is easily counted up, and the necessary constants, *e. g.*, the total number of transpositions necessary to reverse a given order, are also readily calculated. The method has the same advantages in psychological work as are brought out by Spearman in favor of his method of measuring changes in rank; the present method is claimed by its author to be more accurate and adequate for the purpose in hand.

Mr. **Freeman** said in abstract: The reactor traced lines with an ordinary pencil on a fixed sheet of paper, as in writing, and the tracing was taken on the moving kymograph strip beneath through a typewriter ribbon. The pressure changes which accompanied the movement could also be recorded. The three general types of reaction which occur in writing, consisting, respectively, in starting a movement, stopping a movement and changing the direction of a movement, were compared as to their reaction time and as to the relative speed, amplitude and pressure of the movements themselves. The reaction time in stopping a movement was, on the average, over 40 per cent. slower than in starting a movement. This may be accounted for on the ground that preparation for starting a movement can be accurately made. On the other hand, no such preparation can be made in stopping a rhythmic movement, such as is used in writing, since the character of the inhibition depends on the stage of the movement which happens to be in progress at the time of signal. In starting a movement the reaction time varied with the complexity of the course of the movement after the reaction, which seemed to be reflected back into the preparatory state. Changing the direction was the slowest of all. Consciousness in general was correlated with the whole progressively developing coördination rather than with its separate elements.

Dr. **Wells** said in abstract: When a number of representatives of a given class or group independently pass judgment on, say, the relative merits of different authors, the average judgment is important in that it shows how the authors have impressed this class or group, and the deviation of an individual's judgment from the average measures the closeness of his conformity to the group standard. It remains possible that an individual may judge by a better standard than that of the group, and in fact persons who from their experience and ability would be expected to be the best judges of literary merit are sometimes found to differ greatly from the average. The standard of judgment actually employed by a group may differ widely from the standard which the group would themselves consciously assign as the best: such a difference was found by experiment to obtain in the case of judgments of literary merit.

Mr. **Rüdiger** said in abstract: A carefully conducted questionary, adapted to statistical treatment, showed great individual differences in the suddenness and vividness of the transition from early beliefs and intellectual attitudes to those of mature life. A large share of the individuals questioned are unable to point to any period of transition, while others report a perfectly defined intellectual 'conversion.' The period of this change is on the average later than that of religious conversion.

Professor **Thorndike** said in abstract: Twenty-five adults practised from 12 to 40 hours in learning the English equivalents of German words previously unknown to them. This practise did not appreciably increase the number of pairs learned per hour; the result for paired associations differs in this respect from that obtained by James and others in memorizing poetry and by Ebert and Meumann in memorizing nonsense syllables. Also the rapid loss of memory found by Ebbinghaus in case of nonsense syllables did not appear; the loss within a month was very slight. The correlation between the power to remember for a minute and the power to remember for hours and days is surely positive and probably very high. Individual differences in memory, in this test, are of approximately the same magnitude as in efficiency of observation, controlled association and selective thinking, and greater than in reaction time and sense discrimination.

Mr. **Loomis** said in abstract: The movements of the lifted weights, being graphically recorded, showed that, on first approaching the experiment, a person lifted the bulkier weight with the greater force; after repeated lifting this inequality decreased.

Professor **Cattell** in his paper, emphasized, as important among the points of differences between a sensation and an image, the weaker tendency of the image to issue in motor reaction, and advanced a number of facts going to show that this relative lack of motor tendency was valuable in enabling us to distinguish images from sensations.

Professor **Montague** classified and criticized the various conceptions of truth as introductory to a view of 'Truth as Compossibility.'

R. S. Woodworth,
Secretary.

SPECIAL MEETING.

April 29, 1907.

Dr. **Tempest Anderson**, F. G. S., F. R. G. S., of York, England, delivered a public illustrated lecture on

"Vesuvius and Its Eruptions."

President Britton presided, and an audience of 259 persons listened to the lecture.

Edmund Otis Hovey,
Recording Secretary.

BUSINESS MEETING.

May 6, 1907.

The Academy met at 8 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the last meeting were read and approved.

The following candidates for election as Active Members, recommended by the Council, were duly elected:

Ralph Lyon,	453 West 24th Street,
Adolph S. Ochs,	New York Times,
Mrs. Charles Tylor Olmsted,	159 Park Av., Utica, N. Y.,
William Houston Kenyon,	321 West 82nd Street,
William D. Baldwin,	14 West 68th Street,
Henry D. Hotchkiss,	315 West 75th Street,
John A. Fordyce,	8 West 77th Street,
W. M. Martin,	44 West 40th Street,
George D. Cross,	Bernardsville, N. J.,
Charles E. Diefenthäler,	303 West 91st Street,
Harry Ingram,	525 Sixth St., Brooklyn, N. Y.,
M. I. Blank, M. D.,	42 West 115th Street,
James D. Hague,	108 East 40th Street,
William Sturgis Bigelow,	60 Beacon St., Boston, Mass.,
J. W. Leib, Jr.,	869 West End Avenue,
John Rutgers Planten,	44 Eighth Ave., Brooklyn, N. Y.,
R. Degener,	44 West 74th Street,
Thomas Jefferson Hurley,	47 Pierpont St., Brooklyn, N. Y.

President N. L. Britton, as chairman of the Committee appointed to draw up the memorial and resolutions on account of the death of former President John K. Rees, rendered a report which, on motion, was accepted, and the Secretary was directed to have the resolutions engrossed and presented to the family of Professor Rees. The resolutions are as follows:

WHEREAS John Krom Rees, Professor of Astronomy in Columbia University from 1892 to 1907, President of this Academy from 1894 to 1896, a distinguished and successful teacher and investigator, a member of many learned societies and Secretary of the American Metrological Society from 1882 to 1896 and its Vice-President from 1896 to 1907, is lost to us by death,

RESOLVED that the Council of the New York Academy of Sciences deeply mourn the loss of John Krom Rees. His work for this Academy during his Presidency and in subsequent years was of the most important character. It was at his suggestion that the Sections of the Academy were formed which have been so efficient in carrying on its work. He established the Memoirs of the Academy and contributed important papers for them. He was beloved by all his associates, and his public lectures were attended by large audiences. His establishment of the Summer School of Geodesy of Columbia University has led to most important results, and his influence in the establishment of the system of public standard time has been of great value to the Nation,

RESOLVED that a copy of the foregoing preamble and resolution be submitted to the Academy, and that a copy be engrossed and transmitted to his family, as an expression of appreciation of his scientific labors.

On motion, it was voted that when the Academy adjourned, the adjournment should be to 5 P. M., 27 May, 1907.

The Academy then adjourned.

EDMUND OTIS HOVEY,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

MAY 6, 1907.

Section met at 8:45 P. M., Vice-President Grabau presiding.

In the absence of the Secretary, the reading of the minutes of the last meeting of the Section was omitted, and Dr. E. O. Hovey was elected Secretary *pro tem.*

Twenty members and visitors were in attendance.

The following program was offered:

J. Volney Lewis, THE CORRELATION OF THE NEWARK (TRIASSIC) TRAP ROCKS OF NEW JERSEY.

Henry B. Kümmel, RECENT INVESTIGATIONS OF THE POTABLE WATER SUPPLIES OF NEW JERSEY.

H. S. Washington, SOME VOLCANOES OF THE WESTERN MEDITERRANEAN.

Ida H. Ogilvie, A CONTRIBUTION TO THE GEOLOGY OF MAINE. (By title.)

J. F. Kemp and **J. G. Ross**, A PERIDOTITE DIKE IN COAL MEASURES OF SOUTHWESTERN PENNSYLVANIA.

SUMMARY OF PAPERS.

Professor **Lewis** said that the disconnected extrusive traps west of the Watchung Mountains may be explained in several ways, but they are probably the results of scant eruptions, the New Vernon crescent being the upturned western edge of the Long Hill trap. The extrusives at Sand Brook and New Germantown are probably outlying remnants of, or at least contemporaneous with, the flows of First and Second Mountains.

Darton's dike-and-sheet hypothesis of the Palisades sill is not supported by the facts, the trap being roughly conformable to the strata, as far as known, in all directions. The chance of the fissure of intrusion coinciding with the western flank of the Palisades from Weehawken to Haverstraw is exceedingly small. On the other hand, data now available quite satisfactorily establish the connection between the Palisades and the trap of Rocky Hill to the southwest, and a section along the Delaware River shows a threefold repetition of this by faulting. Thus there is but one intrusive sheet, which gives off numerous dikes and apophyses, in contrast with four extrusives, Second Mountain being double.

The intrusive is considered of later age than the first extrusive, and may be contemporaneous with one of the later extrusives or subsequent to all of them. This conclusion is in harmony with the results of recent studies of the copper deposits, which are intimately connected with the intrusion of the great Palisades sill.

There are many points of resemblance to the Connecticut Valley traps: the same number of extrusives appear in both, grouped in the uppermost strata; in both the second is a double flow; an intrusive sill lies near the base, and dikes cut the intervening strata.

The paper was discussed by Messrs. Kemp, Britton, Kümmel, Tuttle, Grabau and Hovey.

Dr. **Washington** described briefly the volcanoes of Catalonia, Sardinia, Pantelleria and Linosa, which he visited for the Carnegie Institution in the summer of 1905. The Catalonian eruptions are referred to two phases, a first of extensive lava flows, followed by the formation of numerous small cinder cones, the material being basaltic in every case, nephelite appearing in some types. The Sardinian occurrences consist of extensive sheets of basalt and trachyte of Tertiary age, with the two later large volcanoes of Monte Ferru and Monte Arci, both of which show an interior core of salic rocks (trachytes and phonolites at the former and rhyolites at the latter), covered by extensive mantles of basalt. The last phase of volcanicity in Sardinia is seen in a long line of small cinder cones of recent date, much resembling those of Catalonia in both form and material. The island of Pantelleria is quite complex, but here also the earlier eruptions were of trachytes and phonolites, the activity closing with the formation of small, basaltic, cinder cones. The small islet of Linosa, which is almost unknown, shows nine volcanic cones, two phases of eruption being evident: the first producing basalt tuff cones, and the second basaltic cinder cones, similar to those from the other localities. The paper was illustrated by numerous photographs taken by the speaker.

The papers of Dr. Ogilvie and Professor Kemp and Mr. Ross have been published in Vol. XVII, Part II, of the Annals.

The Section then adjourned.

Edmund Otis Hovey,
Secretary pro tem.

SECTION OF BIOLOGY.

May 13, 1907.

Section met at 8:15 P. M., Vice-President Crampton presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Henry F. Osborn, Brief Account of the Expedition to the Fayûm, Egypt.

Edmund B. Wilson, The Supernumerary Chromosomes of Hemiptera.

L. Hussakof, Variations in the Leaf Type of *Liriodendron tulipifera* during a Season's Growth.

A. W. Grabau, Orthogenesis in Gastropods.

Summary of Papers.

Professor **Osborn** gave a summary of the valuable results of the expedition to the Fayûm, Egypt, in search of *Palæomastodon* and *Arsinoitherium* which was illustrated by a fine series of stereopticon views. A detailed account of the expedition has been published in Science.

Professor **Wilson,** in his paper, said in brief: In striking contrast to nearly all forms heretofore described, the genus *Metapedius* presents a considerable range of variation in the individual number of chromosomes, though the number is constant in each individual. The following numbers have thus far been observed in a total of 30 individuals (spermatogonia in the males, ovarian cells in the females). *M. terminalis,* males 22, 23, females 22, 25; *M. femoratus,* males 22, 23, 26, females 24, 26; *M. granulosus,* males 23, 26, 27 (?), females 26. The variation is thus seen to be independent of sex; and it is not a casual fluctuation within the individual, since the individual number is constant and in the male is definitely correlated with the number present in the maturation-divisions. Thus with 22, 23 or 26 spermatogonial chromosomes the first spermatogonial division shows respectively 12, 13 or 16 chromosomes — a relation shown constantly and in a large number of cells. Study of the conditions shown in the males leads to the conclusion that all individuals possess a fundamental or type group of 22 chromosomes that are always present and show the same general arrangement in the first division. To these may be added in certain individuals one or more "supernumerary chromosomes" which, like the idiochromosomes differ in behavior from the others in failing to couple at the time of general synapsis, dividing as univalents in the first division where they appear smaller than the bivalents. Thus are explained the peculiar numerical relations above stated, — *e. g.,* 16 chromosomes in the first division include ten bivalents and six univalents (two idiochromosomes and four supernumeraries). In the second division the supernumeraries almost always unite with the idiochromosome-bivalent to form a compound element; and the facts indicate that the individual members of this complex may undergo an asymmetrical distribution to the spermatozoa, which probably gives the explanation of the variations observed in the somatic numbers of different individuals. The new proof given by the facts of the genetic identity of the chromosomes, and their possible bearing on certain phenomena of heredity were indicated.

Dr. **Hussakof,** in his paper, said in abstract: The leaves were collected from a single tree during three successive summers beginning with 1904, and their variations in form statistically studied. During 1905 and 1906 "average samples" (about 500 leaves representing all parts of the tree) were collected at intervals of about a month and systematically tabulated.

It was found that at the end of May the six-pointed type of leaf constitutes over half the total foliage (.58 in 1905; .65 in 1906), and that the four-pointed type is totally absent. During the next month there is a remarkable growth of four-pointed leaves, so that at the end of June they constitute over 50 per cent. of the total foliage. The six-pointed leaves become reduced to about 35 per cent. of the total. During the remainder of the summer these figures vacillate only within about 5 per cent. The leaves with 8, 10, 12 and 14 points were also studied; each makes up only a small per cent. of the total foliage, the last being very rare.

The talk was illustrated by charts and specimens.

The Section then adjourned.

M. A. Bigelow,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

May 20, 1907.

Section met at 8:15 P. M., Vice-President Trowbridge presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

F. W. Pedersen, Viscosity of the Vapors of Certain Isometric Ethers.

William Campbell, On the Iron-Carbon Series of Alloys.

Summary of Papers.

Dr. **Pedersen,** in his paper, dealt with the influence of molecular structure upon the internal friction of the vapors of certain isometric ethers. The viscosity coefficients of various ether vapors at 100° c. were obtained by the well-known transpiration method. The molecules of a Tertiary compound were shown to be smaller than those of a secondary, which in turn are smaller than those of a primary.

Professor **Campbell** revised the various published equilibrium curves of the carbon-iron series, and by a series of lantern slides showed the various changes of structure which take place (a) by variation in carbon, (b) by heat annealing. It was demonstrated that two systems occur (1) Austenite (mixed crystals): cementite, (2) Austenite (mixed crystals): graphite. The former is unstable; the latter stable.

There was some discussion of the latter paper.

The Section then adjourned.

William Campbell,
Secretary.

ADJOURNED BUSINESS MEETING.

May 27, 1908.

The Academy met at 5 P. M. at the American Museum of Natural History, by adjournment from the regular meeting of 6 May, President Britton presiding.

The reading of the minutes of the regular meeting of 6 May was deferred.

The following candidates for Active Membership, recommended by the Council, were duly elected:

C. H. Allen,	1 West 72nd Street,
A. Beller,	38 West 73rd Street,
Samuel R. Betts,	102 Madison Avenue,
Moses Bijur,	944 Park Avenue,
Matilda W. Bruce,	810 Fifth Avenue,
Winthrop Burr,	7 Wall Street,
Mrs. William Combe,	76 East 79th Street,
H. D. Chapin,	51 West 51st Street,
Grace H. Dodge,	262 Madison Avenue,
Thomas Dwyer,	601 West End Avenue,
Arthur F. Estabrook,	15 State St., Boston, Mass,
John C. Eno,	Hotel Belmont, 42nd Street,
G. W. R. Fallon,	184 N. Columbus Ave., Mount Vernon, N. Y.,
Emil Freund,	159 East 61st Street,
Robert W. Gibson,	15 East 77th Street,
George Griggs,	Chihuahua, Mexico,
C. A. Griscom, Jr.,	21 Washington Square, N.,
Hugo von Hagen,	500 Fifth Avenue,
William Halls, Jr.,	Summit, New Jersey,
James J. Higginson,	16 East 41st Street,
Charles R. Flint,	4 East 36th Street,
Frank Hustace,	19 East 42nd Street,
Alois von Isakovics,	Monticello, N. Y.,

Robert E. Jennings,	Jersey City, N. J.,
Mary Sutton Macy, M. D.,	101 West 80th Street,
V. Everit Macy,	Scarborough, N. Y.,
C. S. Mellen,	389 Whitney Ave., New Haven, Conn.,
William T. Meredith,	38 West 50th Street,
John G. Milburn,	16 West 10th Street,
Henry Parish,	52 Wall Street,
Thomas W. Pearsall,	Black Rock, Conn.,
Robert Pearle,	160 West 59th Street,
Philip Bernard Philipp,	327 Central Park West,
Edward Russ,	Hoboken, N. J.,
Paul J. Sachs,	468 West 142nd Street,
Charles R. Saul,	1 West 69th Street,
Fred Sauter,	42 Bleeker Street,
Jacob H. Schiff,	52 William Street,
George S. Scott,	28 West 57th Street,
Mrs. John C. Shaw,	317 Convent Avenue,
Charles Size, Jr.,	19 West 50th Street,
Benson B. Sloan,	141 East 36th Street,
Charles F. Smillie,	29 East 38th Street,
Elbridge G. Snow,	155 West 58th Street,
C. Amory Stevens,	50 Broad Street,
Elizabeth M. Sturgis,	131 Milton St., Brooklyn, N. Y.,
George Taylor,	8 West 126th Street,
Nikola Tesla,	Waldorf Astoria Hotel,
Benjamin Thaw,	1046 Fifth Avenue,
Mrs. Frederick F. Thompson,	283 Madison Avenue,
Rev. C. C. Tiffany, D. D.,	301 West 106th Street,
Herbert L. Wheeler,	12 West 46th Street,
Miss M. B. Wilson,	72 East 77th Street,
Isidor Wormser,	836 Fifth Avenue,
George H. Yeaman,	44 Wall Street.

The committee on a memorial to Professor Moissan presented through its chairman, Professor James F. Kemp, a report which was accepted and on motion ordered published in the annals. The report was as follows:

The death of Professor Henri Moissan, of Paris, has removed from the roll of Honorary Members of the New York Academy of Sciences, one of its most distinguished names. The Academy desires to record its profound appreciation of his life and works and its deep sense of the great loss which Science has sustained in the termination of his labors.

Professor Moissan was born September 28th, 1852, in the City of Paris. After his student days had been passed at the Musée d'Histoire Naturelle and in the École de Pharmacie, he became an instructor in the latter and in 1886, was called to the Chair of Toxicology. He had already begun his investigations by means of the electric furnace, and his notable studies of the element fluorine, which he isolated and described in 1887, speedily made him famous among chemists. His later work, however, with the electric furnace, yielded the results for which he is most widely known. In this branch of investigation he was truly a pioneer, and by the use and control of the most exalted temperatures he made many contributions to science and the arts of the greatest interest and importance. Curious alloys, unusual compounds and even the diamond itself were artificially produced.

In addition to his scientific attainments, Professor Moissan was a man of most agreeable and engaging personality. As a lecturer, he commanded instant and absorbed attention, and as an experimenter before an audience, he was skilful and successful in the highest degree. His loss is felt no less for his personal qualities than for his scientific contributions.

J. F. Kemp, Chairman,
E. O. Hovey,
G. F. Kunz,
C. F. Chandler,
R. S. Woodward.

On motion, it was voted that the Executive Committee be authorized to elect new members during the period between the present date and 1 October, 1907.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SPECIAL MEETING.

September 9, 1907.

Dr. D. Le Soüef of Melbourne, Australia, delivered a public illustrated lecture on

"The Wild Animal Life of Australia."

President Britton presided, and 107 persons were present at the meeting.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

October 7, 1907.

Section met at 8:15 P. M., Vice-President Grabau presiding.

The minutes of the last two meetings of the Section were read and approved.

The following program was then offered:

Alexis A. Julien, On the Pebbles at Harwich (Cape Cod), Mass., and on Rude Arrowheads Found Among Them.

A. W. Grabau, The Sylvania Sandstone — A Study in Paleogeography.

Summary of Papers.

Dr. **Julien's** paper was, in abstract, as follows: Along the south shore of the apron-plain at Harwich the glacial deposits show abundant sections of layers of gravel, often coarse, and at one point huge angular boulders, up to eight feet in diameter, similar to those in the moraine along the north side of the cape. The pebbles consist almost altogether of crystalline rocks in considerable variety, in which, however, three types predominate. The principal one is a coarse binary granite, sometimes porphyroidal, passing by addition of hornblende into monzonite. Its sheared form seems to be represented by pebbles of granite-gneiss or apatite-schist, without mica, and very rarely of a fine biotite gneiss.

This rock appears to have been cut by intrusive dikes, both of an acid rock and of one of intermediate character, occurring in abundant pebbles. The one is a pinkish quartz-porhpyry, a white felsite, or finely striped rhyolite, whose sheared forms appear to be a white phyllitic gneiss, with minute augen-structure. The other, a rather finely granular gabbro, made up of white feldspar and a greenish black hornblende-like mineral. This rock, by shearing, has passed into a hard greenstone, often decidedly schistose, and perhaps into a banded schist. Besides these three types, several varieties of fine crystalline schists, probably metamorphic; rarely small grains of serpentine; and occasional flakes of blue-black argillite. A marked feature in all these rocks is the almost entire absence of mica of any kind and that mineral does not occur even in the sands and clays, at least in scales visible to the naked eye.

By contrast, the characteristic rocks of the adjoining coast along the mainland of eastern New England have not been found, in spite of constant search, *e. g.*, the mica-gneisses and mica-pegmatites north of New Bedford, the granite of Quincy, Mass., the Dorchester conglomerate, the pyroxenic rocks and basic mica-diorites of Nahant, the porphyritic biotite granites of the Maine coast, etc. The conclusion is that the pebbles at Harwich have been transported from some other micaless region.

Among the pebbles in ploughed fields many rude stone implements may be found, such as tomahawks, scrapers, lance-heads, and particularly arrowheads of the simplest form, probably left by Indians of the Massaquoit tribe of whom several small kitchen-middens have been found in the neighborhood. These tools have been made from the local materials above described, chiefly from pebbles of the harder and finer schists, rhyolite, quartz-porphyry and often granite. Their dull edges and rounded points may imply that in many cases they have never been sharpened, but used for stunning birds and small animals. Many show mere traces of human workmanship, perhaps but one or two artificial faces, as if their owners had been content to use the simplest flakes for arrow-points.

Professor **Grabau** described field work carried on in company with Professor Sherzer in southern Michigan for the state survey. The special object of study was the Upper Monroe formation and the Sylvania sandstone. The evidences of the eolian (anemoclastic) origin of this rock were presented. An interesting new fauna of late Siluric age and with Devonic affinities was found in the highest beds. Evidence of the disconformable relation of the Monroe and the overlying Dundee (Onondaga) was obtained.

After discussion of both papers by Professor Kemp, Dr. Hovey and others, the members of the section contributed observations made during the summer. Professor J. F. Kemp stated the general results of study of the petrography of the Adirondack region, and Dr. E. O. Hovey gave an account of excursions of Section E of the American Association for the Advancement of Science in the vicinity of the Adirondacks. Professor C. P. Berkey reviewed his recent investigations in the Highlands of New York and stated the difficulty of correlation of the Manhattan schists on the south with the Cambrian sedimentaries on the north, but reported the passage of the latter into crystalline condition eastward toward the Connecticut line.

The Section then adjourned.

Alexis A. Julien,
Secretary.

BUSINESS MEETING.

October 7, 1907.

The Academy met at 9:25 P. M. at the American Museum of Natural History, Vice-President Grabau presiding in the absence of President Britton.

The minutes of the regular meeting of 6 May and the adjourned meeting of 27 May were read and approved.

The Executive Committee reported that by virtue of authority given 27 May the following candidates had been elected since that date:

Mrs. P. Hackley Barhydt,	40 East 70th Street,
James D. Foot,	Rye, N. Y.,
Walter J. Hewlett,	51 Wall Street,
Charles Kohlman,	1007 Madison Avenue,
Eugene H. Paddock,	149 West 72nd Street,
Mrs. Florence N. C. Nimick,	Waldorf Astoria Hotel,
William H. Taylor,	The Ansonia Hotel.

The report was approved.

Council reported the following nomination for Active Membership

J. de Lagerberg, 70 Park Ave., Passaic, N. J.

On motion the candidate was unanimously elected.

The Recording Secretary reported the death of

Samuel Sloan, Patron,
C. B. Warring, Corresponding Member, and
Giuseppe Grattarola, Corresponding Member.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF BIOIOGY.

October 14, 1907.

Section met at 8:15 P. M., Vice-President Crampton presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

W. M. Wheeler, A Study of Ants in Switzerland.
N. L. Britton, Recent Explorations in Jamaica.
H. E. Crampton, A Second Journey to the Society Islands.
E. B. Wilson gave a brief account of the summer work at Woods Holl, and described some interesting observations made by him on the structure of living cells.

Brief reports were also made by several other members of the Section.
The Section then adjourned.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

October 21, 1907.

Section met at 8: 15 P. M., Vice-President Trowbridge presiding.
The minutes of the last meeting of the Section were read and approved.
The following program was then offered:

L. B. Morse, The Selective Reflection Shown by Carbonates in the Infra-red Spectrum and its Relation to the Atomic Weight of the Bases.
C. C. Trowbridge, The Decay of Phosphorescence in Gases.
William Campbell, Some Temperature Measurements Taken in the Steel Works with the Wanner and other Pyrometers.

Summary of Papers.

Dr. **Morse** discussed his paper in two sub-divisions as follows:

I. The Selective Reflection of Carbonates as a Function of the Atomic Weight of the Base.— Polished plane surfaces of (Mg, Ca, Fe, Mn, Zn, Sr, Ba and Pb) CO_3 were prepared, and the ratio of the reflected to the incident radiation was measured at short wave-length intervals between 4 μ and 15 μ. The following are the principal conclusions reached:

1. The reflection curves for all the carbonates examined show between 4 μ and 15 μ three, and only three, bands of abnormal reflection. Abnormal reflection interpreted means a free resonance period of the molecule.

2. The bands fall into three separate and definite spectral regions, which are distinct from the regions where the salts of other acids, so far as known, show reflection maxima.

3. With few exceptions, an increase in the atomic weight of the base causes a shift of all three reflection maxima toward long waves by an amount roughly proportional to the change in atomic weight of the base.

II. The Rôle Played by Oxygen in the Selective Reflection of Carbonates, Nitrates, Sulphates and Silicates.— Combining with the data on carbonates the scattered observations of other observers on nitrates, sulphates and silicates, the tentative hypothesis has been made that the oxygen atom is the one chiefly responsible for the marked reflection observed.

The wave-lengths of the first reflection bands in $CaCO_3$, KNO_3,[1] $CaSO_4$ and $MgSiO_3$[2] are plotted as abscissæ and as ordinates the weights of the acid-forming elements combined with O_3 ($C = 12$, $N = 14$, $\frac{3}{4}S = 24$, and $Si = 28$).

The lines drawn show clearly that a small increase in the weight of the acid-forming element produces a much greater displacement of the reflection band than does the same increase in the weight of the base, and this is in full agreement with the chemist's view of the relative strength of the bands existing between the acid-forming element and oxygen, and that between the base and oxygen.

The results suggest a new and far-reaching method by which it may some time be possible to express the dynamical relations existing between the separate atoms of a molecule, and thus the present conception of chemical bonds and linkages be given a broader significance.

The paper appears in full in the *Astrophysical Journal* for November, 1907. Addendum, October, 30, 1907.

By reducing the results to zero weight of the base and extending the curve *b* to zero weight of the acid-forming element, the weight with O_3 both in base and as acid-forming element is zero. Thus a wave-length is found which is approximately that found by Ångström for the absorption of ozone.

Also a second absorption band in ozone corresponds to the second carbonate bands, found at a longer wave-length.

This is a very important confirmation of the assumption made, viz.: that "the oxygen atom is the one chiefly responsible for the selective reflection observed."

---

[1] Two values are plotted for KNO_3 corresponding to the results obtained by two independent observers, Pfund and Coblentz.

[2] If a correction be applied to correct for Mg being lighter than Ca, this would bring the $MgSiO_3$ point even nearer the line drawn.

Professor **Trowbridge** described a new form of photometer designed for the purpose of measuring the rate of decay of luminosity of a phosphorescent gas. The photometer consists of a track 3.5 meters long, made of two brass rods under tension. On the track an electrically controlled carriage runs which carries the standard light. The standard light can be moved away from a screen placed close to a tube containing the phosphorescent gas to points *A*, *B*, *C*, etc. The illumination on the screen from the standard light is thus directly compared with the luminosity of the gas, and comparisons are made at *A*, *B*, *C*, etc., as the gas fades. Seven readings can be made within ten seconds, giving a variation of from $\frac{1}{2}$ to $\frac{1}{25}$ the original intensity of the phosphorescent gas. The entire apparatus is operated electrically, time being registered on a chromograph.

By means of this photometer the law of the rate of decay of phosphorescence for gases has been found. In this case, for air at about 0.1 millimeter gas pressure, the expression is the same as that for the decay of phosphorescent solids, or

$$I = \frac{1}{(a+bt)^2}.$$

Plotting the reciprocal of the square roots of the intensities, in the case of one decay of luminous gas, with the corresponding times gives a perfectly straight line. An application of the law to the grading of the light of a body of phosphorescent gas as great in size as a meteor train shows that the light of the self-luminous meteor train can be explained on the assumption that it is a gas phosphorescence, although the train may be visible for thirty minutes. A certain brightening of the sky around the radiant point at the time of meteor showers which has been called the "auroral light" is also explained by the application of the same law. In the latter case it is evident that the feeble phosphorescing of many trains has combined to give a pale glow in the regions of the heavens through which the shower was taking place.

Professor **Campbell** briefly described the instruments used, methods of standardization and application. The temperature readings obtained at the blast furnace were: Metal, 1375° to 1250° C.; slag, 1425° to 1375°. At the Bessemer converter, 1600° C., very hot blow; 1500° C. cool. Average blows 1550° C. The steel was cast at 1500° to 1460° C. At the Open Hearth the furnace temperatures varied from 1550° to 1705° C., the surface of the bath being 1705°. The steel was cast at 1540° to 1460° C. The temperatures of the gas producers varied greatly, one set averaging 650° C., another over 850° C. The most important readings were taken at the Rail Mill, on the finishing temperatures of steel rails. The readings with the Féry pyrometer varied from 1000° to 1070° C., whilst the Wanner averaged 1100° C.

On motion Professor D. W. Hering of New York University was nominated Vice-President of the Academy for 1908 and Professor William Campbell of Columbia University was elected Secretary of the Section for 1908.

The Section then adjourned.

WILLIAM CAMPBELL,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

OCTOBER 28, 1907.

Section met at 8:15 P. M., Professor Woodworth presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

G. L. Meylan, SOME PHYSICAL CHARACTERISTICS OF COLLEGE STUDENTS.

C. Ward Crampton, PHYSIOLOGICAL AGE.

On motion Dr. Adolf Meyer of the Hospital for the Insane, on Ward's Island, was nominated Vice-President of the Academy for 1908 and Professor R. S. Woodworth of Columbia University was elected Secretary of the Section for 1908.

The Section then adjourned.

R. S. WOODWORTH,
Secretary.

SPECIAL MEETING.

OCTOBER 30, 1907.

Professor William Bateson, M. A., of St. Johns College, Cambridge, England, delivered a public illustrated lecture upon

"THE INHERITANCE OF COLOR IN ANIMALS AND PLANTS."

President Britton presided over the meeting, and the lecture was listened to by an audience of 401 persons.

EDMUND OTIS HOVEY,
Recording Secretary.

BUSINESS MEETING.

November 4, 1907.

The Academy met at 8:15 P. M. at the American Museum of Natural History, Former President Kemp presiding in the absence of President Britton and any Vice-President.

The minutes of the regular meeting of 7 October were read and approved.

There being no business to transact the Academy adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

November 4, 1907.

Section met at 8:20 P. M., Professor J. F. Kemp presiding in the absence of Vice-President Grabau.

Seventy persons were present.

The minutes of the last meeting of the Section were read and approved.

On motion, Professor A. W. Grabau was nominated Vice-President of the Academy and Professor C. P. Berkey was elected Secretary of the Section for 1908.

The following program was then offered:

C. N. Fenner, Notes on the Geology of the First Watchung Trap-Sheet. (By title.)

George F. Kunz and **Henry S. Washington**, On the Peridotite of Pike County, Arkansas, and the Occurrence of Diamonds Therein.

F. A. Perret, Vesuvius, Stromboli and the Solfatara in 1906.

Summary of Papers.

Drs. **Kunz** and **Washington's** paper was illustrated with a very interesting series of specimens and with lantern slides and was followed by a discussion.

Mr. **Perret**, of Naples, Italy, gave an informal talk which was illustrated by a series of beautiful lantern slides and of moving pictures, in a novel representation of volcanic outbursts and rising vapors. On motion by Dr. Hovey, a hearty vote of thanks was given by the Section to Mr. Perret for his unique exhibit.

The Section then adjourned.

ALEXIS A. JULIEN,
Secretary.

SECTION OF BIOLOGY.

NOVEMBER 11, 1907.

Section met at 8:15 P. M., Vice-President Crampton presiding.

The minutes of the last meeting of the Section were read and approved.

After a short business meeting, at which Frank M. Chapman was nominated Vice-President of the Academy and Roy W. Miner was elected Secretary of the Section, for 1908, the following papers were read:

Henry F. Osborn, A PALEONTOLOGICAL TRIP TO NORTHWESTERN NEBRASKA.

Frank M. Chapman, THE PTARMIGAN — LIVING AND DEAD.

Jonathan Dwight, Jr. THE DISTRIBUTION OF THE JUNCOS, OR SNOW BIRDS, ON THE NORTH AMERICAN CONTINENT.

SUMMARY OF PAPERS.

Professor **Osborn** reported upon two excursions, during the seasons of 1906 and 1907, into the Lower Miocene beds of northwestern Nebraska, variously known as Arikaree, Harrison and Rosebud.

The recognition of these beds as containing fauna transitional between the Oligocene and Lower Miocene is due to the successive explorations of Hatcher, Barbour, Peterson, Matthew and Thomson. The lower division (Lower Harrison, Lower Rosebud) is more directly comparable with the true Upper Oligocene of France. The upper division (Upper Harrison, Upper Rosebud) may represent the close of the Oligocene or the beginning of the Miocene, and is sharply defined from the lower division by the absence of certain mammals and the presence of others. The formation as a whole is a very grand one, extending continuously over 200 miles east and west; varying in thickness from 1,200 feet in the west to 800 feet farther east. It is, in fact, one of the most extensive, most readily distinguished, and most definable of the Tertiary series, but it still awaits accurate definition and distinction, especially from overlying beds, partly owing to the fact that it has been embraced under the "Arikaree" which practically includes a considerable part of the Miocene series.

In the region of Agate, Sioux County, Neb., the first discoveries of fossils were made by Mr. James H. Cook and his son, Mr. Harold Cook. This region has been especially explored by Carnegie Institution parties under Mr. O. A. Peterson and Mr. W. H. Utterback. The Monroe Creek, Lower Harrison, and Upper Harrison divisions are very distinctly separated from each other geologically and faunistically. The remarkable deposit known as the "Agate Spring Quarry" is about forty feet below the summit of the Lower Harrison and its fauna, and has been especially described by Mr. Peterson. This is on the same level as the Dæmonelix Beds of Barbour, and is characterized by the presence of *Moropus, Syndyoceras, Oxydactylus, Diceratherium* (smaller and larger species), *Parahippus, Blastomeryx, Dinohyus, Thinohyus* and *Promerycochœrus*. *Steneofiber*, a castoroid, is quite abundant and is frequently found in the Dæmonelix spirals. The origin of these spirals still remains a very difficult problem. The Upper Harrison is sharply defined by the appearance of the large *Merycochœrus* in the upper levels, by the presence of cameloids of three or four types. *Dinohyus* persists in the lower levels but disappears above.

A more exact determination of the geological and faunal characters of these beds will mark a great advance in our knowledge of the Tertiary series.

A fine series of lantern slides illustrated the paper.

Mr. **Chapman** said, in abstract: Both the distribution and color of ptarmigans are of special interest. In distribution, we have a circumpolar group extending its range southward on the Arctic Alpine summit of mountain ranges with isolated groups (for example *Lagopus mutus*, in the Alps and Pyrenees, and *Lagopus leucurus*, in the Rocky Mountains of Colorado and New Mexico) occupying restricted areas at the south, which it is probable they reached at some time during the Glacial Period. The fact that the birds of these south Alpine islands are specifically like their representatives at the north indicates absence of differentiation since their isolation, and consequent great stability of color characters.

The ptarmigan's seasonal changes of plumage were described at length and were said to furnish one of the most conclusive proofs of the necessity for protective coloration known among birds.

Particular attention was called to the transitional autumn plumage which, in defiance of the laws of molt, is interpolated between the known summer plumage and the white winter plumage to carry the bird from the end of the nesting season to the season of snowfall in October. If the winter plumage were to be acquired at the end of the nesting season, when molt is apparently a physiological necessity, the bird would be white before the coming of snow.

All the changes in plumage, it was asserted, were accomplished by actual feather loss and growth, no basis being observed for the theory of change of color in the individual feather.

The paper was illustrated with specimens and a series of slides showing the White-tailed Ptarmigan and its haunts on the summits of the Canadian Rockies in Alberta.

Dr. **Dwight** said in brief: The birds of the genus *Junco* are widely distributed, occupying in the breeding season the whole of Canada, the higher parts of the Appalachian, Rocky and Coast ranges of mountains, and the pine forests of Mexico and Central America. They fall quite naturally into several large groups that differ widely in plumage and are also farther divisible into lesser groups that possess characters more or less intermediate. Intergradation between the various forms seems to be complete and one view is to consider them all geographical races of one species, but a view more in harmony with the apparent facts, is to recognize several of the groups as species and to consider the intermediates either as hybrids or as races, or perhaps as both. A blackheaded junco, for instance, would seem to be specifically distinct from a redheaded bird, because each possesses a character not found in the other, while mere color variations, attributable to climatic conditions, point to geographical races.

Whether Mendelian principles will or will not explain the complicated plumage characters of the juncos, here at least there seems to be a promising field for experimental research to supplement the facts derived from field study.

The paper was illustrated by a large series of specimens brought together by Dr. Dwight for his investigations, and representing collections in all parts of the country.

The Section then adjourned.

Roy Waldo Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

NOVEMBER 18, 1907.

Section met at 8: 15 P. M., Vice-President Trowbridge presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

D. W. Hering, WAVES AND RAYS IN PHYSICS.
E. F. Kern, ELECTROLYSIS OF SILICO-FLUORIDE SOLUTIONS.
R. F. Böhler, TOOL-STEEL MAKING IN STYRIA.

SUMMARY OF PAPERS.

Dr. **Hering** pointed out the extent to which waves or rays have dominated in explaining the transmission of a disturbance through space, as many as seven different kinds of waves having been employed, and no less than twenty-one different kinds of rays. The most fruitful generalization was Fourier's analysis of wave motion in his "Théorie Analytique de la Chaleur"; the boldest contention was that of Fresnel in advocating transverse vibration to produce waves of light; the most recent and comprehensive generalization was Maxwell's electromagnetic theory of light. The recent great increase in the number and variety of "rays" has been attended by a great deal of charlatanism.

Dr. **Böhler** reviewed the development of Styrian steel trade from prehistoric and Roman times up to our own days. The paper emphasized a number of special features characteristic of Styrian steel which are so many reasons for its superiority: (1) Crucibles used but once, (2) extreme purity of ores, (3) extensive or exclusive use of charcoal, (4) special skill of workmen in hammer- and heat-treatment.

The works, founded 1446, are now decidedly up-to-date; have pyrometric control; electric melting and hardening furnaces; latest physical testing methods, metallography.

As a consequence extensive use of Styrian steel in the five continents, for tools, rifles, shells, etc., also field guns, motor cars. Hundreds of tons of high-speed steel shipped to the United States yearly.

Dr. **Kern** first of all took up the preparation of the electrolytes, current density, etc., and showed numerous specimens including metallic surfaces of lead, nickel, iron, copper and silver deposited from silico-fluoride and other solutions for comparison. The method on a commercial scale for the purification and desilverization of lead is employed at Trail, B. C., and elsewhere.

The Section then adjourned.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

November 25, 1908.

Section met, in conjunction with the New York Branch of the American Psychological Association, at 3:30 P. M. at the Psychological Laboratory, Schermerhorn Hall, Columbia University, and at 8:15 P. M. at the American Museum of Natural History, Professor MacDougall presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Afternoon Session.

Edward L. Thorndike, Memory for Paired Associates.

G. H. Betts, Correlation of Visual Imagery with College Standing.

E. W. Scripture, Experiments on the Subconscious, with Demonstration of Jung's Method of Detecting Emotional Complexes.

J. Carleton Bell, Effect of Suggestion upon the Reproduction of Triangles and of Point Distances.

F. L. Tufts, A New Spectro-photometer for the Study of Color Vision.

J. McKeen Cattell, The Entoptic Fovea.

F. Lyman Wells, The Tapping Test.

Evening Session.

W. M. Wheeler, On Some Vestigial Instincts in Insects.

E. W. Scripture, Detection of the Emotions by the Galvanometer.

W. P. Montague, Misconceptions of Intensity.

D. S. Miller, Applied Philosophy and Applied Psychology.

Summary of Papers.

Professor **Thorndike** reported some work on memory for paired associates, in which he has found that German-English vocabularies can be learned with a speed far in excess of what is regarded as possible in the usual teaching of a foreign language, and retained much better than would be expected from the results of Ebbinghaus on nonsense material.

Mr. **Betts** said that in studying the correlation of visual imagery with college standing, he had been unable to detect any positive correlation. The relation seems to be a purely chance one.

After mentioning his own early experiments on the association of ideas, Dr. **Scripture** described some work he had lately done with Dr. Jung in the Psychiatrical Institute at Zurich, in which, following Jung's method, the subject gives associates with given words; the time is taken, and the subject is also required afterwards to repeat his former associations from memory. The presence of an emotional complex is indicated by slowness, forgetfulness, superficiality or unusualness of associates, etc. The emotional complexes so revealed are often causes of mental depression, anxiety, excitability, neurasthenia and hysteria. Contrary to Jung, the speaker did not believe them causes also of *dementia precox*.

Dr. **Bell** reported his experiments on the effect of suggestion upon the reproduction of triangles and of point distances. The subject was required to reproduce the height of a given triangle, for instance, in the presence of figures higher or lower than the required height. In the first third of the experiments each of the six observers gave evidence of being influenced by both high and low suggestion, the low being the more effective. There were striking individual differences in the susceptibility to suggestion. As the experiments proceeded, the observers seemed to become habituated to the suggestion, so that the effect grew less and less marked.

Professor **Tufts** said in abstract: The problem of determining the relative luminosity of lights of differing color is fraught with difficulty. Three methods have been used, but as they do not give perfectly concordant results, each depends on its own definition of what shall be regarded as equal luminosity. The three definitions are the following: (1) Two similar surfaces, illuminated by two lights of different color, may be said to be of equal luminosity if, in the judgment of the observer, they appear equally luminous. (2) Two similar surfaces, white, with black markings on them, illuminated by two lights of different color, may be said to be of equal luminosity if, when placed at the same distance from the eye, the details can be distinguished with the same minuteness. (3) Two similar surfaces, illuminated by two lights of different color, are said to be of the same luminosity if, on rapidly replacing one by the other before the eye, there is no sensation of flickering. The author has modified the flicker photometer of Rood so as to use spectral colors. A white disk, rotating between the telescope and the prism of a spectroscope, is cut away for half of its circumference, so as to admit the colored ray from the prism for half of the time, while for the other half it reflects white light from a lamp the distance of which is adjustable along a photometer bar. By moving the lamp along the bar a point is found at which there is no flicker between the white and the colored lights. In this way the luminosity of different parts of the spectrum can be determined with reference to a given white. The relative luminosity of different parts of the spectrum was not changed by fatiguing the eye to one color. Though the eye be fatigued to green by several minutes' exposure to it, so that gray objects appear purple, yet the green of the spectrum has the same luminosity relatively to the other parts of the spectrum as when the eye is fresh. (An exception must be made to this statement, in the case of prolonged exposure to red; if this exposure is not simply long enough to give the complementary after-image, but is continued for a considerable number of minutes, the effect is to displace the point of maximum luminosity towards the violet.) This seems good evidence of the separateness of the luminosity and color senses. Another fact bearing in the same direction is that the luminosity curve of red-green blind eyes shows no constant deviation from the curve for normal eyes. The color-blind eyes so far examined do indeed show luminosity curves differing from that obtained from the majority of normal eyes, but the deviations are in some cases in one direction, in others in the opposite; and some eyes which are apparently normal in color vision have similar deviations from the curve obtained from the majority.

Professor **Cattell** said in abstract: The usual method of demonstrating the fovea entoptically, by looking through a blue glass or a chrome alum solution, fails with many individuals. But if the glass is removed after a few seconds, an after-image effect shows the fovea clearer than the background; and this is more readily seen than the effect while the blue screen is before the eye. The explanation of the effect is probably that the yellow spot abs rbs much of the blue light, so that that part of the retina is less fatigued than the surrounding region.

Dr. **Wells** communicated a study of the maximum rate of repeated voluntary movements during and at the limit of practise in one normal individual, with comparative reference to the performance in other normal and in pathological subjects. The maximum rate has little, if any, relation to subjective feeling of efficiency. The practise curve shows less diurnal variation in its earlier than in its later stages. The general effect of practise from day to day is to increase initial efficiency, while the general effect of the "warming up" in a single day's work is to give relative immunity to fatigue. As a psychological measure, the maximum tapping rate is of little importance compared with the curve of the fatigue losses. The general interpretation of the tapping test is as yet far from clear; most of its phenomena, however, are probably of nervous rather than muscular origin.

Professor **Wheeler** in his paper gave many instances of the reappearance, under unusual conditions, of instincts which had been active ancestrally, but had disappeared. An instinct which seems dead in the species may thus be resuscitated and serve a useful purpose.

Dr. **Scripture** demonstrated a method for the detection of the emotions by the galvanometer. The subject held his hands on large plate electrodes, and after the beam reflected from the mirror of the galvanometer had come to rest, emotions aroused in the subject would cause deflection. Reviewing the original discovery of Tarchanoff and the recent work of Peterson and Jung, the speaker concluded that the cause of the deflection lay in an increased activity of the sweat glands.

Professor **Montague** in his paper maintained that intensities are true quantities, since they are susceptible not only of the relation of more and less, but also of the relation of whole and part. The component parts of an intensive quantity are synthesized by "superposition," and not, as in the case of extensive quantities, by "juxtaposition." It is usually supposed that intensive quantities are simple and without parts. This misconception results from a failure to see that superposition is as truly an additive synthesis as is juxtaposition. The paper gave examples of the addition of several types of intensities, such as velocity, density, temperature and pain. The fundamental rule for the addition of intensities is: So combine the quantities as to keep the extensive factors of the whole equal to the extensive factors of each of its parts. For example, if two densities are to be added, the volume of the sum must be equal to the volume of each of the components. This could only be accomplished by superposing one volume upon another in such a way as to make them interpenetrate. The rule for adding intensities has its analogue in the rule for adding extensive quantities, according to which we are bidden to combine the quantities in such a way as to keep the intensive factors of the whole equal to the intensive factors of each part.

Professor **Miller** devoted himself mainly to the consideration of the various psychological methods by which habit and character can be altered. He mentioned, among such methods, practise, hypnotic suggestion and attraction.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

DECEMBER 2, 1907.

The Academy met at 8:25 P. M. at the American Museum of Natural History, President Britton presiding.

The minutes of the regular meeting of 4 November were read and approved.

The following candidates for election as Active Members, recommended by the Council, were duly elected:

Gano Dunn,	115 West 71st Street,
Charles P. Berkey,	Columbia University,
Samuel H. Bishop,	500 West 122nd Street,
Frederick M. Pedersen,	452 West 144th Street.

The Recording Secretary gave notice of the Annual Meeting of the Academy to be held at the Hotel Endicott at 7 P. M., Monday, 16 December.

The Academy then adjourned.

EDMUND OTIS HOVEY,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

DECEMBER 2, 1908.

Section met at 8:40 P. M., Professor J. F. Kemp presiding, in the absence of Vice-President Grabau.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

C. N. Fenner, NOTES ON THE GEOLOGY OF THE FIRST WATCHUNG TRAP SHEET.

A. W. Grabau, PREGLACIAL DRAINAGE IN CENTRAL NEW YORK.

SUMMARY OF PAPERS.

Mr. **Fenner** specially discussed in his paper the features indicative of physiographic conditions at the time of the trap extrusions in the New Jersey area. Inquiry was made into the conditions of deposition of the Newark beds immediately underlying the First Watchung trap. Many features were found indicative of shallow water or wind formation, and the conclusion was reached that the beds were of continental origin.

The structure of the trap sheet was then taken up, and several peculiar features of structure and texture were described, which are believed to show that a portion of the trap flow covered a lake bed lying in the axis of the continental trough, and other various portions spread over the adjacent shores, and the various facies of the trap are explained upon this theory.

The Section then adjourned.

Alexis A. Julien,
Secretary.

SECTION OF BIOLOGY.

December 9, 1907.

Section met at 8:15 P. M., Vice-President Crampton presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Thomas Hunt Morgan, The Effects of Centrifuging the Eggs of the Mullusc *Cumingia.*

Raymond C. Osburn, The Replacement of an Eye by an Antenna in an Insect.

Herbert Lang, A Naturalist in British East Africa.

Summary of Papers.

Professor **Morgan's** paper was, in abstract, as follows: Experiments were carried out in order to discover if the cleavage pattern in a type with "determinate cleavage" is governed by the distribution of the visible substances of the egg, and also to discover if the formation of the embryo is possible when the visible inclusions ("organ forming substances") of the protoplasm are artificially shifted.

The eggs of *Cumingia* when laid contain the first polar spindle in the center of the egg. The centrifugal force drives the scattered yolk granules to one pole, the pinkish pigment to the opposite pole. Between these two there remains the perfectly clear kinetoplasm, in which the spindle lies, forming an angle with the induced stratification. Its original position has, in fact, been little affected by the movement of the other substances through the egg, although its polar rays may suffer to some extent by prolonged centrifuging. Under the pink cap and concealed by it in the living egg is a vesicular material that is the nuclear sap of the ovarian egg. The polar bodies may appear at any point of the surface of the egg, so far as the location of the three zones is concerned. It is probable that the spindle comes to the same pole as in the normal egg. Since the eggs are not oriented as they fall any one of the three kinds of materials may lie at the "animal pole."

The cleavage always begins beneath the polar bodies, as in the normal egg, and the cleavage pattern, the size of the cells, and their tempo of division are exactly that of the normal. All of the yolk, for example, may be contained in the small cell of the first two, yet the size of this cell and its rate of division are not thereby affected.

It follows that in this egg the determinate type of cleavage is not caused by the distribution of the visible substances of the egg. Sections show that between the time of centrifuging and the appearance of the cleavage planes the induced distribution is to a large extent retained, the amount of disturbance depending on the length of time elapsing and on the location of the polar spindle, etc. The results confirm observations on the living egg, and show that the yolk or the pigment may go largely or entirely to one of the first formed cells.

The centrifuged eggs produce swimming embryos, and in some cultures a large percentage of such embryos. Until isolation experiments have been successfully carried out it is necessary to speak with some reserve concerning the percentage of normal embryos.

In the sea urchin egg, Lyon has shown that the cleavage follows the induced stratification, while in *Cumingia* this is not the case. The difference is due to the shifting of the nucleus in the egg of the sea urchin, while the spindle in *Cumingia* retains its original orientation.

Dr. **Osburn** said, in brief: The specimen in question is a male of *Syrphus arcuatus* Fallén (Diptera), a common and widely distributed species, and was collected at Montreal, Canada, by Mr. G. Chagnon who noted nothing unusual in its behavior. The right side of the head is normal, but on the left side the large compound eye is entirely wanting. A third antenna appears on this side of the head posterior to the normal left antenna and entirely separated from it, occupying a fossa of its own. It is normal in structure except that the arista, or dorsal bristle, is undeveloped, and it is slightly smaller than the normal ones. This condition calls to mind Herbst's experiments in Crustacea (*Palæmon, Sicyonia*) where an antenna developed in regeneration after the excision of the eye, but no similar case is known among insects as far as the writer is aware. It is possible that the eye may have been suppressed owing to some accident during metamorphosis and that the antenna was produced in place of it. A second vertical triangle also appears in this specimen alongside of the normal one. This supernumerary triangle is similar to the normal in pilosity and in the arrangement of the ocelli, but the anterior median ocellus has no cornea and is represented merely by a small prominence.

Lantern slides were also exhibited showing views of a two-headed turtle with many abnormalities in the carapace and plastron.

Mr. **Lang** said that the Tjäder Expedition to British East Africa was undertaken for the purpose of collecting material representing the fauna of that region. From Mombasa, the expedition (which consisted of Mr. Richard Tjäder and Mr. Lang, accompanied by 100 negro porters) proceeded 327 miles inland by the Uganda Railroad to Nairobi. A strip of territory one mile on either side of the railroad is set aside as a government game preserve, and is a place of refuge for mixed herds of antelopes, zebras and ostriches.

After spending a month collecting with great success on the Athi Plains, the expedition moved northwest into the Rift Valley, encamping at Kijabe and at various points in the lake country.

Thence the course was southeast over the Laikipia Plateau to Mount Kenia (18,000 feet), which the party ascended to a height of 14,000 feet. Lack of provisions, however, compelled a return to the railroad, whence the party proceeded to the coast, stopping to collect at intervals.

Four and a half months' collecting netted the expedition a total of about 500 skins of birds and mammals. The most noteworthy of the latter was the skin and skeleton of a fine bull elephant carrying 160 pounds of ivory, 4 rhinoceroses, 1 buffalo, 2 giraffes, one of which is unusually large, 8 zebras representing different districts, and a fine series of antelopes. Lions, spotted hyenas, aard-wolves and other carnivores were also taken. Mr. Lang also secured a remarkable series of photographs illustrating the flora, fauna and ethnology of the region. The talk was well illustrated with colored lantern views.

The section then adjourned.

Roy Waldo Miner,
Secretary.

ANNUAL MEETING.

December 16, 1907.

The Academy met for the Annual Meeting on Monday, December 16, 1907, at 7: 20 P. M., at the Hotel Endicott, President Britton in the chair.

The minutes of the last Annual Meeting, 17 December, 1906, were read and approved.

The accompanying reports were presented for the Corresponding Secretary, Recording Secretary, Librarian and the Editor, all of which were, on motion, received and placed on file.

The Treasurer's report was read and was, on motion, received and referred to the Finance Committee for auditing.

The following candidates for Honorary Membership and Fellowship, recommended by Council, were duly elected:

Honorary Members.

Dr. James Ward, Professor of Mental Philosophy in the University of Cambridge, England.

Professor J. D. Hooker, late Director of the Royal Botanical Gardens, Kew, England,

William Bateson, M. A., Professor of Zoölogy in the University of Cambridge, England.

Fellows.

William Campbell, Ph. D.,	Columbia University,
A. H. Elliott, Ph. D.,	4 Irving Place,
L. P. Gratacap,	Am. Mus. Nat. Hist.,
Robert T. Hill,	25 Broad Street,
Isaac Adler, M. D.,	22 East 62nd Street,
Emerson McMillin,	40 Wall Street,
Herman Knapp, M. D.,	26 West 40th Street,
John B. Smith,	New Brunswick, N. J.,
Ernest E. Smith, M. D.,	26 East 29th Street,
Horace White,	18 West 69th Street.

The Academy then proceeded to the election of officers for the year 1908, Mr. Frank M. Chapman and Professor Charles Baskerville having been appointed as tellers. The ballots prepared by the Council according to the By-laws were distributed, and after the votes had been counted the following officers were declared unanimously elected, more than twenty-five votes having been cast by members of the Academy entitled to vote:

President, Charles F. Cox.

Vice-Presidents, A. W. Grabau (Section of Geology and Mineralogy), Frank M. Chapman (Section of Biology), D. W. Hering (Section of Astronomy, Physics and Chemistry), Adolf Meyer (Section of Anthropology and Psychology).

Recording Secretary, Edmund Otis Hovey.

Corresponding Secretary, Henry E. Crampton.

Treasurer, Emerson McMillin.

Librarian, Ralph W. Tower.

Editor, Edmund Otis Hovey.

Councilors (to serve 3 years), Charles Lane Poor, William J. Gies.

Finance Committee, Charles F. Cox, George F. Kunz, Frederick S. Lee.

On motion of the Treasurer, Emerson McMillin, it was voted that hereafter the fiscal year for the preparation of reports end on the 30th day of November in each year.

The members of the Academy and their friends, to the number of seventy, then sat down together at dinner, after which the retiring President, Professor Nathaniel L. Britton, delivered his formal address upon "The New York Botanical Garden — Its Organization and Construction." The address was illustrated with stereopticon views.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the past year two Honorary Members were dropped from the rolls, because they had not been heard from since 1901 in response to communications, and twelve Corresponding Members have been dropped for the same reason.

We have lost by death three Corresponding Members, as follows:

George Chapman Caldwell,	Elected	in	1876,
N. H. Chandler,	"	"	1876,
Charles B. Warring,	"	"	1876.

There are at present forty-seven Honorary Members and one hundred forty-six Corresponding Members upon our rolls.

Respectfully submitted,

RICHARD E. DODGE,
Corresponding Secretary.

REPORT OF THE RECORDING SECRETARY.

During the year 1907, the Academy held 8 business meetings and 25 sectional meetings, at which 84 stated papers, 3 lectures and 8 demonstrations were presented on the following subjects:

Geology,	16	papers,	1 lecture,
Mineralogy,	2	"	
Biology,	7	"	1 "
Entomology,	2	"	
Ornithology,	2	"	
Embryology,	3	"	
Paleontology,	2	"	
Physics,	8	"	8 demonstrations,
Zoölogy,	1	"	1 lecture,
Botany,	4	"	
Ethnology,	4	"	
Archæology and Anthropology,	7	"	
Psychology,	26	"	

At the present time, the Membership of the Academy includes 500 Active Members, 19 of whom are Associate Active Members and 122 Fellows. There have been 8 deaths during the year, 16 resignations and one member has been dropped for non-payment of dues. The new members elected during the year number 84. As the Membership of the Academy a year ago was 441, there has been a net gain of 59 during 1907.

The affiliation of the following societies,

The Linnæan Society of New York,
The Torrey Botanical Club,
The New York Entomological Society,
The New York Microscopical Society,
The New York Mineralogical Club,
The Brooklyn Entomological Society,

which became operative just before the last annual meeting, and which was mentioned in the last annual report, has worked smoothly during the year, and the announcements and programs of the various meetings have appeared regularly in the weekly *Bulletin* issued by the Academy. In connection with this affiliation, it is proper to speak of the fact that three public lectures by noted foreign scientists have been given at the Museum to the Members of the Academy and the Affiliated Societies and their friends. These lectures were as follows:

April 29.— "Vesuvius and Its Eruptions." By Dr. Tempest Anderson, of York, England. Attendance, 259.

September 9.— "Wild Animal Life of Australia." By Dr. D. Le Soüef, of Melbourne, Australia. Attendance, 107.

October 30.— "The Inheritance of Color in Animals and Plants." By Professor William Bateson, M. A., of Cambridge, England. Attendance, 401.

Another matter of importance in connection with the affiliation was the issuing of the first number of the Annual Directory containing the names and addresses of the Members of all the organizations, corrected to 31 March, 1907.

The first important event of the past fiscal year was the holding, on 28 and 29 December, 1906, in coöperation with the American Museum of Natural History, of an exhibition of the progress of science. The exhibition was well supported by scientists and others having material to exhibit within the scope of the enterprise, and was attended by thousands of visitors. It was maintained by the Museum for four weeks after the Academy ceased to control it.

The second event of particular importance was the celebration, on 23 May, of the two hundredth anniversary of the birth of the Swedish naturalist, Linnæus. Delegates from many important domestic societies were present; valuable addresses were delivered at the American Museum of Natural History, the Museum of the New York Botanical Garden, the Museum of the Brooklyn Institute of Arts and Sciences; a bridge over the Bronx River was dedicated to Linnæus, and a reception to the scientific public was held at the New York Aquarium. Communications were received from many foreign and domestic societies. The full account of the celebration, which forms a volume of about one hundred printed pages, is now in press.[1]

Announcement is made with regret of the loss by death of the following Members:

---

[1] Issued as part I of Volume XVIII of the Annals.

Samuel Sloan,	Patron and Member for many years,
D. Willis James,	Active Member for 31 years,
John E. McDonald,	Active Member for 2 years,
John Murray Mitchell,	Active Member for 21 years,
L. M. Underwood,	Active Member for 9 years.

Respectfully submitted,

EDMUND OTIS HOVEY,
Recording Secretary.

REPORT OF THE LIBRARIAN.

The new accessions from December 13, 1906, to December 14, 1907, have been 423 volumes, 1,752 numbers and 46 pamphlets. Special acknowledgments should be returned to the Berliner Entomologische Verein for the first 48 volumes of their Zeitschrift and to the Kaiserliche Akademie der Wissenschaften in Wien for 30 volumes of their Sitzungsberichte. Other lacunæ in smaller amounts but of great scientific value have been received from the respective Societies and Academies. The usefulness of the library has been enhanced by the binding of many of the important serials.

Respectfully submitted,

R. W. TOWER,
Librarian.

REPORT OF THE EDITOR.

The Editor reports that Part II of Volume XVII of the Annals was distributed in September, 1907. This Part contained the following articles:

"The Origin of Vertebrate Limbs." By Raymond C. Osburn.

"The Orders of Teleostomous Fishes." By William K. Gregory.

"A Peridotite Dike in the Coal Measures of Southwestern Pennsylvania." By J. F. Kemp and J. G. Ross.

A Contribution to the Geology of Southern Maine. By I. H. Ogilvie.

Part III of Volume XVII, containing the records of the Recording Secretary for 1905, special indexes to the Botanical paper by Dr. Harper, the paper on Fishes by Dr. Gregory, and the general index to the volume is now in the hands of the printer and should be issued shortly. Volume XVII contains 697 pages and 32 plates.

A directory of the Members of the Academy and its Affiliated Societies has been issued.

The printing of Volume XVIII has been begun, and about 130 pages are now in type.

Respectfully submitted,

CHARLES LANE POOR,

Editor.

REPORT OF THE TREASURER.

Dec. 18, 1906.	Cash in bank at beginning of fiscal year		$5,494.11
	Cash received during the fiscal year and reported as follows:		
1907	January 31,	$2,292.36	
	February 28,	894.25	
	March 31,	633.00	
	May 6,	768.50	
	September 30,	15,694.02	
	November 4,	416.25	
	December 2,	103.90	
	December 16,	174.00	20,976.28
	Total cash on hand and received		$26,470.39
	Paid out on vouchers during fiscal year and reported as follows:		
	January 31,	$1,604.56	
	February 28,	4,832.95	
	March 31,	207.33	
	May 6,	223.82	
	September 30,	16,283.66	
	November 4,	203.80	
	December 2,	803.01	
	December 16,	356.44	
	Total disbursements		24,515.57
	Balance on hand		$1,954.82

Recapitulation of deposits:

In Bank of Emerson McMillin & Co.	$512.74	
In Guaranty Trust Company	176.27	
In Union Square Savings Bank	1,256.81	
	$1,954.82	$1,954.82

Respectfully submitted,

EMERSON MCMILLIN,

Treasurer.

THE NEW YORK ACADEMY OF SCIENCES.

BALANCE SHEET, DECEMBER 16, 1907.

Investments	$34,510.00	Permanent Fund	$17,602.75
Cash on hand	1,954.82	Publication Fund	3,000.00
		Audubon Fund	2,285.95
		Building Fund	10,400.00
		Newberry Fund	1,249.21
		Income of Permanent Fund	274.65
		Income of Publication Fund	610.48
		Income of Building Fund	818.96
		Income of Newberry Fund	22.82
	$36,464.82		$36,464.82

Examined and approved

C. F. Cox,
G. F. Kunz, } *Auditing Committee.*
F. S. Lee,

MEMBERSHIP OF THE

NEW YORK ACADEMY OF SCIENCES.

31 December, 1907.

HONORARY MEMBERS.

1887. Prof. Alexander Agassiz, Cambridge, Mass.
1898. Prof. Arthur Auwers, Berlin, Germany.
1889. Prof. Charles Barrois, Lille, France.
1907. Prof. William Bateson, Cambridge, England.
1901. Charles Vernon Boys, London, England.
1904. Prof. W. C. Brögger, Christiania, Norway.
1898. Prof. William K. Brooks, Baltimore, Md.
1887. Rev. Dr. William Henry Dallinger, London, England.
1899. Sir George Howard Darwin, Cambridge, England.
1876. Prof. W. Boyd Dawkins, Manchester, England.
1904. Prof. Hugo de Vries, Amsterdam, Netherlands.
1902. Sir James Dewar, Cambridge, England.
1901. Prof. Emil Fischer, Berlin, Germany.
1876. Sir Archibald Geikie, London, England.
1901. Prof. James Geikie, Edinburgh, Scotland.
1899. Prof. Wolcott Gibbs, Newport, R. I.
1898. Dr. David Gill, Cape of Good Hope, Africa.
1889. Prof. George Lincoln Goodale, Cambridge, Mass.
1894. Dr. Ernst Häckel, Jena, Germany.
1899. Prof. Julius Hann, Vienna, Austria.
1898. Dr. George W. Hill, West Nyack, N. Y.
1907. Dr. J. D. Hooker, Kew, England.
1896. Prof. Ambrosius Hubrecht, Utrecht, Netherlands.
1901. Prof. William James, Cambridge, Mass.
1896. Prof. Felix Klein, Göttingen, Germany.
1898. Dr. E. Ray Lankester, London, England.
1880. Sir Norman Lockyer, South Kensington, England.
1900. Prof. Franz Leydig, Tauber, Germany.
1898. Prof. Fridtjof Nansen, Christiana, Norway.

1891. Prof. Simon Newcomb, Washington, D. C.
1898. Prof. Albrecht Penck, Berlin, Germany.
1898. Prof. William Pfeffer, Leipzig, Germany.
1900. Prof. Edward Charles Pickering, Cambridge, Mass.
1900. Prof. Jules Henri Poincaré, Paris, France.
1901. Dr. William Ramsay, London, England.
1899. Lord Rayleigh, Essex, England.
1898. Dr. Hans H. Reusch, Christiana, Norway.
1887. Sir Henry Enfield Roscoe, London, England.
1887. Geheimrath Heinrich Rosenbusch, Heidelberg, Germany.
1904. Dr. G. Johnstone Stoney, London, England.
1896. Prof. Joseph John Thomson, Cambridge, England.
1900. Prof. Edward Burnett Tylor, Oxford, England.
1904. Prof. Karl von den Steinen, Berlin, Germany.
1876. Prof. Viktor von Land, Vienna, Austria.
1907. Prof. James Ward, Cambridge, England.
1904. Dr. William Wundt, Leipzig, Germany.
1904. Geheimrath Ferdinand Zirkel, Leipzig, Germany.

CORRESPONDING MEMBERS.

1883. Dr. Charles Conrad Abbott, Trenton, N. J.
1898. Prof. Frank D. Adams, Montreal, Canada.
1891. Dr. José G. Aguilera, Mexico City, Mexico.
1890. William DeWitt Alexander, Honolulu, Hawaii.
1899. Dr. C. W. Andrews, London, England.
1876. Prof. John Howard Appleton, Providence, R. I.
1899. Dr. J. G. Baker, Kew, England.
1898. Prof. Isaac Bagley Balfour, Edinburgh, Scotland.
1878. Dr. Alexander Graham Bell, Washington, D. C.
1867. Edward L. Berthoud, Golden, Colo.
1897. Dr. Herbert Bolton, Bristol, England.
1899. Dr. G. A. Boulenger, London, England.
1874. T. S. Brandegee, San Diego, Calif.
1884. Prof. John C. Branner, Stanford University, Calif.
1894. Prof. Bohuslay Brauner, Prague, Bohemia.
1874. Prof. William Brewster, Cambridge, Mass.
1876. Prof. George Jarvis Brush, New Haven, Conn.
1898. Prof. T. C. Chamberlin, Chicago, Ill.
1876. Dr. Frank Wigglesworth Clarke, Washington, D. C.

1891. Prof. L. Clerc, Ekaterinburg, Russia.
1877. Dr. Theodore Comstock, Los Angeles, Calif.
1868. M. C. Cooke, London, England.
1876. Prof. H. B. Cornwall, Princeton, N. J.
1880. Charles B. Cory, Boston, Mass.
1877. Dr. Joseph Crawford, Philadelphia, Pa.
1866. Geheimrath Hermann Credner, Leipzig, Germany.
1895. Prof. Henry P. Cushing, Cleveland, O.
1879. T. Nelson Dale, Pittsfield, Mass.
1870. Dr. William Healey Dall, Washington, D. C.
1885. Prof. Edward Salisbury Dana, New Haven, Conn.
1898. Prof. William M. Davis, Cambridge, Mass.
1894. Pres. Ruthven Deane, Chicago, Ill.
1899. Prof. Charles Déperet, Lyons, France.
1890. Dr. Orville A. Derby, Rio Janeiro, Brazil.
1899. Dr. Louis Dollo, Brussels, Belgium.
1876. Henry W. Elliott, Lakewood, O.
1880. Prof. John B. Elliott, New Orleans, La.
1869. Dr. Francis E. Engelhardt, Syracuse, N. Y.
1879. Prof. Herman LeRoy Fairchild, Rochester, N. Y.
1879. Prof. Friedrich Bernhard Fittica, Marburg, Germany.
1885. Dr. Lazarus Fletcher, London, England.
1899. Prof. Eberhard Fraas, Stuttgart, Germany.
1879. Dr. Reinhold Fritzgartner, Teguicigalpa, Honduras.
1870. Prof. G. K. Gilbert, Washington, D. C.
1858. Prof. Theodore Nicholas Gill, Washington, D. C.
1876. Prof. Daniel C. Gilman, Baltimore, Md.
1865. Prof. Charles A. Goessmann, Amherst, Mass.
1888. Prof. Frank Austin Gooch, New Haven, Conn.
1868. Col. C. R. Greenleaf, U. S. A., San Francisco, Calif.
1883. Dr. Marquis Antonio de Gregorio, Palermo, Sicily.
1877. Prof. Paul Heinrich von Groth, Munich, Germany.
1869. R. J. L. Guppy, Trinidad, B. W. I.
1898. Dr. George E. Hale, Mt. Wilson, Calif.
1882. Baron Ernest von Hesse-Wartegg, Lucerne, Switzerland.
1867. Prof. C. H. Hitchcock, Hanover, N. H.
1900. Dr. William Henry Holmes, Washington, D. C.
1890. Dr. H. D. Hoskold, Buenos Ayres, Argentine Republic.
1896. Prof. J. P. Iddings, Chicago, Ill.
1875. Malvern W. Iles, Dubuque, Ia.
1899. Prof. Otto Jäckel, Berlin, Germany.

1876. Prof. Samuel W. Johnson, New Haven, Conn.
1876. Pres. David Starr Jordan, Stanford University, Calif.
1876. Prof. George A. Koenig, Houghton, Mich.
1899. Dr. Friedrich Kohlrausch, Marburg, Germany.
1888. Baron R. Kuki, Tokyo, Japan.
1890. Prof. Alfred Lacroix, Paris, France.
1876. Prof. John W. Langley, Cleveland, O.
1900. Prof. Albert de Lapparent, Paris, France.
1876. Prof. S. A. Lattimore, Rochester, N. Y.
1890. Col. Aimé Laussedat, Paris, France.
1894. Prof. William Libbey, Princeton, N. J.
1899. Prof. Archibald Liversidge, Sydney, New South Wales.
1876. Prof. George Macloskie, Princeton, N. J.
1876. Prof. John William Mallet, Charlottesville, Va.
1891. Prof. Charles Riborg Mann, Chicago, Ill.
1867. Dr. George F. Matthew, St. John, N. B., Canada.
1874. Charles Johnson Maynard, West Newton, Mass.
1874. Theodore Luqueer Mead, Oviedo, Fla.
1888. Seth E. Meek, Chicago, Ill.
1892. J. de Mendizabal-Tamborrel, Mexico City, Mex.
1874. Dr. Clinton Hart Merriam, Washington, D. C.
1898. Prof. Mansfield Merriam, South Bethlehem, Pa.
1890. Dr. A. B. Meyer, Dresden, Germany.
1900. Prof. Kakichi Mitsukuri, Tokyo, Japan.
1878. Prof. Charles Sedgwick Minot, Boston, Mass.
1876. Prof. William Gilbert Mixter, New Haven, Conn.
1890. Dr. Richard Moldenke, Watchung, N. J.
1895. Prof. C. Lloyd Morgan, Bristol, England.
1864. Dr. Edward S. Morse, Salem, Mass.
1898. George Murray, London, England.
——. Prof. Eugen Netto, Giessen, Germany.
1866. Prof. Alfred Newton, Cambridge, England.
1897. Dr. Francis C. Nicholas, New York, N. Y.
1882. Dr. Henry Alfred Alford Nicholl, Dominica, B. W. I.
1881. Prof. William H. Niles, Boston, Mass.
1880. Dr. Edward J. Nolan, Philadelphia, Pa.
1879. Frederick A. Ober, Hackensack, N. J.
1876. John M. Ordway, New Orleans, La.
1898. Prof. Wilhelm Ostwald, Leipzig, Germany.
1900. Prof. George Howard Parker, Cambridge, Mass.
1876. Stephen F. Peckham, New York, N. Y.

1888. Rev. George E. Post, Beirût, Syria.
1894. Prof. Edward Bagnall Poulton, Oxford, England.
1876. Prof. Albert B. Prescott, Ann Arbor, Mich.
1877. Prof. Frederick Prime, Philadelphia, Pa.
1868. Raphael Pumpelly, Newport, R. I.
1876. Prof. Burton A. Randall, Philadelphia, Pa.
1888. T. Mellard Reade, Liverpool, England.
1876. Dr. Ira Remsen, Baltimore, Md.
1874. Robert Ridgway, Washington, D. C.
1886. Prof. William L. Robb, Troy, N. Y.
1876. Prof. Samuel P. Sadtler, Philadelphia, Pa.
1899. D. Max Schlosser, Munich, Germany.
1867. Prof. Paul Schweitzer, Columbia, Mo.
1898. Prof. W. B. Scott, Princeton, N. J.
1876. Prof. Samuel H. Scudder, Cambridge, Mass.
1894. Prof. W. T. Sedgwick, Boston, Mass.
1876. Andrew Sherwood, Portland, Ore.
1883. J. Ward Smith, Newark, N. J.
1895. Prof. Charles H. Smyth, Jr., Princeton, N. J.
1890. Rev. J. Selden Spencer, Tarrytown, N. Y.
1896. Dr. Robert Stearns, Los Angeles, Calif.
1890. Prof. Walter LeConte Stevens, Lexington, Va.
1876. Prof. Francis H. Storer, Cambridge, Mass.
1885. Rajah Sir Sourindro Mohun Tagore, Calcutta, India.
1893. Dr. J. P. Thomson, Brisbane, Queensland, Australia.
1899. R. H. Traquair, Edinburgh, Scotland.
1877. Prof. John Trowbridge, Cambridge, Mass.
1876. D. K. Tuttle, Philadelphia, Pa.
1871. Prof. Henri Van Heurck, Antwerp, Belgium.
1900. Prof. Charles R. Van Hise, Madison, Wis.
1867. Prof. Addison Emory Verrill, New Haven, Conn.
1890. Brig. Gen. Anthony Wayne Vogdes, U. S. A. (retired), San Diego, Calif.
1898. Dr. Charles Doolittle Walcott, Washington, D. C.
1876. Leonard Waldo, New York, N. Y.
1900. Prof. Sho Watasé, Tokyo, Japan.
1897. Prof. Stuart Weller, Chicago, Ill.
1874. Dr. I. C. White, Morgantown, W. Va.
1898. Prof. C. O. Whitman, Chicago, Ill.
1898. Prof. Henry Shaler Williams, Ithaca, N. Y.
1898. Prof. N. H. Winchell, Minneapolis, Minn.

1866. Prof. Horatio C. Wood, Philadelphia, Pa.
1899. Dr. A. Smith Woodward, London, England.
1869. Dr. Henry Woodward, London, England.
1876. Prof. Arthur Williams Wright, New Haven, Conn.
1876. Prof. Harry Creecy Yarrow, Washington, D. C.

PATRONS.

Britton, N. L., N. Y. Botanical Garden.
Brown, Addison, 45 West 89th Street.
Casey, Major Thomas L., U. S. A., Washington, D. C.
Chapin, Chester W., 34 West 57th Street.
Field, C. de Peyster, 21 East 26th Street.
Gould, Edwin, Dobbs Ferry, N. Y.
Gould, George J., 195 Broadway.
Gould, Miss Helen M., Irvington, N. Y.
Herrman, Mrs. Esther, 59 West 56th Street.
Julien, Alexis A., Columbia University.
Levison, W. Goold, 1435 Pacific Street, Brooklyn.
Mead, Walter H., 67 Wall Street.
Senff, Charles H., 300 Madison Avenue.

ACTIVE MEMBERS.

31 December, 1907.

Fellowship is indicated by an asterisk (*) before the name. Life Membership is shown by heavy-faced type. The names of Patrons are in capitals.

*Abbe, Cleveland, Ph.D.
Adams, Edward D.
*Adler, I., M.D.
Alexander, Chas. B.
Allen, C. H.
*Allen, J. A., Ph.D.
Allen, James Lane
*Allis, Edward Phelps, Jr.
*Amend, Bernard G.
Anderson, A. A.
Anderson, A. J. C.
Anthony, R. A.
Anthony, Wm. A.,
Archer-Shee, Mrs. M.
Arend, Francis J.
Armstrong, S. T., M.D.
*Arnold, E. S. F., M.D.
Astor, John Jacob
Avery, Samuel P., Jr.
Bailey, James M.

Bangs, Francis S.
Barhydt, Mrs. P. H.
Barnes, Miss Cora F.
Barron, George D.
*Baskerville, Prof. C. M.
Baugh, Miss M. L.
Baxter, M., Jr.
Beal, William R.
Bean, Henry Willard
Beard, Daniel C.
***Beck, Fanning C. T.**
Beckhard, Martin
*Beebe, C. William
Beers, M. H.
Beller, A.
Berkey, C. P.
Berry, Edward W.
Betts, Samuel R.
*Bickmore, A. S., Ph.D.
Bien, Julius
*Bigelow, Prof. M. A.
Bigelow, William S.
Bijur, Moses
Billings, Elizabeth
Billings, Frederick
Birdsall, Mrs. W. R.
Birkhahn, R. C.
Bishop, H. R.
Bishop, S. H.
*Blake, J. A., M.D.
Blank, M. I.
***Bliss, Prof. Charles B.**
*Boas, Prof. Franz
Boettger, Henry W.
Boyd, James
*Bristol, Prof. C. L.
Bristol, Jno. I. D.
*BRITTON, PROF. N. L.
*BROWN, HON. ADDISON
Brown, Edwin H.
*Brownell, Silas B.
Bruce, Matilda
*Bumpus, Prof. H. C.
Burr, Winthrop
*Burr, William H.
Bush, Wendell T.
*Byrnes, Miss Esther F.
*Calkins, Prof. Gary N.
*Campbell, William, Ph.D.
Canfield, R. A.
Case, Charles L.
*CASEY, COL. T. L.
*Caswell, John H.
***Cattell, Prof. J. McK.**
Chamberlain, Rev. L. T.
Champollion, Andrew
*Chandler, Prof. C. F.
CHAPIN, CHESTER W.
Chapin, H. D.
*Chapman, Frank M.
*Cheesman, T. M., M.D.
Clarkson, Banyer
Cline, Miss May
Cohn, J. M.
*Collingwood, Francis
Collins, Miss Anna E.
Collord, George W.
Condit, William L.
Constant, S. Victor
Cooper, G. R.
Corning, C. R.
Cowles, David S.
*Cox, Charles F.
*Crampton, Prof. Henry E.
Crane, Zenas
Crawford, Joseph
Cross, George D.
Culgin, Guy W.
*Davenport, Prof. C. B.
Davies, J. Clarence
Davies, William G.
Davis, Charles H.

*Day, William S.
*Dean, Prof. Bashford
De Coppet, E. J.
De Forest, Robert W.
Degener, R.
Delafield, Maturin L., Jr.
Delano, Warren, Jr.
De Milhau, Louis J.
Demorest, William C.
De Puy, Henry F.
Devereux, Walter B.
Devoe, Frederick W.
DeWitt, William G.
Dickerson, Edward N.
Diefenthäler, C. E.
Dimock, George E.
Dix, Rev. Morgan, S. T. D.
Dodge, Rev. D. Stuart, D.D.
*Dodge, Prof. Richard E.
Dodge, Miss Grace
Doherty, Henry L.
Donald, James M.
*Doremus, Prof. Chas. A.
Douglas, James
Douglass, Alfred
Draper, Mrs. M. A. P.
Drummond, Isaac W., M.D.
*Dudley, P. H., Ph.D.
*Dunham, E. K., M.D.
Dunn, Gano
Dunscombe, George E.
Du Pont, H. A.
Durand, John S.
*Dutcher, William
Dwight, J., Jr., M.D.
Dwyer, Thomas
Eickemeyer, Carl
***Elliott, Prof. A. H.**
Emanuel, John H., Jr.
Emmet, C. Temple
Eno, J. C.
Eno, William Phelps
Enrich, Mrs. J. S.
Escobar, Francisco
Estabrook, A. F.
Evans, Samuel M., M.D.
*Eyerman, John
Fairchild, Charles S.
Fallon, G. W. R.
Fargo, James C.
Farmer, Alexander S.
*Farrand, Prof. Livingston
Ferguson, Mrs. Farquhar
Ferguson, H. B., M.D.
FIELD, C. DEPEYSTER
Field, William B. Osgood
*Finley, John H.
*Fishberg, Maurice, M.D.
*Flexner, Simon, M.D.
Flint, C. R.
Foot, James D.
Ford, James B.
Fordyce, J. A.
Forster, William
Foxworthy, Dr. F. W.
Freund, Emil
Frissell, A. S.
Gade, William F.
Gallatin, Frederick
Gibson, R. W.
*Gies, Prof. William J.
Gordon, Clarence E.
GOULD, EDWIN
GOULD, GEORGE J.
GOULD, MISS HELEN M.
*Grabau, Prof. A. W.
*Gratacap, Louis P.
Greefe, Ernest F.
*Gregory, W. K.
Griggs, G.
Griscom, C. A.
Guggenheim, W.

von Hagen, Hugo.
Hague, James D.
Halls, William
Hammond, James B.
Harriman, E. H.
Haupt, Louis, M.D.
Havemeyer, William F.
Heinze, Arthur P.
Heller, Max
*Hering, Prof. D. W.
HERRMAN, MRS. ESTHER
*Herter, C. A., M.D.
Hess, Selmar
Hewlett, Walter J.
Higginson, J. J.
*Hill, Robert T.
Hinchman, Mrs. C. S.
Hirsch, Charles S.
*Hitchcock, Miss F. R. M.
Hodenpyl, Anton G.
Hoe, Robert
Hoffman, Mrs. E. A.
*Hollick, Arthur, Ph.D.
Holst, L. J. R.
Holt, Henry
Hopkins, George B.
Hoppin, W. W.
*Hornaday, William T.
***Hovey, E. O., Ph.D.**
*Howe, Prof. Henry M.
*Howe, M. A., Ph.D.
Hubbard, Thomas H.
Hubbard, Walter C.
Hughes, Charles E.
Hulshizer, J. E.
Hunt, Joseph H., M.D.
Huntington, Archer M.
Hustace, Frank
Huyler, John S.
Hyde, B. Talbot B
Hyde, E. Francis
Hyde, Frederic E., M.D.
Hyde, Henry St. J.
Iles, George
*Irving, Prof. John D
Irving, Walter
von Isakovics, Alois
*Jacobi, Abram, M.D.
*Jacoby, Prof. Harold
James, D. Willis
Jarvie, James N.
Jennings, R. E.
Jesup, Morris K.
Jones, Dwight A.
*JULIEN A. A., Ph.D.
Kahn, O. H.
***Kemp, Prof. James F.**
Kennedy, J. S.
Kenyon, W. H.
Keppler, Rudolph
Kessler, George A.
Klar, A. Julien
*Knapp, Herman, M.D.
Kohlman, C.
*Kunz, G. F., M.A., Ph.D.
de Lagerberg, J.
***Lamb, Osborn R.**
Lambert, Adrian S.
Langdon, Woodbury G.
Langeloth, J.
*Langmann, Gustav, M.D.
Lawrence, A. E.
Lawrence, John B.
Lawton, James M.
Leao, F. Garcia P., M.D.
*Ledoux, A. R., Ph.D.
*Lee, Prof. Frederick S.
Lefferts, Marshall C
Leib, J. W.
*LEVISON, W. G.
Levy, Emanuel
Lichtenstein, Paul

*Linville, H. R., Ph.D.
Loeb, James
*Loeb, Prof. Morris, Ph.D.
Lounsberry, R. P.
Low, Hon. Seth, LL.D.
*Lucas, Fred. A.
*Luquer, Prof. Lea McI.
*Lusk, Prof. Graham
Luttgen, Walther
Lyon, Ralph
McCook, Col. J. J.
McDonald, John E.
McKim, Rev. Haslett
*__McMillin, Emerson__
*MacDougall, Prof. R.
Mack, Jacob W.
Macy, Miss M. S.
Macy, V. Everitt
Mager, Robert F.
Mann, W. D.
Marble, Manton
Marcou, John B.
Marling, Alfred
Marshall, Louis
Marston, E. S.
Martin, Bradley
*Martin, Prof. D. S.
*Martin, T. C.
Martin, W. M.
*__Matthew, W. D., Ph.D.__
Maxwell, Francis T.
MEAD, WALTER H.
Meigs, Titus B.
Mellen, C. S.
*Meltzer, S. J., M.D.
Merriam, H. F.
*Merrill, F. J. H., Ph.D.
Metz, Herman A.
*Meyer, Adolf, M.D.
Meyer, T. C.
Milburn, J. C.
Miller, George N., M.D.
*Miner, Roy Waldo
Mitchell, Arthur M.
Mitchell, Edward
Morewood, George B.
Morgan, J. Pierpont
*Morgan, Thos. H.
Morris, Lewis R.
Mortimer, W. G., M.D.
Myers, Joseph G.
Nimick, Mrs. A. K.
Nunn, R. J.
Oakes, Francis J.
O'Brien, J. M.
Obrig, Adolph
Ochs, A. S.
Oettinger, P. J., M.D.
*__Ogilvie, Miss Ida H., Ph.D.__
Olcott, E. E.
Olcott, Mrs. E. E.
Olmsted, Mrs. C. T.
*__Osborn, Prof. Henry F.__
Osborn, William C.
Owen, Miss Juliette A.
Owens, W. W.
Paddock, Eugene H.
Paine, A. G , Jr.
Painter, H. McM., M.D.
Parish, Henry
*Parker, Prof. H. C.
Parsell, Henry V. A.
Parsons, Mrs. Edwin
*Parsons, John E.
Patton, John
Peale, Rembrandt
Pearsall, F. W.
Pedersen, F. M.
*Pellew, Prof. C. E.
Pennington, William
Perkins, William H.
Perry, Charles J.

*Peterson, F., M.D.
*Petrunkewitsch, A.
Pettigrew, David L.
*Pfister, J. C.
Phipps, Henry
Phoenix, Lloyd
Pickhardt, Carl
Pierce, Henry Clay
*Pinchot, Gifford
*Pitkin, Lucius, Ph.D.
Planten, J. R.
Poggenburg, H. F.
*Poor, Prof. Charles L.
Poor, Henry W.
Porter, Eugene H.
Post, Abram S.
*Post, C. A.
*Post, George B.
*Prince, Prof. J. D.
Procter, William
Proctor, George H.
*Prudden, Prof. T. M., M.D.
*Pupin, Prof. M. I.
Pyne, M. Taylor
Quackenbos, Prof. J. D.
Quintard, Edward
Reilly, F. James
Richardson, Frederick A.
*Ricketts, Prof. P. de P.
Riederer, Ludwig
Riker, Samuel
Riley, R. Hudson
Robb, Hon. J. Hampden
Robert, Samuel
Roberts, C. H.
Rogers, Allen Morrill
Rogers, E. L.
Rogers, H. H.
Rowe, S. H.
Rowland, Thomas Fitch
*Rusby, Prof. H. H.
Russ, Edward
Saul, C. R.
Schermerhorn, F. A.
Schiff, J.
Schott, Charles M., Jr.
Scott, G. S.
Seabury, George J.
SENFF, CHARLES H.
Shaw, Mrs. J. C.
Shepard, C. Sidney
*Sherwood, George H.
Shiland, Andrew, Jr.
Shultz, Charles S.
*Sickles, Ivin, M.D.
Sieberg, W. H. J.
Sloan, Benson B.
Smillie, Charles F.
Smith, Elliott C.
*Smith, Ernest E., M.D.
*Smith, Prof. John B.
Smith, W. Wheeler
Snook, Samuel B.
Snow, E. G.
*Starr, Prof. M. Allen
Stetson, F. L.
Stevens, C. A.
*Stevens, George T., M.D
***Stevenson, Prof. John J.**
Stokes, James
Stone, Mason A.
*Stratford, Prof. William
Straus, Isidor
*Strong, Prof. Chas. A.
Sturgis, Elizabeth
*Stuyvesant, Rutherford
Taggart, Rush
***Tatlock, John, Jr.**
Taylor, George
Taylor, William H.
Terry, James,
Thaw, Benjamin

Thompson, Mrs. F. F.
Thompson, Lewis S.
*Thompson, Prof. W. G.
Thompson, Walter
*Thorndike, Prof. E. L.
Thorne, Samuel
*Torrey, J. C., Ph.D.
*Tower, R. W., Ph. D.
*Townsend, Charles H.
Tows, C. D.
*Trotter, Alfred W.
*Trowbridge, Prof. C. C.
Tuckerman, Alfred, Ph.D.
Ullmann, E. S.
Van Beuren, Fred. T.
Van Slyck, George W.
Van Wyck, Robert A.
Voratka, Edward J.
Vredenburgh, Wm. H.
Wainwright, J. W., M.D.
*Waller, Prof. Elwyn
Wallin, Ivan E.
Warburg, F. N.
Warburg, Paul M.,
Ward, Artemas
Ward, John Gilbert
*Washington, H. S., Ph.D.
Waterbury, J. I.
Weir, John
Wellington, A. H.
Wheeler, H. L.
*Wheeler, Prof. W. M.
*White, Horace
White, Leonard D.
*Whitfield, Prof. R. P.
Wicke, William
Wiggin, F. H., M.D.
Williams, R. H.
Wills, Charles T.
*Wilson, Prof. E. B.
Wilson, Henry R.
Wilson, J. H.
Wilson, Miss M. B.
*Wissler, Clark, Ph.D.
Wolff, A. R.
Wood, Mrs. Cynthia A.
*Woodbridge, Prof. F. J. I.
*Woodhull, Prof. John F.
*Woodward, Prof. R. S.
*Woodworth, Prof. R. S.
Ybarra, A. M. F., M.D.
Yeaman, George, H.
Younglove, John, M.D.
Zabriskie, George

ASSOCIATE MEMBERS

Brown, T. C.
Gordon, Clarence
Dublin, L. J.
Harper, Roland M., Ph.D.
Hunter, George W.
James, F. Wilton
Jones, A. L.
Kellicott, W. E.
Montague, W. P.
Northup, Dwight
Osburn, R. C.
Read, T. T.
Stevenson, A. E.
Van Siclen, Matthew

NON-RESIDENT MEMBERS

Buchner, Edward F.
Burnett, Douglass
Davis, William H.
English, George L.
Finlay, Prof. G. I.
Frankland, Frederick W.
Hoffman, S. V.
Kendig, Amos B.
*Lloyd, Prof. F. E.
*Mayer, Dr. A. G.
*Pratt, Dr. J. H.
*Ries, Prof. H.
Reuter, L. H.
*Sumner, Dr. F. B.
*van Ingen, Prof. G.

PUBLICATIONS

OF THE

NEW YORK ACADEMY OF SCIENCES

[Lyceum of Natural History, 1818–1876]

The publications of the Academy consist of two series, viz.:

(1) The **Annals** (octavo series), established in 1823, contain the scientific contributions and reports of researches, together with the records of meetings and similar matter.

A volume of the Annals will in general coincide with the calendar year and will be distributed in parts. The price of the current issues is one dollar per part or three dollars per volume. Author's reprints are issued as soon as the separate papers are printed, the dates appearing above the title of each paper.

(2) The **Memoirs** (quarto series), established in 1895, are issued at irregular intervals. It is intended that each volume shall be devoted to monographs relating to some particular department of Science. Volume I is devoted to Astronomical Memoirs, Volume II; to Zoölogical Memoirs, etc. The price is one dollar per part, as issued.

All publications will be sent free to Fellows and Active Members. The Annals will be sent to Honorary and Corresponding Members desiring them.

Publication of the **Transactions** of the Academy was discontinued with the issue of Volume XVI, 1898, and merged in the Annals.

Subscriptions and inquiries concerning current and back numbers of any of the publications of the Academy should be addressed to

The Librarian,
New York Academy of Sciences,
care of
American Museum of Natural History,
New York City.

CONTENTS OF VOL. XVIII, PART II.

VOL. XVIII PART III

ANNALS

OF THE

NEW YORK ACADEMY OF SCIENCES

EDITOR

Edmund Otis Hovey

NEW YORK

PUBLISHED BY THE ACADEMY

1909

THE NEW YORK ACADEMY OF SCIENCES.

Founded, 1817.

OFFICERS, 1909.

President—CHARLES F. COX, Grand Central Station.
Vice-Presidents—J. J. STEVENSON, F. M. CHAPMAN,
D. W. HERING, MAURICE FISHBERG.
Recording Secretary—EDMUND OTIS HOVEY, American Museum.
Corresponding Secretary—HERMON C. BUMPUS, American Museum.
Treasurer—EMERSON McMILLIN, 40 Wall St.
Librarian—RALPH W. TOWER, American Museum.
Editor—EDMUND OTIS HOVEY, American Museum.

SECTION OF GEOLOGY AND MINERALOGY.

Chairman—J. J. STEVENSON, New York University.
Secretary—C. P. BERKEY, Columbia University.

SECTION OF BIOLOGY.

Chairman—FRANK M. CHAPMAN, American Museum.
Secretary—LOUIS HUSSAKOF, American Museum.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

Chairman—D. W. HERING, New York University.
Secretary—WILLIAM CAMPBELL, Columbia University.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

Chairman—MAURICE FISHBERG, 1337 Madison Ave.
Secretary—R. S. WOODWORTH, Columbia University.

Sessions of 1909.

The Academy meets on Monday evenings at 8:15 o'clock from October to May, inclusive, at the American Museum of Natural History, 77th Street and Central Park, West.

[ANNALS N.Y. ACAD. SCI., Vol. XVIII, No. 9, Part III, pp. 385–424. 29 August, 1908.]

AN INVESTIGATION OF THE FIGURE OF THE SUN AND OF POSSIBLE VARIATIONS IN ITS SIZE AND SHAPE.

BY CHARLES LANE POOR.

CONTENTS.

Part I. Historical.

INTRODUCTORY NOTE.

Questions as to the exact size and shape of the sun are of great astronomical interest and have been made the subjects of many researches during the last hundred years. Many of these investigations, involving long series of observations, show a distinct ellipticity of the sun and indicate a possible variation of its diameter, yet, after a thorough re-discussion of these observations, Auwers concludes that all such indications are illusory and that the sun is sensibly a sphere of constant diameter. As a result of an independent discussion, Newcomb confirms this conclusion of Auwers, and traces the supposed observed variations to changes in terrestrial temperature and to fluctuations in the haziness and cloudiness of the earth's atmosphere. As these investigations and discussions appeared in various journals and publications of scientific societies, it may not be without value to preface the present investigation with a *résumé* of the more important papers, and to show exactly upon what grounds Auwers and Newcomb base their conclusions.

Measures of the sun's diameter which have heretofore been used are of two classes; 1st, Those made with a meridian circle or transit instrument, and, 2d, Those made with a heliometer. The papers and discussions relating to these two classes will be taken up separately, although this will interfere with the chronological order in which the papers actually appeared.

MERIDIAN OBSERVATIONS.

Von Lindenau. — The first important investigation was that of Von Lindenau, which appeared in Zach's "Monatliche Correspondenz" for June, 1809. From observations made at Seeberg, in 1808–09, with a transit instrument, he found a periodic variation in the sun's diameter. In order to test this suspected variation, he discussed the Greenwich meridian observations made in the years 1750–55 and 1765–86. These observations apparently confirmed the results obtained from those made at Seeberg, and Lindenau concluded that the sun is an ellipsoid, rotating about its longer axis. His calculations made the polar radius exceed the equatorial by from 4″ to 6″, or, what is the same thing, he found an equatorial compression of $\frac{1}{280}$ to $\frac{1}{140}$. These results, however, were criticised the following month by Bessel,[1] who showed that the observations could be represented equally well by periodic changes in the transit instrument itself.

Bianchi. — Piazzi[2] and afterwards Bianchi[3] investigated the subject, and reached conclusions diametrically opposed to those of Lindenau. While they found the sun to be an ellipsoid, they made the equatorial radius the greater. Bianchi based his work on some 440 measures of the vertical and 439 of the horizontal diameter made during the years 1827, 1828 and 1829. From the measures of the vertical diameter alone, he deduced a polar compression of $\frac{1}{1925}$; from the horizontal measures, a compression of $\frac{1}{110}$; while from a combination of all the observations, he found the value $\frac{1}{249}$. This latter value would make the equatorial exceed the polar radius by some 3″.87.

Secchi. — In spite of these papers, the generally accepted conclusion was that the solar disk was circular and its diameter constant. Not until after a lapse of forty years was the subject reopened. In 1871 Secchi became interested in the question of the sun's shape, and, with his assistant Rosa, undertook a systematic series of observations with the meridian circle of the Collegio Romano. As these observations apparently showed great variations in the sun's diameter, Secchi induced the Palermo Observatory to make an independent series of measures. These confirmed the results obtained at Rome. According to these investigations,[4] the diameter of the sun varied with the number of sun-spots, being greatest when the number of spots was least, and least when the number of spots was greatest. In conformity with this, he also found that those diameters which pass through regions of intense spot-activity are less than those passing through other regions. He found the diameter which passes through latitude 21° to 23° to be some 1″.56 smaller than the diameter which passes through latitude 6°.

Hilfiker. — Hilfiker, assistant at the Observatory of Neuchâtel, published the results of twenty-two years' observations. In all he made use of 3468 homogeneous transits of the sun, all observed with the same instrument and in precisely the same manner. This instrument had an objective of 115 mm. aperture and 2 m. focal length. In making the observations, a uniform magnification of 200 was used, and each limb of the sun was observed on thirteen threads of the reticle. From this great mass of observations, Hilfiker drew the definite conclusion that the sun's diameter is

---

[1] Zach, Monatliche Correspondenz, July, 1809.
[2] Specola Astronomica di Palermo, Liv. VI.
[3] Astronomische Nachrichten, Vol. IX, No. 213, August, 1831.
[4] Atti dell'Accademia dei Lincei, January, 1872.

variable and that it varies with the number of visible sun-spots. He found the diameter of the sun to be greater when the number of spots is a minimum, to be smaller when the number is a maximum. In this conclusion he agreed with Secchi, with the observations made at Rome and Palermo.

DISCUSSION OF MERIDIAN OBSERVATIONS.

Auwers. — The results derived by Secchi depended upon a very small number of observations (187), and they covered a period of only one year; yet they attracted considerable attention, and caused Auwers to undertake a complete discussion of the entire matter of the sun's shape and its possible variability. This resulted in a series of papers, published by the Berlin Academy, which are distinguished by their thoroughness and by the great skill of the author. In these papers Auwers clearly shows the utter unreliability of the observations upon which Secchi depended, and concludes that "the assertions concerning variations in the sun's diameter are totally and entirely unfounded."

In the first paper of this series,[1] Auwers examined a mass of observations made in the years 1871–72, at Greenwich, Neuchâtel, Oxford, Washington, Paris, Königsberg and Brussels, and showed that the different series of observations furnished conflicting results. These series covered the period of time during which were made the observations upon which Secchi relied; and the entire disagreement between the various sets of observations led Auwers to the conclusion that the changes noticed by Secchi were due to "casual errors of observations." The Oxford series showed a distinct relation between the diameter and the sharpness of the image. When the sky was more or less overcast and the image indistinct, the measured diameter was greater. Dividing the observations into five classes, according to the state of the weather, he found the following mean residuals for each class:

Class.	Residuals.	No. of Observations	
Best image	$-0^s.020$	1	
Very sharp	$+0^s.147$	4	$0^s.129$ (7.)
Sharp; thin clouds	$+0^s.103$	3	
Many clouds	$+0^s.237$	8	$0^s.264$ (24)
Clouds	$+0^s.277$	16	

This dependence of the measured diameter upon the state of the atmos-

[1] Ueber eine angebliche Veränderlichkeit des Sonnendurchmessers, Monatsberichte of the Royal Academy of Sciences at Berlin, May, 1873.

phere, or the astronomical "seeing," was also found by Wagner,[1] and was corroborated by Gyldèn at Pulkowa, by Becker at Neuchâtel and by Newcomb and Holden[2] at Washington. The Washington observations show clearly that both the vertical and horizontal diameters vary with the amount of cloudiness in the sky. In bright weather, when the image was clear and sharp, the diameters as measured were smaller than when the sky was overcast, or was more or less covered by clouds.

In the paper above referred to, Auwers also investigated two long series of Greenwich observations; one made by Bradley and Maskelyne between the years 1750 and 1786, and the other made during the years 1851–70. The intervening years were partly covered by two shorter series; one made by Bessel at Königsberg in the years 1820–28, and the second by W. Struve at Dorpat in 1823–38. These series all showed small variations in the measured diameter; but when these variations were compared with the fluctuations in the number of sun-spots, no dependence of the one phenomenon upon the other could be traced. As to the minute variations shown by the observations, Auwers concluded that there was "no indication whatever of the reality of these fluctuations."

Newcomb and Holden. — Newcomb and Holden[3] investigated the subject of possible variations in the diameter in an entirely different manner. If there be two independent series of simultaneous observations, and the difference between each measure and the mean of the whole series to which it belongs be taken, then, if the differences are due entirely to accidental errors, there will be no relation between the differences of the two series. If, on the other hand, a portion of the difference is due to actual change in the sun, then, as a general rule, positive differences in one series will correspond to positive differences in the other, and negative differences to negative differences. When the corresponding differences of one series are multiplied by those of the other, and the sum of all the products taken, then, if there be a real change in the sun, this sum should be a large positive quantity.

Unfortunately no such simultaneous series were available. The two series which most nearly satisfied the conditions were those made at Greenwich and Washington during the years 1862–70. Instead of being simultaneous, the observations were thus separated by an interval of about five hours. These series contained a total of 3639 observations, of which num-

---

[1] Vierteljahrschrift, January, 1873.

[2] On the Possible Periodic Changes in the Sun's Apparent Diameter (American Journal of Sciences and Arts, October, 1874).

[3] On the Possible Periodic Changes in the Sun's Apparent Diameter (American Journal of Sciences and Arts, October, 1874).

ber 1813 were of the horizontal and 1826 of the vertical diameter. Of this large number, however, only 584 were made on corresponding days and were available for the test. These observations were freed from personal equation, and the resulting series of residuals found. Each Washington residual was multiplied by the corresponding Greenwich residual, and the sum of the products taken with the following results:

	Hor. Diam.	Vert. Diam.
Sum of products	$-0^s.1077$	$-23''.14$
Number of observations	313	271

This preponderance of negative products would show that positive residuals at Greenwich are followed five hours later by negative residuals at Washington and *vice versâ*. This would apparently indicate vibrations in the sun of short period, somewheres around ten hours' duration. Again, the result seems, according to Newcomb, to be conclusive against any variability whose period is a multiple of a day.

The apparent short-period vibration is, however, attributed by the authors to chance.

Auwers. — Auwers[1] enlarged the scope of his investigation, and discussed all available transit material. This included the following long series:

Greenwich Observations . . .	1851–83	Radcliffe Observations .	1862–83
Washington Observations . .	1866–82	Neuchâtel Observations .	1862–83

and a number of shorter series.

Practically every series showed fluctuations, more or less periodic, in the observed diameters; and an investigation as to the reality or non-reality of these apparent fluctuations formed the main part of Auwers' papers. These apparent variations fell into two classes; 1st, Irregular or long period variations, and, 2d Annual variations.

In discussing the variations of the first class, Auwers carefully investigated the personal equations of the ninety-two observers who took part in the four main series of observations. These personal errors were determined in the usual manner. In each series the observations (mean of each year) of each observer were compared with the corresponding mean of all the observers, or with that of a standard observer or observers. In the case of the Greenwich series, the mean of four observers, — Dunkin, Ellis, Criswick and J. Carpenter [the observers who had the largest consecutive

---

[1] Neue Untersuchungen über den Durchmesser der Sonne, I, II (Sitzungsberichte of the Berlin Academy, December, 1886 and June 9, 1887).

series of observations], — was taken as standard. With the personal equations so determined, the observations were reduced, and the results showed periodic variations, which at first sight bore some resemblance to the variations in the sun-spot frequency.

During the period 1862–72 this resemblance was more striking than in periods before and after those dates. In investigating the probability of a connection between the diameters as observed in each series, and the number of sun-spots, Auwers assumed that, if present, such connection could be expressed by the equation

$$V = x + A.y$$

where V is the residual obtained by subtracting the mean of all the horizontal diameters from the mean of each year, and A is a number arbitrarily obtained for each year by Auwers, from Wolf's "relative number" for that year and from the observed magnetic variations during that year. From such equations for each year, as given by the Greenwich and Washington observations for the central period, Auwers found by least squares the values

$$x = +0.030$$
$$y = -0.500$$

with a weight of 2.73 and a mean error of 0.198 for y. Thus y was over twice its mean error, a result which seemed to confirm a connection between the observed diameter and the sun-spot period.

Auwers also plotted the yearly residuals of the Greenwich and Washington observations in connection with the sun-spot curve, and the relation between the two was again clearly indicated. Thus the observations, when interpreted graphically or mathematically, point toward a close connection between the variations in the diameter and those in the number of visible sun-spots.

Not content with this conclusion, Auwers proceeded further and investigated the various series of observations made by the individual observers. In these individual series of residuals he found variations, some abrupt, some periodic. These changes in an observer's residuals he now assumes as due to changes in the personal equations rather than to changes in the measured quantity. When abrupt changes in the residuals are found, corresponding abrupt changes in the observers' personal equations are assumed; when gradual periodic changes in the residuals are seen, corresponding periodic changes in the personal equation are taken. Thus, in his second or definitive reduction of the Greenwich and Washington observations, Auwers assumes arbitrary and variable personal equations for the different observers. Some of the more important of the fifty-seven personal equations of the Greenwich observers as used by Auwers are given in the following table. Under the head "First System" will be found the values of personal equations as determined by Auwers in his first reduction; under the head "Second System" will be found the variable equations used in the second reduction:

Table I.

	First System.	Second System.
Dunkin	$+0^s.084$ / $+0^s.025$ } 1861	$+0^s.058-0s.006(t-1860.5)$
Downing	$-0^s.023$	$-0^s.010+0s.010(t-1878.5)$
Thackeray	$+0^s.038$	$-0^s.014$ / $+0^s.063$ } 1876
Stone	$-0^s.057$	$-0^s.135$ / $+0^s.041$ } 1863
Pead	$-0^s.034$	$-0^s.035$ / $+0^s.013$ } 1880
H. Breen	$+0^s.221$ / $-0^s.021$ } 1855	$+0^s.230$ / $-0^s.028$ } 1855
Criswick	$+0^s.062$	$+0^s.061$
J. Carpenter	$-0^s.095$	$-0^s.099$

The dates following a bracket indicate the year in which an abrupt change in personal equations was adopted. The system of equations adopted for the vertical diameters was still more complicated; those of Dunkin, Ellis, Criswick, J. Carpenter and H. Carpenter varying with the time. The personal equation of Criswick contained a term involving the square of the time, and that of Ellis showed an abrupt change in 1871. Besides these, the equations of Lynn, Downing and Thackeray, show abrupt changes.

By using this new set of personal equations, Auwers was enabled to reduce the apparent variations in the observations, so that all semblance of periodicity disappeared; and, because the outstanding residuals are so reduced, he concludes that this system best represents the observations, and that the diameter of the sun is constant while the personal equations of the different observers are variable. This may be the true explanation of the observed discordances; but it is evident that, with a different system of variable personal equations, an entirely different result could be obtained.

By similar discussions of all the various series of observations made between 1851 and 1883, Auwers reached the conclusion that the meridian observations showed no long-period variation, nor any long existing change in the sun's diameter, of a greater amplitude than $\pm 0''.2$.

As to the second class, or annual variations, Auwers investigated nineteen independent series of observations, made at seven different observatories and with twelve different instruments. In all, these series contained more than 21,000 observations of the horizontal diameter and about half as many more of the vertical diameter. From sixteen of these series, containing more than 26,000 observations, Auwers found, after eliminating the effects of personal errors, that the diameter was either constant for the entire year, or showed variations of such form and size as to be clearly the result of temperature upon the instruments. In these series he found the measured diameter to be the smallest when the image was sharpest, and at those temperatures when the threads of the reticle were exactly in the focal plane of the objective.

The three remaining series showed annual variations which could not be accounted for by the effects of temperature. In the Madras series, Auwers traced the apparent variation to personal errors of the various observers. The other two series which showed variations were those very early observations of Maskelyne and Lindenau. To these series Auwers devoted a separate paper,[1] and in it he showed Lindenau's deductions to be entirely unfounded. In the early Greenwich observations many cases occurred in which the second limb of the sun was observed on different threads from those used for the first. Such observations can only be utilized when the thread-intervals are known. Now Lindenau confined his discussion to observations made on the same threads, while Auwers took into account all the observations. To do this Auwers had first to find, from other observations, the thread-intervals; but, while this work was extremely laborious, it enabled Auwers ultimately to utilize three times as many observations as did Lindenau. Still further, Auwers found the Greenwich observations to be a heterogeneous mass made by different observers, by Maskelyne and his assistants. He discussed the personal equations of these various observers, eliminated their effects and finally obtained results radically different from those of Lindenau, — results which showed no trace of variability in the sun's diameter.

The possible departure of the sun from a spherical shape was also discussed by Auwers in these three papers. At Greenwich, Washington and Radcliffe, the vertical as well as the horizontal diameter was measured. Auwers discussed these observations separately, and found the results as given below:

[1] Neue Untersuchungen über den Durchmesser der Sonne, III (Sitzungsberichte of the Berlin Academy, October 31, 1889).

Table II.

	Diameter.		No. of Observations.		No. of Observers.
	Horizontal.	*Vertical.*	*Hor.*	*Vert.*	
Greenwich	32′ 2″.01	32′ 2″.73	3114	3289	62
Washington	32′ 2″.41	32′ 2″.57	1321	1297	15
Radcliffe	32′ 2″.87	32′ 3″.51	—	—	7
Neuchâtel	32′ 3″.27	—	—	—	8

In each of three series, therefore, the vertical diameter appears as larger than the horizontal.

The inclination of the sun's equator to the horizontal line changes with the season of the year. If, therefore, the sun had a marked ellipticity, the measured horizontal and vertical diameters would each show periodic variations, the length of the cycle being six months. If the equatorial diameter exceeded the polar by 1″, then Auwers showed that, at the date of the observations, the measured mean for any month should exceed the yearly mean by the value

$$\pm\,(0''.01 \sin 2t + 0''.09 \cos 2t)$$

where t is the fractional part of the year; and the upper sign applies to horizontal measures, while the lower one applies to vertical diameters. Giving the Greenwich and Neuchâtel observations weights of 3, the Washington observations 2, and those of Radcliffe 1, Auwers, from the mean of all the observations, found the expressions

Horizontal diameter	$-0''.01 \sin 2t + 0''.06 \cos 2t$
Vertical diameter	$-0''.01 \sin 2t - 0''.04 \cos 2t$

And these expressions show absolutely no relation with the real form of the expression as above given.

Auwers concluded, however, that a polar compression of $\frac{1}{4000}$, or an excess of 0″.5 of the equatorial over the polar diameter, would best represent all the observations.

HELIOMETER MEASURES.

In the first of the before-mentioned series of papers,[1] Auwers examined two short series of heliometer measures made by Schlüter and Wichmann

[1] Monatsberichte of the Royal Academy of Sciences at Berlin, May, 1873.

in 1842–43 and 1846–51. The observations were too few in number to allow any certain conclusion to be drawn, but they indicated a change in the diameter. Schlüter also measured on a few days both the polar and equatorial diameters, and, as a result of these measures, the polar diameter appeared to exceed the equatorial by a small fraction of a second.

Measures made in Connection with Transit of Venus. — While adjusting and determining the constants of the heliometers which were used in observing the transits of Venus in 1874 and 1882, the German observers made a great number of determinations of the sun's diameter. In all, some 2692 separate measures of the diameter were made by twenty-three observers. Five heliometers were used, measures with the same instrument being made in various stations by the same observer and in the same station by various observers. Thus heliometer A was used by Adolph, Wittstein, Valentiner, Ambronn, Peters, Kobold, Deichmuller, Hartwig, Kustner and Weinek in Strassburg; by Adolph and Valentiner in Tschifu; and by Franz and Kobold in Aiken.

This immense mass of data was most thoroughly discussed by Auwers in "Die Venus-Durchgänge, 1874 und 1882"; the conclusions being published in the "Astronomische Nachrichten."[1] These measures were all reduced to distance unity and arranged in groups, the observations made with each instrument being subdivided for each observer and also for each place of observation. From the observations made with the different heliometers, Auwers reached the conclusion that D and E gave smaller images than A, B and C, and he deduced corrections for the five instruments, so as to reduce the measures made with each to the mean of $A + B + C + D + \frac{1}{2} E$. These corrections are given by the table,

For A	—0″.01	For D	+0″.18
For B	—0″.20	For E	+0″.16
For C	—0″.06		

With these corrections the observations were reduced and the results for the various observers tabulated. The observations of Hartwig made the diameter the greatest, 1920″.29, while those of Clauss made it the least, 1918″.38: the difference between these two observers thus amounted to 1″.91. To these various means Auwers assigned weights, and finally deduced the value for the diameter of the sun at distance unity as

$$1919''.26 \pm 0''.10.$$

[1] Astronomische Nachrichten, Vol CXXVIII, No. 3068, December, 1891.

These observations were made along different diameters of the sun; some were made on the equatorial diameter; some, at right angles to the equator; and others, at various position angles. In all, nineteen sets of observations were made which directly gave the difference between the equatorial and polar diameters, and twenty-seven sets in which inclined pairs of diameters were measured. From these, Auwers found that the polar diameter exceeds the equatorial by

	P.–E.
In the 19 sets	+0″.026
In the 27 sets	+0″.053

And from the weighted mean of the whole series, he found that

$$P.–E. = +0''.038 \pm 0''.023.$$

This apparent anomaly in the shape of the sun was explained by Auwers as being due to the tendency on the part of an observer to measure vertical diameters greater than horizontal diameters, and he concluded therefore that the sun is sensibly a sphere.

The mean diameter of the sun as determined from these observations does not show any variation with the time. The observations were made practically around the whole circumference of the solar disk, and mostly fall into two great groups, the first containing those made in 1873–75, and the second those made in 1880–85. There were two short series of observations made in 1876–77, not included in either group. The weighted means of the two great groups are practically identical, the mean of the second group exceeding that of the first by only

$$+0''.04,$$

a quantity less than half the probable error of the mean of the entire series as given by Auwers

$$\pm 0''.10.$$

Observations of Schur and Ambronn. — In 1905 Ambronn published, under the title "Die Messungen des Sonnen-durchmessers," [1] a most exhaustive and valuable research upon the shape and size of the sun. This paper embodies the results of the solar investigations of Schur and Ambronn, made with the six-inch Repsold heliometer of the Göttingen

[1] Astronomische Mittheilungen der k. Sternwarte zu Göttingen, Theil 7, 1905.

Observatory during a period of nearly thirteen years, from 1890 to 1902, and it furnishes the best and most precise series of measures of the sun's diameter which have yet been made.

When the Repsold heliometer was mounted in Göttingen, Schur determined to investigate this subject thoroughly, and to make with that instrument a complete and uniform series of measures which should extend over the whole of a sun-spot period. In carrying out this programme, every conceivable precaution was taken to exclude systematic errors: in fact, two complete, parallel and independent series of observations were made, one by Schur and one by Ambronn. Whenever possible, each observer obtained a series of four measures each week, two of the polar and two of the equatorial diameter. All the necessary instrumental constants for the reduction of these observations were obtained by each observer independently of the other. But the same methods and the same formulas of reduction were used in the two series; so that these series are directly comparable. The series of Schur extends from 1890 to the beginning of 1901; that of Ambronn, from 1890 to the end of 1902; both series thus covering an entire sun-spot period.

In reducing and discussing this great number of observations, Ambronn investigates the questions of the figure and of the variability of the sun separately. A brief *résumé* of his methods of investigating each of these points is given below, together with the conclusions he reaches in regard to these important questions.

1. *The Figure of the Sun.* — On each day of observation the polar and equatorial diameters were both measured twice, so that the research furnishes a great mass of data regarding the shape of the sun. The values of the differences between the diameters, in the sense polar minus equatorial, are tabulated and given by Ambronn. From these are formed the mean values of this difference for each year; and from these yearly means, the mean value for the entire series of observations.

The yearly means as given by Ambronn in Appendix IV, and also on page 44 of his memoir, contain typographical errors which were later corrected by the author.[1] The corrected table is as follows:

---

[1] Astronomische Nachrichten, Vol. CLXXI, No. 4086. May, 1906.

Table III.

MEAN OF YEARS (P.–E.).

YEAR.	SCHUR		AMBRONN.		MEAN.	WEIGHTED MEAN.	WT.
	P.–E.	No. of Obs.	P.–E.	No. of Obs.	P.–E.	P.–E.	
1890 . . .	+0.13	10	+0.12	14	+0.12	+0.13	6
1891 . . .	+0.02	17	+0.14	14	+0.08	+0.08	6
1892 . . .	—0.06	12	+0.07	16	0.00	+0.02	7
1893 . . .	—0.09	10	—0.01	14	—0.06	—0.07	6
1894 . . .	+0.10	11	—0.07	11	+0.02	—0.04	10
1895 . . .	+0.04	13	+0.03	15	+0.04	+0.03	9
1896 . . .	—0.05	19	—0.01	18	—0.03	—0.03	8
1897 . . .	+0.02	26	—0.04	21	—0.01	—0.01	13
1898 . . .	+0.11	21	+0.07	21	+0.09	+0.08	11
1899 . . .	+0.05	21	—0.03	24	+0.01	—0.01	12
1900 . . .	+0.04	24	+0.01	21	+0.02	+0.02	20
1901 . . .	+0.43	1	+0.06	27	—	+0.07	10
1902 . . .	—	—	—0.06	15	—	—0.06	5

The column "Mean" is from Ambronn; that headed "Weighted Mean" was formed by assigning weights to the observations of Schur and Ambronn in conformity with the values of the mean error for each year of a single observation as given by Ambronn. Upon the assumption that the shape and size of the sun are constant for each year, Ambronn found, from the separate observations made during that year, the value of the mean error of a single observation, and these mean errors are tabulated in Appendix IV. From these and the number of observations were found by the ordinary formulas the weights assigned to the yearly means.

The observations during the first two years, 1890–91, were made under instrumental conditions different from those during the rest of the interval. In order to find definitive results, therefore, Ambronn forms the means of all the observations, and also means excluding these two years. These means are given as follows:

	SCHUR.	AMBRONN.	MEAN.
Mean of all observations	+0″.028	+0″.022	+0″.025
Mean excepting the years 1890–91 . . .	+0″.018	+0″.002	+0″.010

The final mean as thus given by Ambronn shows that the polar diameter exceeds the equatorial by

$$+0''.025 \pm 0''.018,$$

a quantity which agrees closely with that (0″.038) obtained by Auwers from the transit of Venus observations. The mean errors of the individual results are given by Ambronn as

From Schur	±0″.021
From Ambronn	±0″.013

And these are nearly, if not quite, as large as the quantity sought. Ambronn concludes, therefore, that the deviations are accidental and that the sun is sensibly a sphere.

In testing this result, Ambronn investigates the effect of the inclination of the measured diameter on the result to determine whether there was any tendency on the part of the observer to measure vertical diameters differently from horizontal.

He could find no such effect; but he calls special attention to the observations made during the two years 1890 and 1891, which show the polar diameter to be decidedly the greater, and points out the fact that these results may be due to physiological causes, for during this interval no precautions were taken to obviate this difficulty. A prism was attached to the heliometer in October, 1891, in such a manner that all the diameters of the sun were measured in the same relative positions as regards the vertical; and from that date on, the observations are perfectly homogeneous.

Ambronn also investigates the possibility of errors in the constants of refraction which were used in reducing the observations. In the winter months the sun was at an average lower altitude at the time of observation than in the summer months. Hence, if there were any systematic errors in computing the differential refraction, such errors would be apparent when the observations are grouped according to the months in which they were made. When the observations are so grouped, no periodic variation is shown; and Ambronn concludes, therefore, that the constants and the methods used in computing the differential refraction are sensibly correct.

2. *Variation of the Sun's Diameter.* — Each series of observations is treated separately. Ambronn first finds the mean value of the sun's diameter from all the observations of each series; then, subtracting this mean from the separate values, he finds the residual for each observation. From these residuals he finds the value of the mean residual for each year, and tabulates these "yearly residuals," which thus show the yearly variation in the diameter.

In the first of these steps, Ambronn was confronted with a difficulty: the series of observations were not strictly homogeneous. In October, 1891, a prism was introduced into the instrument in such a manner that the line joining the centers of the two images could always be brought into the same position relative to the eyes of the observer. This was to obviate any possible physiological influence which might cause the observer to measure the polar and equatorial diameters differently. An investigation, however, showed that the prism had a sensible effect upon the measures of all diameters, equatorial as well as polar. The diameters measured with the prism were all somewhat smaller than those measured without it. As the prism was used continuously after October, 1891, the series of observations are divided into two periods by this date. The mean results from the observations in each period are given below, where the various values are expressed in scale-divisions, one division of the scale being approximately equal to 40″.

Table IV.

	Without Prism.	Number.	With Prism.	Number.
Schur	47.9919	25	47.9823	159
Ambronn	47.9819	27	47.9745	200

As a result of special measures made by Schur and Ambronn, both with and without the prism, Ambronn concludes that all observations made without the prism must be diminished by 0″.4 or 0.01 scale-division, in order to make them comparable with those made with the prism.

Correcting all the observations made without the prism by this amount, taking the general means, and reducing scale to arc, Ambronn finally obtains for the definitive values of the sun's diameter at distance unity.

Schur	1920″.14	±0″.040
Ambronn	1919″.80	±0″.036

From these means the yearly residuals were found, and as given by Ambronn are tabulated below.

Table V.

Year.	Schur.	Ambronn.	Mean.
1890	—0″.10	—0″.08	—0″.09
1891	+0″.03	—0″.11	—0″.04
1892	+0″.09	—0″.08	0″.00
1893	+0″.10	+0″.06	+0″.08
1894	+0″.10	+0″.11	+0″.10
1895	—0″.04	+0″.25	+0″.10

Table V, continued.

Year.	Schur.	Ambronn.	Mean.
1896	—0″.10	+0″.12	+0″.01
1897	—0″.06	—0″.12	—0″.09
1898	+0″.01	—0″.08	—0″.04
1899	+0″.05	—0″.06	0″.00
1900	0″.00	+0″.02	+0″.01
1901	—	+0″.03	—
1902	—	+0″.09	—

A simple inspection of these figures shows a certain periodicity. This is shown in the series of each observer and in the series of means. The periodic time of these variations is somewhere between six and eight years, and the amplitude about 0″.1. The large residual (0″.25) for the year 1895 is considered by Ambronn to be due to purely personal or accidental causes.

Ambronn further compares the curves which represent the above series of residuals with Wolfer's sun-spot curve for the corresponding years. This curve, together with the above series of residuals, shows clearly, according to Ambronn, that there is no relation between the observed variations in the sun's diameter and the relative frequency of sun-spots.

In considering these results of Ambronn, we note that he investigates the possible variation in the average or *mean* diameter of the sun. The above residuals and the corresponding points on his curves are found by taking, in the series under consideration, the mean for each year of all the observations of both the polar and equatorial diameters. Thus his investigation would show whether there had been any change, periodic or secular, in the volume of the sun, and not whether there had been any change in either the polar or the equatorial diameter. Changes in the relative sizes of the diameters of the sun, or changes in its shape which do not alter its volume, could not be discovered by the methods used by Ambronn in this portion of his paper. His conclusions show that, during the entire period of nearly thirteen years, there was not present any periodic or secular variation in the sun's volume larger than that represented by a change of 0″.1 in the mean diameter of that body.

A comparison of the final values of the sun's diameter as found by Schur and Ambronn, with that found by Auwers from the transit of Venus observations, shows the new values to be considerably larger; but this difference is attributed to instrumental and personal peculiarities. The aperture of the objective, the color and density of the shade-glass used, — each has its effect on the measured diameter. The insertion of a prism in the Repsold heliometer reduced the apparent diameter by 0″.4. The earlier observations of Schur and Ambronn, as given by Auwers, were

Schur	1919″.52
Ambronn	1919″.26

But at the time of these observations other observers made the diameter vary between the limits

1920″.29 and 1918″38.

and Auswers found systematic errors depending upon the instrument used.

Part II. Photographic Measures.

The following investigation of the figure of the sun was suggested by the number of solar photographs taken by Lewis M. Rutherfurd in his private observatory, and by him presented to the Observatory of Columbia University. In a series of investigations of the Rutherfurd star plates, Jacoby has shown that the plates have suffered no deterioration, and that they are capable of giving results comparable in accuracy with the best heliometer determinations. It was hoped, therefore, that the Rutherfurd photographs of the sun would serve to determine with great precision the shape of that body, and in 1905 the writer undertook the measurement and reduction of all the Rutherfurd plates.

After the investigation was well under way and some preliminary results were obtained, it was decided to enlarge the scope of the investigation so as to include all available photographs. Unfortunately it was soon found that the number of suitable photographs is very limited. While several observatories have long series of solar photographs, yet in nearly every case these were taken with a horizontal telescope and without the necessary precautions to secure an edge sufficiently sharp for measurement. The mirror of horizontal instruments introduces errors and makes the solar image unsymmetrical. Only such plates as have been made with an equatorially mounted objective of relatively long focus can be used, and there are no long series of such plates.

Direct photographs of the sun's disk serve to determine the shape of that body, but cannot well be used to determine its absolute diameter. Changes in temperature affecting the focal length of the objective cause variations in the scale of the photographs. In stellar photography the scale of each plate is determined from measures of known stars whose images are found on that plate; in solar photography the plates do not contain data sufficient to find the scale value. The relative lengths of the various diameters can, however, be most accurately measured, and the shape, and variations in the shape, of the disk determined.

RUTHERFURD PLATES.

The Observatory of Columbia University has in its possession a series of 139 solar photographs taken by Rutherfurd during the years 1860–74. This series of plates may be divided into two groups; one group of plates covering the years 1860–66, and a second group taken during the years 1870–74. The plates of the first series were made with a small lens; those of the second group, with his thirteen-inch photographic objective, which was completed in 1868. The earlier plates were simple photographs of the sun without orientation-marks or data of any kind. In 1870 he began to place orientation-marks on the plates, but even after that date fully half of the plates lack this essential. In these four years, Rutherfurd took a hundred plates, grouped as follows:

1870, Feb. 16—Oct. 14	61 plates
1871, April 17—Aug. 19	14 "
1872, Jan. 2—Nov. 27	13 "
1874, April 5—Dec. 9	12 "
Total	100 plates

Of the sixty-one plates taken in 1870, only four were available for measurement, the remaining plates not having sufficient data to orient them. These four plates were rejected in the preliminary investigation, but were afterwards measured, and found to give satisfactory results.

Of the fourteen plates taken in 1871, eight were found to be measurable. A ninth plate was measured, but the measures were so discordant that it was rejected. The remaining five plates were either poorly developed or did not have orientation-marks upon them.

Of the thirteen plates taken in 1872, ten were found to be measurable. An eleventh plate was discarded after measurement, the separate measures being very discordant.

Of the twelve plates taken in 1874, only one had on it the full data for orientation. This was a very poor plate and was discarded after an attempt to measure it.

This left available for measurement a series of twenty-two plates, of which four were taken in 1870, eight in the spring and summer of 1871, and ten in the spring and summer of 1872. The measures were all made on the Repsold measuring-machine of Columbia University, and all measures were made in duplicate by Miss Harpham and Miss Davis of the Observatory computing staff. On each plate twenty-eight points on the sun's limb were measured,— seven points at or near each pole, and seven points at or near each extremity of the equator. In each of these four groups the separate points were five degrees apart, each group thus covering an arc of 30°, or 15° on each side of the pole or equator respectively. The measurement of each point consisted in the determination of its polar co-ordinates, position angle and distance, as referred to the center of revolution of the plate in the machine. This center of revolution does not coincide with the center of the sun's disk, but the plates can be quite accurately adjusted in the machine. In no case did the center of revolution differ from the true center of the disk by more than 0.05 mm. or 1″.2.

The measures were corrected for differential refraction, the formulas as given by Chauvenet being used. From these corrected measures were then found the co-ordinates of the center of the sun and the most probable value of the sun's radius. The measured co-ordinates were then transferred from the center of revolution to the center of the sun's disk as origin; and thus were found, for each plate, the values of twenty-eight radii of the sun.

The mean of the fourteen polar radii, as thus found, for each plate, was taken as the value of the polar radius; and the mean of the fourteen equatorial radii, as the value of the equatorial radius for that plate. The difference between these values of the polar and equatorial radii was then formed, in the sense polar minus equatorial, and the results for the various plates are exhibited in the following tables:

Table VI.

1870.

Date.	P.–E. (arc).	Wt.
Aug. 18	+0″.49 ±0″.28	2.4
Sept. 24	—0″.12 ±0″.31	2.0
Sept. 28	+0″.81 ±0″.25	3.0
Oct. 5	+0″.60 ±0″.26	2.9

Table VI, continued.

1871.

Date.	P.–E. (arc).	Wt.
April 21	—0″.63 ±0″.36	1.8
June 16	—0″.18 ±0″.22	5.6
July 16	—0″.68 ±0″.19	6.7
July 20	—0″.67 ±0″.35	1.6
July 21	—0″.72 ±0″.30	2.4
July 22	—1″.00 ±0″.30	2.4
Aug. 12	+0″.04 ±0″.21	7.1
Aug. 19	+0″.36 ±0″.20	5.0

1872.

Date.	P.–E. (arc).	Wt.
May 7	+0″.30 ±0″.17	10.0
May 10	+0″.45 ±0″.23	5.3
May 27	+0″.32 ±0″.27	2.3
June 15	+0″.48 ±0″.29	2.5
June 29	+0″.40 ±0″.27	3.0
July 6	+0″.77 ±0″.33	1.8
July 17	+0″.36 ±0″.22	5.9
Aug. 10	—0″.21 ±0″.14	14.3
Aug. 12	+0″.32 ±0″.33	2.0
Sept. 21	+0″.49 ±0″.30	2.5

In the above tables the first column gives the date on which the plate was taken; the second and third columns give the difference between the polar and equatorial radii in arc, together with the mean error of this result as determined from the separate measures; the third and last column gives the relative weights of the different plates as determined from their mean errors. The scale value differed for each plate, and was determined by assuming that the value of the mean radius of the sun at distance unity is equal to 961″. Approximately one division of the scale is equal to 24″.6 of arc.

The different plates in each year give quite consistent results, but the mean results for the different years differ radically. The plates in 1871 show the equatorial radius to exceed the polar by some 0″.3; while the plates of 1870 and 1872, on the other hand, show the polar radius to be the greater by some 0″.2. Forming the mean by weights of the results obtained from the plates in the different years, we see that the yearly means are as follows:

1870, Sept. 22	$+0''.50 \pm 0''.10$
1871, July 19	$-0''.32 \pm 0''.16$
1872, July 2	$+0''.22 \pm 0''.09$

These measures thus seem to indicate a change in the relative sizes of the polar and equatorial radii of the sun. During the interval 1871–72, the polar radius was increasing relatively to the equatorial, and by 1872 was decidedly the greater. These changes in the shape of the sun are apparently real changes, and can hardly be accounted for in any other way. The plates were all taken with the same instrument and under the same conditions, and in corresponding seasons of the year. They were nearly all taken in the morning hours and at approximately the same distance from the meridian. So far as can be determined from the data at hand, there is no instrumental explanation for the difference between the results in the different years.

The conclusion from this investigation is, that during this period, 1870–72, there was a real change in the shape of the sun; the equatorial diameter first increasing and then shrinking relatively to the polar diameter.

Forming the mean by weights of the entire series, it is found that during the years 1870–72 the polar radius exceeded the equatorial by

$$P.-E. = -0''.06.$$

NORTHFIELD PLATES.

Under the direction of Professor W. W. Payne, Dr. H. C. Wilson has taken a long series of solar photographs at Northfield, Minn. Only a few of these photographs are available for measurement. Dr. Wilson selected and sent to Columbia University for measurement nine plates, which were taken during the years 1893 and 1894, all of which were well oriented and had on them the necessary data for measurement and reduction.

These nine plates were measured in the same manner as were the Rutherfurd plates, with the following results:

Table VII.

1893.

Date.	P.–E. (arc).		Wt.
Sept. 8	—1″.10	±0″.24	2.8
Sept. 9	—0″.94	±0″.21	3.7
Sept. 11	—0″.72	±0″.18	5.9
Sept. 20	—1″.60	±0″.25	2.5
Sept. 21	—0″.76	±0″.33	1.5
Sept. 27	—0″.70	±0″.30	1.8
Sept. 28	—0″.41	±0″.29	1.9

1894.

Date.	P.–E. (arc).		Wt.
July 10	—0″.72	±0″.24	3.3
July 17	+0″.36	±0″.31	3.1

Forming the mean by weights of the entire series, it is seen that, during the years 1893–94, the equatorial radius was the greater, exceeding the polar by

$$P.–E. = —0''.72.$$

YERKES PLATES — THE PHOTO-HELIOMETER.

In the latter part of 1896 a six-inch lens of forty feet focal length was mounted on the tube of the forty-inch Yerkes telescope. This lens was made by Brashear and was specially designed and corrected for photographic work. With it a long series of experiments were carried out and many photographs taken. These experiments were undertaken with the view of determining the best methods of applying photography to the determination of the size and shape of the sun. While the photographs obtained can only be regarded as experimental, yet they lead to definite conclusions as to the value of this method and as to its possibilities.

This investigation of photographic methods led to experiments with a photographic heliometer, and early in 1907 the six-inch was dismounted and a pair of two-inch photographically corrected lenses of twenty-five feet focal length were mounted side by side in the same cell, so as to give overlapping images of the sun. The cell was arranged so as to revolve about the collimation axis in a manner similar to the cell of a heliometer. Thus the line joining the centers of the two lenses could readily be placed parallel to the equatorial or to the polar diameter of the sun. The apparatus was attached to the great forty-inch Yerkes telescope and a series of photographs taken by Mr. Fox. On each day a set of two photographs was taken, one of the polar and one of the equatorial diameters. As a rule these two exposures were made within three or four minutes of each other.

On each photograph the length of the chord common to the two images is a measure of the radius passing through the extremity of the chord. This chord furnishes an accurate measure of the radius, for slight changes in the radius produce large changes in the chord. A given change, Δ r, in the radius will produce a change, Δ d, in chord approximately equal to

$$\Delta d = \frac{r}{d} \Delta r$$

where r and d are the respective lengths of the radius and the chord. If, therefore, the chord be one-third the radius, then a change of only 0″.3 in the radius will produce a change of 1″ in the chord. As the scale of the photographs is such that one millimeter is approximately equal to 27″, changes of 0″.10 in the radius would under these circumstances produce changes of 0.01 mm. in the chord; and on good photographs quantities of this size can be readily measured.

On the test photographs made at Yerkes, the image at distance unity was 71 mm. in diameter and the chord 32 mm. long. When, therefore, the line joining the centers of the lenses was parallel to the equator of the sun, the radii passing through the extremities of the chord were inclined 26° to the equator; and similarly, in the reversed position of the objective, the measured radii made angles of 26° with the axis of the sun. In other words, the radii as measured on the equatorial and polar plates cut the surface of the sun in latitudes 26° and 64° respectively. The results reduced to distance unity for these test plates are shown below.

Table VIII.

Date.	Mean Radius.	Residuals. mm.	Residuals. arc.	P.–E. arc.
Oct. 18	35.538	+033	+0″.89	—0″.81
Oct. 21	35.469	—036	—0″.97	—1″.16
Oct. 22	35.497	—008	—0″.22	—1″.43
Oct. 23	35.536	+031	+0″.84	—1″.08
Nov. 18	35.469	—036	—0″.97	—0″.62
Nov. 12	35.521	+016	+0″.43	—0″.57
Means	35.505			—0″.95

These results are fairly accordant, and indicate that at this time the radius passing through latitude 26° exceeded that passing through latitude 64° by nearly one second of arc. The plates, however, were few in number; but they show, at least, the value of the method, and confirm to some slight degree the non-spherical shape of the sun.

The photographic tests made at the Yerkes Observatory established the value of the photographic method and of the photo-heliometer; but they showed conclusively that, in order to obtain satisfactory plates, two essentials must be observed.

1. The photographic lens must be carried on a separate and specially designed equatorial mounting, so constructed that the shutter is independent of the mounting. If attached to the mounting, the shutter will almost invariably cause jars and consequent distortions of the image.

2. Wet plates should be used. On the modern rapid dry plates the edges of the image are not sufficiently sharp for accurate measurement.

Part III. Discussion of Observations and Results.

THE FIGURE OF THE SUN.

A New Tabulation of the German Heliometer Measures. — In the investigation of the general subject of the figure and the possible variations in the size and shape of the sun, the writer was led to a re-discussion, or rather to a re-tabulation, of the results obtained by Auwers from the transit of Venus observations.

In forming his means from which the heretofore given result was obtained, Auwers kept together all observations made with a single instrument, and thus observations of different years were grouped together. As arranged by Auwers, these observations do not afford any indication of a change of the relative diameters with the time. In order to investigate this point, I re-arranged the series of observations as given by Auwers, arranging them in order of the time without regard to the observer or the instrument. When thus arranged, the observations fall into two series: one extending from September, 1873, to January, 1875; the other, from May, 1880, to June, 1883. There is an isolated observation in July, 1877, another isolated one in March, 1884, and two short series in the latter part of 1884 and the beginning of 1885.

There is an uncertainty of some days in assigning a date to each determination of the ratio of the solar diameters; for the value of the difference between the polar and equatorial diameters (P.–E.), as given by Auwers for each observer, is found by him as the mean result of a number of observations, extending in many instances over a period of a month or more. In very few cases did an observer measure the polar and equatorial diameters on the same day, nor is the number of polar and equatorial diameters the same in any series. In reducing the observations of any one observer, Auwers took the mean of all diameters measured within 15° of the poles, and called such mean the polar diameter. He similarly took the mean of all diameters measured within 15° of the equator, and called such mean the equatorial diameter. The mean dates to which these mean diameters belong are not given by Auwers. For example, the observations made by Adolph in Strassburg were all made on fifteen days between Sept. 2 and Sept. 25, 1873. In this series Adolph made in all some fifty-seven determinations of the sun's diameter; of which fifty-seven measures ten fall within the 15° limit of the pole, and nine within the corresponding limit of the equator. The polar measures were made on Sept. 8, 14, 18 and 21; the equatorial measures, on Sept. 18, 20, 21, 23 and 25. The remaining thirty-eight observations of this series were not utilized by Auwers in this investigation.

As a result of these nineteen measures by Adolph, Auwers finds the value for the ratio between the polar and equatorial diameters —0″.16, in the sense polar minus equatorial; and this value, I have assumed, is the value for Sept. 18, the mean date of the observations. Such an assumption is, of course, more or less approximate, but it gives a date sufficiently close for the purpose in hand.

Series of 1873–75. — In the first series of observations, extending from 1873 to 1875, there are in all thirteen such sets of observations. These are tabulated below, being arranged according to the mean dates of the observations, the weights being those assigned by Auwers.

Table IX.

Date.	Observer.	P.–E.	Weight
1873, Sept. 18	Adolph	—0″.16	0.5
1873, Sept. 20	Borgen	+0″.03	0.5
1873, Oct. 20	Valentiner	—0″.21	0.5
1873, Dec. 15	Wittstein	+0″.05	1.0
1874, Feb. 4	Weinek	+0″.15	0.8
1874, March 18	Schur	+0″.09	0.2
1874, April 3	Adolph	—0″.32	0.2
1874, May 15	Schur	+0″.15	1.0
1874, Dec. 26	Adolph	+0″.16	1.7
1874, Dec. 28	Borgen	+0″.21	0.1
1874, Dec. 29	Valentiner	+0″.23	0.2
1875, Jan. 5	Schur	+0″.44	0.4
1875, Jan. 5	Seeliger	+0″.13	0.2

While the separate determinations vary, a simple inspection of the above table shows that there was a progressive change in the difference between the polar and equatorial diameters. In the earlier measures the equatorial diameter was slightly the greater; in the later measures the polar diameter was decidedly the larger. This is shown not only by the average result, but by the measures of each observer. Adolph, Borgen, Valentiner and Schur made observations in the fall of 1873 and the spring of 1874; again, these same observers made other series of observations in the latter part of 1874 and in January, 1875. In the case of each of these four observers, the difference, P.–E., is greater in the latter series. These results are shown in the following table:

Observer.	1873–74.	1874–75.
Adolph	—0″.20	+0″.16
Borgen	+0″.03	+0″.21
Valentiner	—0″.21	+0″.23
Schur	+0″.14	+0″.44

Again, divide the entire series of observations into three groups, placing in the first group all the observations made in 1873, in the second group those made in the spring of 1874, and in the third group those made in December, 1874, and in January, 1875. Give to each observer the weight assigned by Auwers, and form the weighted mean of each of the three groups. The observations then fall into the following order:

Mean Date.	P.–E.	Weight.
1873, October	—0″.06	2.5
1874, March	+0″.10	2.2
1874, December	+0″.21	2.6

And these means show the same progressive change as do the observations of the separate observers.

Series of 1880–85.— In this series there are in all thirty-two sets of observations, of which number, however, twenty-three were made in 1882. These are tabulated in Table X, being arranged according to the date of observation in a manner entirely similar to the former table for 1873–75.

Table X.

Date.	Observer.	P.–E.	Weight.
1880, May 9	Ambronn	+0″.19	1.1
1880, July 15	Ambronn	+0″.08	4.0
1881, Sept. 30	Franz	—0″.51	0.3
1881, Nov. 10	Schur	+0″.22	2.8
1882, March 14	Kobold	+0″.28	0.5
1882, March 25	Peter	+0″.06	5.0
1882, March 28	Müller	+0″.37	0.5
1882, April 4	Kobold	—0″.05	2.8
1882, April 6	Marcuse	+0″.07	0.7
1882, April 15	Küstner	.00	0.4
1882, April 15	Kempf	+0″.09	1.7
1882, May 3	Deichmüller	—0″.04	4.0
1882, May 15	Hartwig	+0″.09	6.2
1882, May 15	Schur	+0″.13	4.0
1882, May 22	Franz	+0″.06	0.5
1882, June 4	Wislicenus	+0″.02	4.0
1882, July 2	Bauschinger	—0″.05	1.7
1882, Nov. 20	Franz	—0″.06	1.0
1882, Nov. 25	Küstner	+0″.13	1.3
1882, Nov. 25	Kobold	—0″.01	1.7
1882, Nov. 30	Deichmüller	—0″.30	0.1
1882, Nov. 30	Müller	—0″.34	0.2
1882, Nov. 30	Auwers	—0″.01	1.7
1882, Dec. 2	Wislicenus	—0″.28	0.3
1882, Dec. 4	Peter	+0″.15	0.5
1882, Dec. 5	Kempf	+0″.32	0.6
1882, Dec. 5	Hartwig	+0″.30	0.7
1883, May 15	Wislicenus	—0″.21	6.2
1883, June 4	Hartwig	—0″.02	2.8
1884, March 17	Marcuse	+0″.28	0.3
1885, Jan. 7	Kobold	+0″.14	0.3
1885, Jan. 16	Battermann	—0″.48	0.3

An inspection of these results will again show a change in the difference between the polar and equatorial diameters. This change is not at once apparent, for the relative weights of the separate determinations in this series differ greatly, the largest being 6.2, the smallest 0.1. Some of the determinations of small weight differ considerably from adjacent and better observations, and these poor values tend to conceal the progressive change in the ratio between the diameters. This change, however, is clearly brought out when the observations are divided into groups and the weighted means of each group formed. When this is done, we find that the observations arrange themselves as in the following table:

Date.	P.–E.	Weight.
1880, June	+0″.10	5.1
1881, October	+0″.11	3.1
1882, March	+0″.06	11.6
1882, June	+0″.05	20.4
1882, November	+0″.05	8.1
1883, May	—0″.15	9.0
1884, March	+0″.28	0.3
1885, January	—0″.17	0.6

We thus see that during the interval from 1881 to 1883 there is a progressive change; the equatorial diameter apparently growing longer in relation to the polar diameter. While the division of the observations of the year 1882 into three groups is more or less arbitrary, yet, no matter how these observations had been grouped, the progressive character of the change would have been apparent. The mean of all the determinations for the year 1882 is + 0″.05 with a weight of 40.1.

Tabulation of Results. — Collecting the results of the various determinations into a single table, we have the following data from which to determine the shape of the sun. In this table the measures are all reduced to the same form, and give the excess in arc of the polar radius over the equatorial. For convenience of comparison the series of Auwers and Ambronn are separated into groups, the observations of various years or series of years being collected together.

Table XI.

Meridian Observations.

Date.	*Observer.*	*P.–E.*
1809	Von Lindenau	+5″.0
1831	Bianchi	—3″.0
1871	Secchi	—0″.8
1885	Auwers	—0″.2

Heliometer Observations.

Date.	*Observer.*	*Series*	*P.–E.*	
1891	Auwers	1873–75	+0″.05	
1891	Auwers	1880–82	+0″.03	+0″.019
1891	Auwers	1883–85	—0″.01	
1905	Ambronn	1890–91	+0″.05	
1905	Ambronn	1893–94	—0″.02	+0″.013
1905	Ambronn	1894–00	+0″.01	

CONCLUSIONS. — While very little weight can be attached to the meridian observations, yet every series shows a measurable departure from the spherical form. The observations of the Von Lindenau series were afterwards included in the more complete and thorough discussion of Auwers, who showed that the great difference, 5″, found by Lindenau was not warranted by the observations. Meridian observations are unsuitable for the investigation, and if there be any departure of the sun from sphericity, it is below the limit of such measures.

The heliometer measures confirm the result that the departure from sphericity is extremely small, but they hardly warrant the assumption that the sun is a sphere. Auwers, Ambronn, Seeliger and Wellmann have shown that the measured diameters depend upon the color and thickness of the shade-glasses used in the observations; Auwers found instrumental peculiarities, different instruments giving different results; and Ambronn found that the introduction of a reflecting prism diminished the measured diameter by 0″.4. The series of observations used by Auwers were extremely heterogeneous, twenty-three observers using five heliometers. The individual series were short, extending over periods of a few months only. The series of Ambronn, on the other hand, are perfectly homogeneous, and they furnish the very best evidence yet obtained. They indicate that the departure of the sun from spherical form is extremely minute, and at the very limit of possible measurement by these means. Considering this series by itself, if no weight be placed upon possible variations in the solar diameter, then the conclusion must be that the sun is sensibly a sphere.

Unfortunately for a thorough test of the photographic method, no long series of plates were available. While several observatories have for many years photographed the sun on each clear day, yet these photographs are not suitable for the present investigation.[1] They were mostly made with horizontal instruments and no attention paid to sharpness of edge. The mirror of such instruments introduces errors and makes the image unsymmetrical. Only such plates as have been made with an equatorially mounted objective of relatively long focus can be used, and there are no long series of such plates. The early plates of Rutherfurd give quite consistent results, the general mean of all the plates agreeing closely with that of Auwers as found from the heliometer measures in the same years. These plates of Rutherfurd were made on collodion films and give the sharpest and best images of any plates measured.

[1] This applies to American observatories. The photographs taken at the Royal Observatory at Greenwich are probably well adapted for this investigation.

In 1893–94 the plates by Wilson give a result having the same sign as Ambronn's mean for these same years. The photographic result, however, is very much larger. The photo-heliometer promises to give accurate results; and a forty-foot instrument of this character should finally decide the question as to the shape of the sun.

The only conclusion that can safely be drawn from the conflicting data is, that the exact shape of the sun is not known with certainty. On the average, it approximates very closely to a sphere; the difference between the equatorial and polar radii, if such difference exists, being probably not more than 0″.25. The heliometer measures show marked variations in the different years, and a part of the conflict in the results may be due to actual variations in the shape and size of the sun.

VARIABILITY OF THE SUN'S DIAMETER.

The following table exhibits the results of the various investigations mentioned in the first part of this paper.

Table XII.

MERIDIAN OBSERVATIONS.	
1809 *Lindenau*	Periodic variations.
1809 *Lindenau*	Re-discussed 1889 by Auwers — no variations.
1871 *Secchi*	Varies inversely with the number of sun-spots.
1871 *Secchi*	Re-discussed 1885 by Auwers — no variations.
1874 *Newcomb & Holden*	No long-term variation.
1895 *Auwers*	1st discussion — varies with number of sun-spots.
1895 *Auwers*	2d discussion — observed variation due to variable personal equations.
HELIOMETER OBSERVATIONS.	
1905 *Ambronn*	Periodic variation of 0″.1, but no relation to sun-spot period.

These investigations dealt with possible variations in either the equatorial or polar diameter, as in Auwers' work, or in the average or mean diameter, as in Ambronn's paper. But the state of the atmosphere, the sharpness of the image, the color of the shade-glass used, — all these affect the measured diameter, and introduce accidental and semi-periodic errors. Any actual variations in the diameter will, therefore, be masked by these errors of observation, and correspondingly difficult to determine. On the other hand, if there be a variation in the sun's diameter, it is improbable that such variation affects both the polar and equatorial diameters in the same way. The measured differences between the two diameters is thus more likely to show the presence of a variation than will the direct measures of either diameter by itself. Again, when both diameters are measured on the same day, both are affected by the errors due to atmospheric conditions and to instrumental peculiarities. Measures of the differences of the diameters are, therefore, to a large extent, free from the troubles which mark the measures of each diameter itself, and such measures furnish the best test for possible variations in the sun.

For such an investigation the observations of Schur and Ambronn provide material, for on each day of observation during twelve years, they measured both equatorial and polar diameters. The transit of Venus heliometer measures, as reduced by Auwers, are not so satisfactory; for the polar and equatorial measures were not made on the same days. In each series used by Auwers, the measures of the respective diameters were scattered irregularly, only a few days, however, separating the individual measures; and the mean results should be more free from the masking errors due to atmospheric conditions than simple determinations of either diameter. Such measures should be free from instrumental peculiarities and the effects of different colored shade-glasses.

Fluctuations Having the Same Period as the Sun-spots. — The writer proposes to investigate possible variations in the sun, using the difference of diameters (polar-equatorial) as given in the works of Auwers and Ambronn. The method of equations of condition as elaborated by Newcomb will be used; and for the purpose of forming such equations it will be assumed that the difference between the diameters (P.–E.) fluctuates harmonically in a period of 11.13 years. This is the mean sun-spot period as determined by Newcomb, and if there be any variation in the shape of the sun, it is just as likely to follow this rigorous period as to follow any arbitrary system of numbers based upon the actual number and size of spots visible at a given time.

This assumption may be represented by an equation of the form

$$P-E=\rho \cos (\mu t+C)+z$$

where μ is so taken that the angle $\mu t + C$ shall increase by 360° in the sun-spot period of 11.13 years. When the year is the unit of time, this gives

$$\mu=32^\circ.25.$$

The constant C determines the phase at the epoch from which it is measured. This epoch is arbitrary, and in the present investigation will be taken as 1889.12, corresponding to a sun-spot minimum.

Expanding the cosine term, the above expression can be put into the form

$$n=x \cos \mu t+y \sin \mu t+z$$

where

$$x=\rho \cos C$$
$$y=-\rho \sin C$$
$$n=P-E.$$

If, now, we write

$$a=\cos \mu t$$
$$b=\sin \mu t$$

the equation of condition becomes finally

$$ax+by+z=n.$$

The yearly values of the quantity P.-E. are taken from the results of Auwers and Ambronn as given in the previous tables. The values of the coëfficients a and b can be readily computed for each year from the corresponding value of μ. The resulting equations of condition are given in the following table:

Table XIII.

Date.	Observer.	*a.*	*b.*	*n.*
1873, October	Auwers	—0.7	—0.7	—0″.06
1874, March	Auwers	—0.5	—0.8	+0″.10
1875, January	Auwers	—0.1	—1.0	+0″.21
1880, June	Auwers	+0.1	+1.0	+0″.10
1881, October	Auwers	—0.5	+0.8	+0″.11
1882, July	Auwers	—0.8	+0.6	+0″.05
1883, June	Auwers	—1.0	0	—0″.15
1885, January	Auwers	—0.6	—0.8	—0″.17
1890, July	Ambronn	+0.7	+0.7	+0″.12
1891, July	Ambronn	+0.2	+1.0	+0″.08
1892, January	Ambronn	—0.3	+0.9	0″.00
1893, July	Ambronn	—0.8	+0.6	—0″.06
1894, July	Ambronn	—1.0	+0.1	+0″.02
1895, July	Ambronn	—0.9	—0.4	+0″.04
1896, July	Ambronn	—0.5	—0.9	—0″.03
1897, July	Ambronn	0	—1.0	—0″.01
1898, July	Ambronn	+0.5	—0.8	+0″.09
1899, July	Ambronn	+0.9	—0.4	+0″.01
1900, July	Ambronn	+1.0	+0.1	+0″.02
1901, July	Ambronn	+0.8	+0.7	+0″.06
1902, July	Ambronn	+0.3	+1.0	—0″.06

Three least square solutions were made, the first including the Auwers series 1873–85; the second, the Ambronn series, 1890–1902, and the third, the entire series of heliometer measures from 1873 to 1902. The results of these three solutions are shown below:

SERIES.	x.	y.	z.
1873–85	$+0''.255$	$+0''.015$	$+0''.156$
1890–02	$+0''.032$	$+0''.001$	$+0''.019$
1873–02	$+0''.048$	$+0''.006$	$+0''.029$

The probable error for x in the whole series is $\pm$ 0″.021. Thus the value of x as found from the equations is slightly more than twice its probable error. Moreover, in each series the three quantities come out with the same sign and approximately of the same relative values. Reducing the results to monomials, we have finally for the three determinations

$$\text{P.–E.} = +0''.256 \cos(\mu t - 4^\circ) + 0''.156 \quad \text{series of 1873–85.}$$
$$= +0''.032 \cos(\mu t - 2^\circ) + 0''.019 \quad \text{series of 1890–02.}$$
$$= +0''.049 \cos(\mu t - 6^\circ) + 0''.029 \quad \text{series of 1873–02.}$$

These results were obtained by assuming a harmonic variation having a period of 11.13 years. They show that the phases of such a variation coincide to within one-fifth of a year with the phases of the sun-spot fluctuations; that, at times corresponding to minimum of sun-spottedness, the polar diameter is relatively larger; that, at times of maximun sun-spottedness, the equatorial diameter is relatively larger.

The amplitude of the variation is extremely small, but its reality would seem to be established. The present investigation at least renders the existence of such periodic fluctuations in the shape of the sun more probable than their non-existence.

SEARCH FOR SHORT-TERM PERIODIC VARIATIONS. — If the equator of the sun were of permanent elliptic shape, then we should have a periodic variation in the observed differences between the polar and equatorial diameters, and the period of this variation would be equal to the sun's synodic rotation. While it is extremely improbable that any such permanent deformation exists, yet semi-permanent deformations may readily occur. The sun-spots are local phenomena; and when large spots exist on one portion of the surface, the equator may be deformed in such regions, and such deformation may persist during many rotations of the sun.

Unfortunately for investigating the question of the existence or non-existence of fluctuations in the measured shape of the sun, corresponding to possible deformations of the equator, the sun's synodic rotation is not a well defined constant. Different portions of the surface rotate in different periods. According to the latest spectroscopic researches, the equatorial regions rotate in 24.46 days, and regions in latitude 80°, in 30.56 days.

The corresponding synodic periods are 26.92 and 33.35 days respectively. Sun-spot observations give 27.25 days for the synodic period. This uncertainty in the period prevents us from using the method of equations of condition, similar to that used in investigating the fluctuations corresponding in period to the sun-spot cycle. But Newcomb[1] has lately developed a method, which he calls the "method of time-correlation," by which the fluctuations in any measured quantity can be investigated and the existence of or tendency towards periodic variations detected. This method may be briefly outlined as follows.

Suppose we have a series of values of a measured quantity for equidistant intervals of time,

$$t,\ 2t,\ 3t,\ \text{etc.}$$

and let

$$a_0,\ a_1,\ a_2,\ a_3\ \ldots\ldots\ a_n$$

be the departures of these values from the general mean. Now multiply each one of these residuals in turn by the first residual, a_0, so that we have the products

$$a_0a_0,\quad a_0a_1,\quad a_0a_3\ \ldots\ldots\ a_0a_5.$$

If these residuals be purely periodic, having for a period some multiple of t greater than 2, then these products will fall into a rhythmical series. The first product and the product corresponding to the end of the period will both be positive; the intermediate products, positive or negative. If we form a similar series of products by multiplying the second and each succeeding one by the second residual, then these products will again fall into a similar rhythmical series. Continuing the process we should have the following:

	a_0a_0	a_0a_1	a_0a_2	. . . .	a_0a_4
	a_1a_1	a_1a_2	a_1a_3	. . . .	a_1a_5
	a_2a_2	a_2a_3	a_2a_4	. . . .	a_2a_6
	|	|	|		|
Sums	$[a_0a_0]$	$[a_0a_1]$	$[a_0a_2]$		$[a_0a_4]$

If, now, the period in which the residuals repeat be 4t, then the first and fifth products will in every series be positive, and therefore the sums of these products, $[a_0\,a_0]$ and $[a_0\,a_4]$, will be positive. The intermediate

[1] A Search for Fluctuations in the Sun's Thermal Radiation through their Influence on Terrestrial Temperature (American Phil. Society, N. S., Vol. XXI, Part V).

sums will be positive or negative and the whole series of sums will form a rhythmical curve.

Even if the purely accidental errors of the observations be so large as to mask completely the periodic character of the residuals, yet the effects of these errors will be largely eliminated in forming the products and taking the sums, and the final sums will form a rhythmical curve. Instead of using these sums directly, Newcomb finds the ratio of each sum to the first, $[a_0 a_0]$, and calls these successive ratios x_1, x_2, x_3, etc., so that

$$x_i = \frac{[a_0 a_i]}{[a_0 a_0]}$$

where $i = 1, 2, 3$, etc.

Now if the observations be periodic, or if there be a tendency toward a rhythmical deviation whose period is approximately a multiple of t, then such period or tendency will be shown by an increasing value of x at the time corresponding most nearly to the completion of the period. If there be no tendency toward any period between 2t and nt, then the series of x's should converge toward zero.

This method was used in an investigation of the observations of the difference between the polar and equatorial diameters of the sun as made by Schur and Ambronn during the years 1892–1902. As has been noted, the general mean of all of Schur's observations made during the period was + 0″.018, while that of Ambronn was only + 0″.002. In the case of Schur, therefore, the residuals found by subtracting this mean (+ 0″.02) from each observation were used instead of the observations themselves. In the case of Ambronn, the mean being so nearly zero, the observations were used directly. The whole series of observations was then divided into consecutive periods of seven days, and the mean residual for each period found. In all there were 654 such seven-day periods, out of which number seventy-one periods only contained observations by both observers. In eighteen periods, Schur had two or more observations, and in six periods Ambronn had two observations.

The series is disconnected; there are many periods in which no observations were made, and these periods are scattered irregularly throughout the series. The longest period in which consecutive observations were made was begun in May, 1899, when observations were made in eleven successive seven-day periods. In the entire series there are found only nine cases in which observations were made on six or more consecutive seven-day periods and which therefore could be used in the present investigation. In addition to these nine, two other sets were utilized, in one of which observations were made on thirty-nine weeks with but three or four breaks of single weeks; in the other set, observations were made on nineteen weeks with but three breaks.

To illustrate the method by which the periodicity was investigated, the tabulation for the longest series of consecutive observations is given in full. The first column gives the date of beginning of each of the seven-day periods into which the observations were divided. The second column gives the mean residual for the period as taken from Appendix IV of Ambronn's work. In the first period there were two observations by Schur and one by Ambronn; and the mean of the three, after subtracting + 0″.02 from each of Schur's, is — 0″.11. The remaining columns in the table give the successive products formed by multiplying a_0 into the successive residuals. The products of the first a_0 (— 0.11) by itself and the following five residuals are found in the first horizontal line.

Table XIV.

Date.	a_0	a_0a_0	a_0a_1	a_0a_2	a_0a_3	a_0a_4	a_0a_5
1899, May, 29	—0.11	+0.0121	+0.0209	—0.0011	+0.0066	+0.0088	—0.0341
1899, June, 5	—0.19	+0.0361	—0.0019	+0.0114	+0.0152	—0.0589	0.0000
1899, June, 12	+0.01	+0.0001	—0.0006	—0.0008	+0.0031	0.0000	+0.0003
1899, June, 19	—0.06	+0.0036	+0.0048	—0.0186	0.0000	—0.0018	+0.0012
1899, June, 26	—0.08	+0.0064	—0.0248	0.0000	—0.0024	+0.0016	—0.0328
1899, July, 3	+0.31	+0.0961	0.0000	+0.0093	—0.0062	+0.1271	+0.0465
1899, July, 10	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	
1899, July, 17	+0.03	+0.0009	—0.0006	+0.0123	+0.0045		
1899, July, 24	—0.02	+0.0004	—0.0082	—0.0030			
1899, July, 31	+0.41	+0.1681	+0.0615				
1899, Aug. 7	+0.15	+0.0225					
Sums		+0.3463	+0.0511	+0.0095	+0.0208	+0.0768	—0.0189
x_i			+0.1476	+0.0274	+0.0601	+0.2218	—0.0546

Each column of the table is summed up and the bottom line gives the cœfficients of correlation x_i, found by dividing the footings of the last five columns by the sum of the a_0 a_0's.

The values of x thus found are distinctly periodic. There is a marked increase in the third and fourth values, and this indicates a tendency towards a period of approximately twenty-eight days. The series, however, is too short for any definite conclusion, and considered by itself this series would have but little weight in testing the actuality of this apparent periodicity.

The ten other series of observations were each tabulated and investigated for periodicity in the same manner. It does not seem necessary, however, to give the individual residuals and products in detail. But the following table gives the footing for each column of products in the different series, and shows the date of beginning and the number of seven-day periods in each.

Table XV.

Date.	No.	a_0a_0	a_0a_1	a_0a_2	a_0a_3	a_0a_4	a_0a_5
1891, Feb. 16	7	+0.3262	+0.0812	+0.0602	+0.0887	—0.0040	—0.0174
1892, March 7	6	+0.1255	+0.0347	+0.0132	+0.0097	—0.0343	—0.0248
1895, April 29	6	+0.0563	+0.0114	—0.0181	—0.0079	—0.0026	—0.0105
1896, April 27	6	+0.7938	+0.0390	+0.1749	+0.2698	—0.0908	+0.0040
1897, April 19	10	+0.3557	—0.0352	—0.0393	—0.0547	+0.0293	—0.1033
1897, April 19	37*	+1.5752	—0.2549	—0.2903	—0.0217	+0.2213	—0.1859
1899, Jan. 23	9	+0.3446	+0.1257	+0.1269	—0.0255	—0.0275	—0.0801
1899, May 29	11	+0.3463	+0.0511	+0.0095	+0.0208	+0.0768	—0.0189
1900, Feb. 5	19*	+0.2688	+0.0063	—0.1188	+0.0543	+0.1251	—0.0138
1900, April 16	8	+0.0335	+0.0133	+0.0062	+0.0067	+0.0035	+0.0078
1901, April 15	8	+0.1022	—0.0026	+0.0038	—0.0444	—0.0019	—0.0062
Sums		+4.3281	+0.0700	—0.0718	+0.2958	+0.2949	—0.4491
x_i			+0.0162	—0.0166	+0.0683	+0.0681	—0.1038

The series of x's are again distinctly periodic, and indicate a tendency towards a twenty-eight-day period. This tendency is not only shown by the final series of x's, but it is also shown by nearly every one of the individual sets of footings as given in the above table. In six cases the increase is marked in the $a_0\,a_4$'th column; in two cases, in the $a_0\,a_3$'d column; and in one case, in the $a_0\,a_5$'th column. Two series only show no tendency towards periodicity, and of these one is a short series of six weeks only, beginning March 7, 1892. The other series, which shows no periodicity, is the relatively long one beginning Jan. 23, 1899, and extending over nine weeks. On the whole, however, the tendency towards a recurrence at the end of approximately twenty-eight days is quite marked.

Continuing the products for the two long series up to $a_0\,a_8$, we have for the series of products:

* Broken series.

Table XVI.

	1897 April 19.	1900 Feb. 5	Sums.	x_i.
a_0a_0	+1.5752	+0.2688	+1.8440	
a_0a_1	—0.2549	+0.0063	—0.2486	—0.1348
a_0a_2	—0.2903	—0.1188	—0.4091	—0.2219
a_0a_3	—0.0217	+0.0543	+0.0326	+0.0174
a_0a_4	+0.2213	+0.1251	+0.3464	+0.1878
a_0a_5	—0.1859	—0.0138	—0.1997	—0.1083
a_0a_6	—0.5121	—0.0470	—0.5591	—0.3032
a_0a_7	+0.0105	+0.0732	+0.0837	+0.0454
a_0a_8	+0.5543	+0.0544	+0.6087	+0.3301

The x's pass through two complete cycles in fifty-six days, thus again showing the tendency of the observations to group themselves in periods of twenty-eight days.

The present investigation would appear to show, therefore, that, at the time of these observations, the measured differences between the equatorial and polar diameters of the sun had a decided tendency to fluctuate in a period of approximately twenty-eight days. This would indicate that the sun's equator was deformed; whether this deformation was permanent or transitory, the observations afford no means of deciding.

Part IV. Conclusions.

The general results of the present investigation may be summed up in the following: —

1. The exact shape of the sun is not known. The generally accepted idea that the sun is a sphere is at least open to question. Practically every series of measures heretofore made show departures from a spherical form; but these departures are extremely minute, the difference between the different radii of the sun being probably not more than 0″.25.

2. A study of all the available heliometer measures shows a fluctuation in the shape of the sun corresponding in period with the sun-spot cycle. The amplitude of this fluctuation is small, being probably not over 0″.10. This variation is shown by the great mass of heliometer measures made by the German observers in connection with the transits of Venus in 1874 and 1882, and by the superb series of observations made by Schur and Ambronn at Göttingen in 1890–1902.

3. In addition to this long-period variation, the observations of Schur and Ambronn would seem to indicate a fluctuation in the measured value of P.–E. having a period of about twenty-eight days. The observations are so scattered that they do not permit of a thorough determination of the reality of this fluctuation and of the exact length of its period. If real, this fluctuation can be accounted for by a permanent or semi-permanent deformation of the sun's equator.

4. Questions as to the exact shape of the sun, and as to possible variations in its size and shape, can only be set at rest by a long series of homogeneous observations. The data at present available are not sufficient for this purpose. Observations should be made on every clear day, and the series should be extended over at least one solar cycle.

5. A photographic heliometer would probably furnish the best results. With such an instrument, the moments of good "seeing" can be utilized and a number of plates taken within a short time. These plates can later be measured and reduced by the ordinary staff of a computing bureau.

Columbia University,
March, 1908.

[ANNALS N. Y. ACAD. SCI., Vol. XVIII, No. 10, Part III, pp. 425–429.
16 December, 1908.]

OUTLINE OF THE GEOLOGY OF LONG ISLAND, N. Y.[1]

BY W. O. CROSBY.

(*Read before the Academy 5 October, 1908.*)

The crystalline rocks (chiefly granitic and gneissic) outcropping in Astoria and Long Island City are the foundation or true bed-rock of Long Island geology. Their origin need not be considered here; for the geological history of Long Island begins with the development on this crystalline bed-rock of the Cretaceous peneplain, with its heavy load of sediments. The Cretaceous was a period of slow subsidence, the land sinking beneath the sea slowly enough to permit its almost perfect planation by marine erosion. In other words, this peneplain has a dual origin, — subaërial and marine; true peneplanation obtaining above sea level, and still more approximate planation below sea level. This seaward plain, in further contrast with the landward peneplain, was covered by the Cretaceous sediments by which it is still, in large part, protected. It is clearly indicated, where recently uncovered, in the straight crest line of the Palisades.

The progressive subsidence was favorable to the progressive landward overlap of the Cretaceous sediments, by virtue of which only the later divisions are exposed to observation, the true lower Cretaceous being confined to the continental shelf, beyond the existing shore line. The conditions were undoubtedly favorable, also, to the extensive subaërial decay of the crystalline rocks, thus furnishing in abundance the variegated clays and muscovitic or fluffy sands so characteristic of the Raritan formation. Marine planation was clearly favorable, too, to the elimination from the mechanical detritus of all decomposable materials, leaving a residuum of clean quartz sand and gravel, thus accounting for the Lloyd Sand and other highly quartzose members of the formation. The increasing remoteness and degradation of the land finally made possible the deposition of the clay

[1] Published by permission of the Chief Engineer of the Board of Water Supply, City of New York.

marls and greensand marls of the upper Cretaceous; and it is probable, as others have suggested, that the deposition was continuous without important break through Eocene time. The original inland extension of this mantle of conformable sediments is clearly indicated by the southeastward deflection of the Connecticut River at Middletown and of the Housatonic River in approximately the same latitude. Entering at these points upon the newly-formed coastal plain, the rivers, released from the control of the bed-rock structure, naturally took the most direct course seaward; and subsequently, through the erosion of the Cretaceous mantle, found themselves superimposed upon the bed-rock in the obliquely transgressive and unsympathetic relation which we now observe. The Hudson, on the contrary, has felt throughout its history the efficient control of the continental re-entrant into which it debouches.

The continental elevation which finally terminated the Cretaceous-Eocene deposition was probably at least equal to the present relief of the Cretaceous peneplain; and it may have been much more than this. It made possible the rapid erosion of the uplifted sediments and, probably, the trenching of the underlying peneplain. From this time, apparently, dates the wide and deep transverse valley which divides the Cretaceous beds in the western part of Long Island and which Veatch has called the valley of Sound River. In this valley was deposited, probably by stream action, the so-called Jameco Gravel, containing a high percentage of granitic detritus, which Veatch has regarded as the product of early Pleistocene glaciation. The granite pebbles, although now in an advanced state of decay, are well rounded or water-worn, showing that they must have been firm and undecomposed at the time of their deposition. The composition of this gravel suggests that the post-Eocene elevation may have been sufficient to induce glaciation. But, whether of glacial or non-glacial origin, this dark gravel, which blends upward with clays of probable Tertiary age, should be referred to the Tertiary series and not to the Pleistocene.

During the deposition of the Jameco Gravel, the land subsided to a position of comparative stability at the Tertiary base-level and the development of the Tertiary or Piedmont peneplain, under the joint agency of subaërial and marine erosion, began. The fluvial portions of the Tertiary base level, developed, for the most part, on comparatively weak rocks, have gained general recognition as the broad valley floors of the Hudson, Connecticut and other rivers. But in New England, at least, the marine contribution to this base-level, developed chiefly on relatively resistant crystalline rocks, has usually failed of differentiation from the older and far more continuous and complete Cretaceous peneplain. Profiles normal to the coast show, nevertheless, a more or less distinct terrace, and show, further, that this far exceeds in extent and continuity the portions of the Tertiary base-level developed by fluvial erosion. In eastern Massachusetts, where, apparently, the exposure to the Atlantic surges was, as now, unrestricted, the Tertiary base-level has a broad and singularly perfect development; but on the coasts of Rhode Island and Connecticut, protected in Tertiary times, as now, by a cordon of islands and reefs, it is rather less distinct and continuous, though by no means wanting.

The planation of the uplifted and tilted Cretaceous sediments by the Tertiary sea progressed rapidly, developing the well-known unconformity at the base of the Miocene and furnishing, doubtless, the major part of the heavy bed of clay overlying the Jameco Gravel, which I have elsewhere correlated with the Chesapeake division of the Miocene and which Veatch has correlated with the Sankaty Head deposits of probable early Pleistocene age. This clay is predominantly dark and carbonaceous and abundantly characterized by lignite and segregations of iron sulphide,— characters which seem to forbid its correlation with the Pleistocene, and especially with the fossiliferous quartz sands of Sankaty Head. Certainly the fact that it passes downward into gravel containing decomposed granitic pebbles does not demand such correlation.

When, finally, the Tertiary sea had transgressed over the Cretaceous series and reached the crystalline bed-rock, marine erosion was able, by virtue of the excessively slow subsidence, to accomplish its perfect work, reducing the surface to a plane and the detritus to a residuum of indestructible quartz, which we now know as the "Yellow Gravel" and correlate chiefly, at least, with the Pliocene (Lafayette). The composition of the Yellow Gravel is vastly significant, especially in its genetic relation to the pleneplain; and comparison with the Jameco Gravel should prove fatal to the suggestion of an ultimate glacial origin. Its volume is also impressive and, in view of the limited extent of the Tertiary peneplain, suggests derivation, in part, from the similar gravels of the Cretaceous series. As a result of the progressive subsidence during the deposition of the several Tertiary terranes, we find that in their areal relations the Jameco Gravel is very restricted; the Chesapeake Clay is less restricted, and the Yellow Gravel is virtually unrestricted.

Contrary to the views of several of the later workers in this field, I hold that the Pleistocene glacial history of Long Island is relatively simple. The known facts appear to be satisfactorily accounted for by a single ice invasion; and correlation with the complex Pleistocene stages of the Mississippi Valley is certainly not demanded.

That the Pleistocene glacial period was, for this region, preceded and ushered in by a long-continued continental uplift is generally conceded, and we have positive proof in the submerged canyon of the Hudson of an elevation of approximately three thousand feet, or, according to Spencer, of nine thousand feet or more. From this elevation date the trenching of the Tertiary peneplain and its connecting base-leveled valleys and the main features of the modern coastwise topography, including the cuesta of Long Island and the inner lowland of Long Island Sound.

It appears most probable, as first suggested by Upham, that the Pleistocene ice-sheet originated in this latitude by accumulation, with the subsequent development by movement and ablation of a bold, aggressive, moraine-building front. The now drowned inner lowland of Long Island Sound is undoubtedly still floored by Cretaceous clays and sands. Across this floor, except at the narrow east and west ends, as shown by Merrill, the ground moraine was not dragged; and the erratics from the Connecticut shore must have been transported englacially, as also suggested by Merrill. The building of the moraines is due to the deformation by the thrust, and in part also by the vertical pressure, or dead weight, of the ice of the plastic Cretaceous clays and sands and the overburden of Tertiary gravel, and the incorporation in the latter, by the joint agency of the deformation and glacial streams, of the erratic detritus set free by the ablation of the ice.

The transverse valleys and deep bays of the north shore of Long Island are probably in part pre-glacial,— original features of the cuesta and inner lowland. But in part, also, they must be attributed to the erosive action of the advancing ice, and to the occupation of pre-determined depressions by lobes of stagnant ice during the glacial retreat, while the bordering areas were being overspread by washed or modified drift, chiefly sand and gravel. In this connection it is interesting to note the close agreement in trend of these valleys with the glacial movement.

During the advance, as well as during the retreat, of the ice-sheet, conditions favored the formation of glacial lakes; and the outflowing glacial streams were, doubtless, building both delta and outwash plains of sand and gravel (earlier Manhasset gravels), derived chiefly from the deformed beds of Pliocene Yellow Gravel and Cretaceous sand. These plains were, in turn, deformed by the continued advance of the ice and buried beneath the moraines. Thus deposits essentially contemporaneous with the moraines have come to be regarded as belonging to a distinctly earlier stage of the Pleistocene; and, apparently, sufficient account has not been taken of the disturbing and complicating agency of the ice acting in conjunction with the glacial waters,— fluvial and lacustral.

The recession of the ice margin, first from the outer, and later from the inner, moraine inaugurated anew general glacial-lake conditions along the north shore. The transverse valleys and bays were occupied by lobes of ice after the uncovering of the intervening peninsulas,— chiefly irregular ridges of Cretaceous and Tertiary sediments and the earlier Manhasset gravels. Bordering the ice-lobes and overspreading the ridges was deposited a second series of deltas and outwash plains (later Manhasset gravels).

Both the earlier and the later Manhasset gravels merge outward with the moraines and the outwash plains, and, through these, are chronologically as well as stratigraphically continuous, the chief structural contrast being the general absence in the later Manhasset gravels of deformation due to glacial thrust.

The Manhasset was, in general, never continuous across the bays and harbors, toward which it still presents in part normal ice-contact slopes, and we are thus relieved of the necessity of attributing these wide and deep valleys to the erosive action in post-glacial time of the wholly insignificant tributary streams.

As noted by Woodworth and others, the bowlder bed conformably dividing the Manhasset Gravel on the west side of Hempstead Harbor is probably best explained as iceberg drift; and to the same agency, apparently, may well be referred, in general, the larger erratics scattered through and over the gravel. The so-called veneer of till over the undisturbed or later Manhasset Gravel, north of the moraine, seems to demand no other explanation. It is not a continuous body of drift, but it consists chiefly of widely scattering granitic bowlders devoid of clayey matrix, and is clearly recognizable in none of the numerous borings penetrating the Manhasset Gravel. In part, no doubt, it is till (ground moraine) which has not been completely covered by the modified drift (Manhasset Gravel).

The later Manhasset Gravel is in general entirely undisturbed and no where shows deformation that would not be readily accounted for by a relatively slight movement of the ice during its deposition. In short, proof that the later Manhasset is older than the moraines or was ever over-run by the ice-sheet, is wanting; and hence it may fairly be regarded as the last chapter in the glacial history of Long Island. The only important later contributions to the geology of the island are the post-glacial beach, dune and marsh deposits. It is especially noteworthy that there is no evidence of marine deposition during the Pleistocene or between the Yellow Gravel (Lafayette) and the modern shore.

[ANNALS N. Y. ACAD. SCI., VOL. XVIII, No. 11, Part III, pp. 431–451. Author's separates published 10 February, 1909.]

CHARLES DARWIN AND THE MUTATION THEORY.[1]

BY CHARLES F. COX.

PROFESSOR HUGO DE VRIES, in his American lectures on "Species and Varieties, Their Origin by Mutation," claims that his work is "in full accord with the principles laid down by Darwin," [2] and boldly asserts that Darwin recognized both "mutation" and individual variation, or "fluctuation," [3] as steps towards what Professor Cope aptly called "the origin of the fittest." I think many persons unfamiliar with Darwin's writings must have been much surprised on reading Professor de Vries's statement, for it has been a common belief in the scientific world for many years that the establishment of the mutation theory would be fatal to Darwinism, or would at least take from it its most original and essential features. The perpetuation of this impression has been due, very largely, to Mr. Alfred R. Wallace and certain of his followers, who have steadfastly refused to admit the possibility of the evolution of species and varieties by any form of saltation and have insisted more uncompromisingly than did Mr. Darwin himself upon the exclusive efficiency of selection exercised upon small, recurring individual fluctuations. In fact, many of Mr. Wallace's views have out-Darwined Darwin and yet Darwin, somewhat unreasonably, has been held responsible for them. Accordingly, Darwin has been charged with a radicalism which he never professed and champions of a *supposed* Darwinism have felt called upon to do battle against theories which he never distinctly repudiated or which he might even have accepted if he had known of them. Thus, Professor E. B. Poulton, in his recently published "Essays on Evolution," attacks with great severity, under the name of "Batesonians," believers in the validity of mutation as a factor in the process of evolution, although, as he admits, "mutation was of course well known to Darwin." [4] Now,

[1] Presidential address. Read at the annual meeting of the New York Academy of Sciences, 21 December, 1908.

[2] Preface by the author, p. ix.

[3] Second edition, p. 7.

[4] "Essays on Evolution," 1908, p. xviii.

I think we are justified in saying that if mutation was "*known*" to Darwin it must have been, and still is, a veritable fact; and if evolution is a universal law of nature it can not, in that case, exclude mutation. We, therefore, who believe in general evolution are compelled to decide for ourselves whether mutation has taken place and is now occurring; and we who are really Darwinians — that is to say, we who believe that Darwin set forth correctly the essential steps in the evolutionary process — are interested in knowing whether he actually recognized the fact of "discontinuous variation" or mutation, and, if so, how he fitted it into, or reconciled it with his system.

The essential factors in organic evolution, from the Darwinian point of view, are: (1) Variation, (2) inheritance, (3) over-reproduction, (4) competition, (5) adaptation and (6) selection and survival. The general explanation of these factors is as follows:

1. All organisms vary continually and in every part of their structures — that is to say, no two individuals are exactly alike in any particular.

2. Nevertheless, characters anatomical, physiological and psychological are in general transmitted to descendants; in other words, progeny essentially resemble their parents.

3. More animals and plants are brought into the world than can possibly find means of subsistence.

4. There results competition for what subsistence there is, or, as it is otherwise called, a struggle for life.

5. Since out of all the variations that occur in the constitutions or characters of organisms some must happen to be in directions to give their possessors an advantage, or advantages, in procuring the means of existence, as compared with other individuals of the same class, some of the new-born animals and plants are best adapted to their surroundings or "conditions of life."

6. These best-adapted forms ("the fittest") will win in the struggle for life and are figuratively said to be selected; the unfit will in the end be exterminated. The result is the origination (evolution) of new classes of organisms out of the old ones and their substitution for the earlier classes or groups.

Not one of these factors was originally discovered by Darwin, but he first discerned their interrelations and bound them together by a consistent and convincing philosophy. He, for example, was not the earliest observer of progressive change in the organization and external characters of animals and plants, but no one before him had had the insight to perceive that this changeability was the manifestation of a force great enough to burst the artificial limits placed about the groups called species and varieties and to enable them to transform themselves into other groups better adapted to the changing environment. Before Darwin's time every one of course had ocular demonstration of the fact that there were differences between individuals and that descendants were not in every respect like their ancestors. There was universal belief, however, that these variations never extended beyond certain narrow boundaries built round species like inviolable walls. Curiously enough, Darwin, who first broke down these boundaries, took these same individual variations as the principal foundations of his selection theory. He assumed — for he admitted that it could not be proved for any particular case — that these small differences, which ordinarily fluctuate about a certain average for each species or variety, are at times accumulated to such a degree as to carry all the members of the group forward to a new center of oscillation so as to constitute in effect a new group. It was not at first his idea that a single individual, or a small number of individuals, might occasionally develop evolutionary force enough to overleap suddenly the imaginary limit and become the nucleus of a new colony beyond; that is the substance of the mutation theory; and, while I think it can be shown that Darwin more or less clearly recognized the possibility of the occasional origin of permanent races by this method of saltation, there can be no doubt that he entertained a strong bias in favor of the evolution of species generally by slow and minute steps.

As far as cultivated plants and domesticated animals were concerned, Darwin was willing to grant the widest range of variation and the most abrupt changes, but as to animals and plants in a state of nature he was more sparing of his admissions that great and sudden departures from specific types might occur. This tenure of the two points of view was due to his belief that domesticated animals and plants were more variable than feral forms, because of the direct influence of man upon their surroundings and habits of life. Inasmuch as his theory of the origin of species through natural selection is founded on analogy between the deliberate operations of breeders in choosing the most desirable individuals of their flocks and gardens, and the inevitable sifting out of feral forms through their competition with one another in the struggle for existence, it is difficult to see why Mr. Darwin hesitated about carrying the comparison to its logical conclusion in the admission that what we now call mutations, but what he referred to as "spontaneous variations," "sports," "monstrosities," etc., stand upon substantially the same basis in nature as in cultivation. According to the present-day views of scientific students of animal and plant breeding, I understand, there is no good evidence that cultivated plants and animals are more subject to wide and abrupt variations than are those living under natural conditions. On this point Professor de Vries remarks that "it is not proved, nor even probable, that cultivated plants are intrinsically more variable than their wild prototypes."[1] As to distinct mutations, we must remember that plants and animals preserved and nurtured by man are constantly under the eyes of many thousands of pecuniarily interested observers, while those in a state of nature are closely studied by but a handful of scientific investigators. We must also remember that it is only within a few years that a small fraction of these men of science have been led to look for cases of mutation, while all gardeners, farmers and breeders have had the inducement of financial profit to watch for marked variations among their stock and to preserve such variations if desirable. The naturalists specially interested in evolutionary questions are exceedingly few in number, but their field of research is immensely extended and varied. The number of those who have raised animals and plants for gain, however, has always been large, though the number of forms which they have been called upon to consider have been relatively few. The two fields have consequently had exceedingly different degrees of scrutiny. But since de Vries and others opened up the subject an astonishing number of clearly proven cases of mutation has been discovered in very various classes of organisms, just as numerous paleontological evidences of evolution have been brought to light as a consequence of Darwin's turning men's minds in that direction.

As I have already intimated, Mr. Darwin undoubtedly dealt with numerous cases of mutation among domesticated animals and plants, and they gave him little or no intellectual disquietude. In his work on "Animals and Plants Under Domestication," he gives a long catalogue of "spontaneous variations" or "sports," many of which he freely acknowledges were the starting points of new and constant races; and there is good reason to believe that some of them occurred before the animals and plants which underwent the sudden changes had been actually brought under domestication and cultivation; in fact that the mutations themselves suggested to men the directions in which their breeding operations should be conducted. For example, take the case of the tumbler pigeon; Mr. Darwin remarks concerning this that "no one would ever have thought of teaching, or probably could have taught, the tumbler pigeon to tumble,"[2] but it seems to me obvious that no one would ever have thought of accumulating slight variations in the direction of tumbling. It is much more reasonable to suppose that the birds which were artificially selected as the progenitors of the present race of tumbler pigeons actually tumbled — that is to say, they were mutants. As to the origin of domestic races through modifications so abrupt as to

[1] "Species and Varieties, their Origin by Mutation," 2d ed., 1906, p. 66.

[2] "Origin of Species," 6th ed., 1882, p. 210.

have been thought by Darwin entirely independent of selection, he gave it as his judgment, as late as 1875, that

"It is certain that the Ancon and Mauchamp breeds of sheep, and almost certain that the Niata cattle, turnspit and pug-dogs, jumper and frizzled fowls, short-faced tumbler pigeons, hook-billed ducks, &c., suddenly appeared in nearly the same state as we now see them. So it has been with many cultivated plants." [1]

Now, considering, as I said a moment ago, that Mr. Darwin's theory of the origin of species by means of natural selection has for its main foundation-stones facts derived from observation of the effects of man's selection among domesticated animals and plants (without which, indeed, he admitted that he had no actual proof of the operation of natural selection), it is difficult to realize the state of mind which led Mr. Darwin to add to the sentence just quoted the following caution:

"The frequency of these cases is likely to lead to the false belief that natural species have often originated in the same abrupt manner. But we have no evidence of the appearance, or at least of the continued procreation under nature, of abrupt modifications of structure; and various general reasons could be assigned against such belief."

I am not aware that Mr. Darwin ever presented definite and convincing reasons for the sharp demarkation here attempted, and, indeed, I can not see how the state of knowledge in his time could have justified his doing so, for, as I have already stated, mutations had not been much looked for among feral plants and animals. In fact, by absolutely excluding from his theory the idea that mutation could occur under nature, Mr. Darwin, by the force of his great authority and influence, would have prevented a careful weighing of the pros and cons, if the human mind had at that time been prepared to weigh them. It is practically only since the Darwinian hypotheses have themselves been subjected to prolonged scrutiny, and since de Vries and a few others entered upon detailed experimental examination of this particular subject, within the last twenty years, that the matter can be said to have received anything like scientific treatment.

But, after all, Darwin was not *wholly* prejudiced against a belief in the occurrence of mutations in nature, for he several times expressed the opinion that the establishment of such a fact would in some ways be an advantage to the evolution theory. For instance, in a letter of August, 1860, to W. H. Harvey, he says:

"About sudden jumps: I have no objection to them — they would aid me in some cases. All I can say is that I went into the subject and found no evidence to make me believe in jumps; and a good deal pointing in the other direction." [2]

---

[1] "Animals and Plants Under Domestication," 2d ed., 1875, Vol. II, pp. 409–10.

[2] " More Letters," Vol. I, p. 166. See also, " Life and Letters," 1886, Vol. II, p. 333.

This of course refers to discontinuous variations in organisms under natural conditions, for he had certainly found evidence to make him believe in similar variations among domesticated animals and plants. I think Mr. Darwin never specified the directions in which a belief in mutation would be a help to him, but, from casual remarks made in various places, I fancy he had in mind the way in which it would ease him over that difficult subject, the imperfection of the geological record, and would reconcile him with the physicists and cosmogonists, who were not disposed to allow him the lapse of past time he required for the evolution of species by the accumulation of successive minute or "insensible" individual variations. But I will not discuss these points now. What I wish to dwell upon at the moment is that Darwin recognized and accepted the fact of mutation among animals and plants under domestication, although it is worth while to repeat the statement that some of his cases probably happened in a state of nature, since they occurred at the very beginning of, and were the points of origination for, man's selective operations. As Mr. Darwin himself says: "Man can hardly select, or only with much difficulty, any deviation of structure excepting such as is externally visible,"[1] which means, as I take it, that nature usually presents some quite manifest variation before artificial selection begins and this must have been the case at the time when man's first choices were made, particularly when half-civilized and unobserving men began the cultivation of our now domesticated animals and plants. It is necessary to remember, however, in this connection, that the mutation theory, as interpreted by de Vries, requires for its starting point only a variation which marks a distinct separation of a form from its parent group without connecting gradations, and not necessarily any great or extraordinary change of characters; for, as he says: "Species are derived from other species by means of sudden small changes which, in some instances, may be scarcely perceptible to the inexperienced eye."[2] None the less it remains true that man is apt to select only striking variations and hence Mr. Darwin, in treating of "sports," or what we should now call mutants, among cultivated plants and animals, usually speaks of them as wide departures from type, or, rather, he deals only with such as *are* large deviations. Even when treating of organisms in a state of nature, however, he admits that "there will be a constant tendency in natural selection to preserve the most divergent offspring of any one species."[3] Returning to the subject of artificial selection, Mr. Darwin says:

---

[1] "Origin of Species," 6th ed., p. 28.
[2] "Plant Breeding," 1907, p. 9.
[3] "Origin of Species," 6th ed., 1882, p. 413.

"No man would ever try to make a fan-tail till he saw a pigeon with a tail developed in some slight degree in an unusual manner, or a pouter till he saw a pigeon with a crop of somewhat unusual size; and the more abnormal or unusual any character was when it first appeared the more likely it would be to catch his attention." [1]

In another place he says:

"It is probable that some breeds, such as the semi-monstrous Niata cattle, and some peculiarities, such as being hornless, &c., have appeared suddenly owing to what we may call, in our ignorance, spontaneous variation;....During the process of methodical selection it has occasionally happened that deviations of structure more strongly pronounced than mere individual differences, yet by no means deserving to be called monstrosities have been taken advantage of." [2]

Now, in his work on "Animals and Plants Under Domestication", Darwin has given a long list of these widely varying forms, from each of which has descended a new race conforming to his own test of a species, namely its possession of "the power of remaining for a good long period constant .... combined with an appreciable amount of difference." [3] One of the most striking of these cases is that of the "japanned" or "black shouldered" peacocks which have occasionally appeared "suddenly in flocks of the common kind," which "propagate their kind quite truly," which, according to good authority, "form a distinct and natural species," and which tend "at all times and in many places to reappear." [4] Mr. Darwin rejects the idea that these birds are the result of hybridization and reversion and declares in favor of their being "a variation induced by some unknown cause," and says that "on this view the case is the most remarkable one ever recorded of the abrupt appearance of a new form which so closely resembles a true species that it has deceived one of the most experienced of living ornithologists." In all points this case agrees with the modern idea of a mutation, even in the respect that it comes from a family of birds not usually considered very variable.

Concerning fowls, Mr. Darwin remarks:

"Fanciers, whilst admitting and even overrating the effects of crossing the various breeds, do not sufficiently regard the probability of the occasional birth, during the course of centuries, of birds with abnormal and hereditary peculiarities. .... Whenever, in the course of past centuries, a bird appeared with some slight abnormal structure, such as with a lark-like crest on its head, it would probably often have been preserved from that love of novelty which leads some persons in England to keep rumpless fowls and others in India to keep frizzled fowls. And after a

---

[1] "Origin of Species," 6th ed., p. 28.

[2] "Animals and Plants Under Domestication," 2d ed., 1875, Vol. I, p. 96. See also, Vol. II, pp. 189–90.

[3] "More Letters of Charles Darwin," 1903, Vol. I, p. 252.

[4] "Animals and Plants Under Domestication," 2d ed., 1875, Vol. I, pp. 305–7.

time any such abnormal appearance would be carefully preserved from being esteemed a sign of the purity and excellence of the breed; for on this principle the Romans eighteen centuries ago valued the fifth toe and the white ear-lobe in their fowls." [1]

But Mr. Darwin's cases of what we must regard as saltations are not confined to the animal kingdom. We might easily cull from his list numerous more or less pertinent examples under the peach, plum, cherry, grape, gooseberry, currant, pear, apple, banana, camellia, cratægus, azalea, hibiscus, althæa, pelargonium, chrysanthemum, dianthus, rose and perhaps other plants. Concerning useful and ornamental trees he says: "All the recorded varieties, as far as I can find out, have been suddenly produced by one single act of variation," [2] and as to roses, he remarks on their marked tendency to "sport" and to produce varieties "not only by grafting and budding but often by seed," and quotes Mr. Rivers as saying that "whenever a new rose appears with any peculiar character, however produced, if it yielded seed" he "expects it to become the parent of a new family." In this connection Mr. Darwin called attention to the now well-known fact that the mutative tendency is an inheritable one by citing the case of the common double moss-rose, imported into England from Italy about the year 1735, which "probably arose from the Provence rose (*R. centifolia*) by bud-variation," the White Provence rose itself having apparently originated in the same way.[3] He called attention also to the significant fact that many abrupt variations were not to be attributed either to reversion or to the splitting-up of hybrids. Thus he declares:

"No one will maintain that the sudden appearance of a moss-rose on a Provence rose is a return to a former state, for mossiness of the calyx has been observed in no natural species; the same argument is applicable to variegated and laciniated leaves; nor can the appearance of nectarines on peach-trees be accounted for on the principle of reversion." [4]

In another place in the same work he says:

"Many cases of bud-variation....can not be attributed to reversion, but to so-called spontaneous variability, as is so common with cultivated plants raised from seed. As a single variety of the chrysanthemum has produced by buds six other varieties, and as one variety of the gooseberry has borne at the same time four distinct kinds of fruit, it is scarcely possible to believe that all these variations are due to reversion. We can hardly believe....that all the many peaches which have yielded nectarine-buds are of crossed parentage. Lastly, in such cases as that of the moss-rose, with its peculiar calyx, and of the rose which bears opposite leaves,

---

[1] " Animals and Plants Under Domestication," 2d ed., Vol. I, pp. 242–4.
[2] *Ibid.*, p. 384.
[3] *Ibid.*, pp. 405–6.
[4] *Ibid.*, Vol. II, p. 242.

in that of the Imantophyllum, &c., there is no known natural species or variety from which the characters in question could have been derived by a cross. We must attribute all such cases to the appearance of absolutely new characters in the buds. The varieties which have thus arisen can not be distinguished by any external character from seedlings. . . . It deserves notice that all the plants which have yielded bud-variations have likewise varied greatly by seed." [1]

Now, Darwin is here treating of saltations among cultivated plants, but it is instructive to read in this connection the following passage in which he prepares the ground for a belief in the possibility of similar abrupt and wide variations under natural conditions. He remarks:

"Domesticated animals and plants can hardly have been exposed to greater changes in their conditions of life than have many natural species during the incessant geological, geographical, and climatal changes to which the world has been subject; but domesticated productions will often have been exposed to more sudden changes and to less continuously uniform conditions. As man has domesticated so many animals and plants belonging to widely different classes, and as he certainly did not choose with prophetic instinct those species which would vary most, we may infer that all natural species, if exposed to analogous conditions, would, on an average, vary to the same degree." [2]

But now let us take a specific example of spontaneous variability which deeply impressed Mr. Darwin. It is a case which was brought to his attention in 1860 by Professor W. H. Harvey concerning *Begonia frigida*, as to which Mr. Darwin says:

"This plant properly produces male and female flowers on the same fascicle; and in the female flowers the perianth is superior; but a plant at Kew produced, besides the ordinary flowers, others which graduated towards a perfect hermaphrodite structure; and in these flowers the perianth was inferior. To show the importance of this modification under a classificatory point of view, I may quote what Professor Harvey says, namely, that had it 'occurred in a state of nature, and had a botanist collected a plant with such flowers, he would not only have placed it in a distinct genus from Begonia, but would probably have considered it as the type of a new natural order.' . . . . The interest of the case is largely added to by Mr. C. W. Crocker's observation that seedlings from the *normal* flowers produced plants which bore, in about the same proportion as the parent-plant, hermaphrodite flowers having inferior perianths." [3]

This was written in the first edition of "Animals and Plants Under Domestication" (1868) and was allowed to stand in the second and last edition (1875). In both editions, however, Mr. Darwin made the statement in an entirely different part of the work, that "the wonderfully anoma-

[1] "Animals and Plants Under Domestication," 2d ed., Vol. I, pp. 439–40. See also *ibid.*, Vol. II, p. 278.

[2] *Ibid.*, Vol. II, p. 401–2.

[3] *Ibid.*, Vol. I, p. 389.

lous flowers of *Begonia frigida,* formerly described, though they appear fit for fructification, are sterile."[1] The last point, however, does not invalidate the claim to this new type of Begonia as a mutant, since the facts which determine its position in this regard are, first, the sudden appearance of the form bearing three kinds of flowers and, second, the production by seed of descendants also bearing three kinds of flowers.

It is very evident that this case troubled Mr. Darwin, for he referred to it a number of times and did not relish Professor Harvey's assertion that "such a case is hostile to the theory of natural selection, according to which changes are not supposed to take place *per saltum,*" and Harvey's further declaration that "a few such cases would overthrow it (natural selection) altogether."[2] Sir Joseph Hooker attempted to explain the matter so as to weaken Professor Harvey's argument against the doctrine of natural selection, but Darwin himself wrote Hooker saying:

> "As the 'Origin' now stands Harvey is a good hit against my talking so much of the insensibly fine gradations; and certainly it has astonished me that I should be pelted with the fact that I had not allowed abrupt and great enough variations under nature. It would take a good deal more evidence to make me admit that forms have often changed by *saltum.*"

About the same time, namely early in 1860, Darwin wrote to Lyell on this subject, saying:

> "It seems to me rather strange; he (Harvey) assumes the permanence of monsters, whereas monsters are generally sterile and not often inheritable. But grant this case, it comes that I have been too cautious in not admitting great and sudden variations."[3]

There is an added point of interest about this discussion in the fact that it is the earliest record in print of the consideration of saltation or mutation by Mr. Darwin.

You have doubtless noticed Mr. Darwin's protest against the belief in the occurrence of important changes "*per saltum.*" He uses this expression with disapproval a number of times and yet his condemnation of the idea involved is not entirely unqualified, as is shown by the following significant statement:

> "On the theory of natural selection we can clearly understand the full meaning of the old canon in natural history, "Natura non facit saltum." This canon, if we look to the present inhabitants alone of the world, is not strictly correct; but if we include all those of past times, whether known or unknown, it must on this theory be strictly true."[4]

---

1 "Animals and Plants under Domestication," 1st ed., Vol. II, p. 166. Also *ibid.*, 2d ed., Vol. II, p. 150.

2 "Life and Letters," 1886, Vol. II, p. 274.

3 *Ibid.*, p. 275. Also, "More Letters," 1903, Vol. I, p. 141.

4 "Origin of Species," 6th ed., p. 166. See also *ibid.*, pp. 156, 234, 414.

This I understand to be, in effect, a protest against deducing proof of separate creations from the imperfection of the geological record, coupled with an admission that saltation or mutation does, at least occasionally, occur among existing living forms. I trust you perceive the importance of the concession that *natura non facit saltum* is not strictly correct as applied to *the present inhabitants of the world.*

Having noticed Mr. Darwin's repeated use of the words *per saltum,* I now wish to revert to his frequent use of the words *monster* and *monstrosity* and to call your attention to the fact that they are not always employed with exactly the same meanings. Sometimes by "montrosity" he evidently intends to indicate a mere deformity, of the nature of an accidental injury, or aborted or perverted development, but more generally he refers to a deviation from type wide enough, or discontinuous enough, to exclude it from the category of variations to which he supposed the operation of natural selection must be confined. Among domesticated animals and plants, however, the word "monster," as used by him, often meant no more than the word "sport." In most cases when he used this term or one of its derivatives he took care to explain that monstrosities could not be qualitatively separated from other kinds of variations. Thus, in writing to R. Meldola, in 1873, he says:

"It is very difficult or impossible to define what is meant by a large variation. Such graduate into monstrosities or generally injurious variations. I do not myself believe that these are often or ever taken advantage of under nature." [1]

In the "Origin of Species" he wrote:

"At long intervals of time, out of millions of individuals reared in the same country and fed on nearly the same food, deviations of structure so strongly pronounced as to deserve to be called monstrosities arise; but monstrosities cannot be separated by any distinct line from slighter variations." [2]

He frequently repeats this last statement and it is quite clear that he intends to convey the idea that all variations are merely quantitative, at any rate he failed to adopt a nomenclature that would enable his readers to judge as to the degrees of difference he meant to indicate by such adjectives as "insensible," "minute," "slight," "large," "wide," "sudden," and "abrupt," as applied to variations. I am convinced, however, that he recognized the fact that there were two different kinds of variations, namely, first, what he oftenest called "individual variations," by which he referred to the ordinary differences between the single organisms of the same group, or what

[1] "More Letters," 1903, Vol. I, p. 350.

[2] "Origin of Species," 6th ed., p. 6, also p. 33. See also "Animals and Plants Under Domestication," 2d ed., Vol. I, pp. 312, 322. Also "More Letters," 1903, Vol. I, p. 318.

mutationists now call "fluctuations," and, second, those radical and generally extensive deviations from type which constitute an actual break with the species, variety or race, and which are substantially what we of these later times have named "mutations." There are places in Darwin's works where the two kinds of variation just mentioned are spoken of as "indefinite" and "definite" and as results, respectively, of the *indirect* and the *direct* action of the conditions of life, and once only, I think, he uses the term "*fluctuating variability*" as synonymous with *indefinite* variability.[1] Now I do not assume to say that the realization of these distinctions by Mr. Darwin proves that he clearly foresaw the present-day mutation theory with its foundation in the principle of unit characters, but I think it is true that he had at least a glimpse of the coming modifications to be required in his own theory to meet the then dawning truth. De Vries declares that his own field researches and testing of native plants are based "on the hypothesis of unit-characters as deduced from Darwin's Pangenesis," which conception, de Vries points out, "led to the expectation of two different kinds of variability, one slow and one sudden." [2]

But the main point I wish to dwell upon at present is that Darwin recognized, at least dimly, a kind of variability the results of which were essentially different from the "individual" or "indefinite" variations, which mistakenly seemed to him alone capable of being acted upon by selection. He was sorely puzzled by what he saw and realized in this direction, for he had spent more than twenty years of intense thought in elaborating his theory that new species were evolved from older ones by the gradual building up of new characters from extremely small differences, and he feared that the admission of saltation in any form meant the undermining of the foundations he had labored so hard to construct. He had once said:

> "When we remember such cases as the formation of the more complex galls, and certain monstrosities, which cannot be accounted for by reversion, cohesion, &c., and sudden strongly-marked deviations of structure, such as the appearance of a moss-rose on a common rose, we must admit that the organization of the individual is capable through its own laws of growth, under certain conditions, of undergoing great modifications, independently of the gradual accumulation of slight inherited modifications." [3]

In the last edition of the "Origin of Species," however, which was published in the year of the author's death, although he introduces this apology: "In the earlier editions of this work I under-rated, as it now seems probable,

---

1 "Animals and Plants Under Domestication," 2d ed., Vol. II, pp. 280, 281, 345.
2 "Species and Varieties, their Origin by Mutation," 2d ed., 1906, p. 689.
3 "Origin of Species," 5th ed., 1869, p. 151.

the frequency and importance of modifications due to spontaneous variability,"[1] he still later interpolates the following rather sweeping recantation:

"There are, however, some who still think that species have suddenly given birth, through quite unexplained means, to new and totally different forms; but, as I have attempted to show, weighty evidence can be opposed to the admission of great and abrupt modifications. Under a scientific point of view, and as leading to further investigation, but little advantage is gained by believing that new forms are suddenly developed in an inexplicable manner from old and widely different forms, over the old belief in the creation of species from the dust of the earth."[2]

In this sixth, and last, edition of the "Origin of Species" Mr. Darwin devoted to the task of answering criticisms made by St. George Mivart far more space than he had ever allowed to any other one critic and the passage just read is evidently one of those inspired by Mr. Mivart's attacks. The sore point with Mr. Darwin at that time was the doctrine of natural selection and, as I have already remarked, he had adopted the erroneous belief that this important principle must be greatly weakened if not entirely sacrificed if any form of saltation was to be admitted in nature. He had, therefore, wavered between his loyalty to his cherished hypothesis and his fearless devotion to truth. By this time, however, he had so long contemplated the possibility of the origin of new species and varieties through single long steps and had had so many convincing examples brought to his attention, that his hesitancy and doubt concerning the validity and sufficiency of the arguments urged in favor of this mode of evolution were ready to give way, and I regard the passage which I am about to quote, as a virtual surrender on this point. The fact that, in this emphatic form, it was written at the close of his life, as his last word on this subject, and that he must have felt that it contained a concession very damaging to the theory to the establishment of which that life had been devoted, gives it, in my mind, a deeply pathetic significance. Mr. Darwin says:

"It appears that I formerly underrated the frequency and value of [variations which seem to us in our ignorance to arise spontaneously] as leading to permanent modifications of structure independently of natural selection. But as my conclusions have lately been much misrepresented, and it has been stated that I attribute the modification of species exclusively to natural selection, I may be permitted to remark that in the first edition of this work, and subsequently, I placed in a most conspicuous position — namely at the close of the Introduction — the following words: 'I am convinced that natural selection has been the main but not the exclusive means of modification.' This has been of no avail. Great is the power of steady misrepresentation; but the history of science shows that this power does not long endure."[3]

---

[1] "Origin of Species," 6th ed., 1882, p. 171.

[2] *Ibid.*, p. 424.

[3] *Ibid.*, p. 421. See also, "Life and Letters," 1886, Vol. III, p. 243, and "More Letters," 1907, Vol. I, p. 389.

The sting of this vehement declaration is in the underlying implication that the limitation placed upon the applicability of natural selection was deemed necessary because of Mr. Darwin's inability to free his mind from the belief that it could not act upon large and sudden variations as well as upon small and unimportant ones. This point of view seems illogical when we consider his repeated declaration that no qualitative distinction could be established between the two kinds of variation, but it may be partially accounted for by the fact that a slight confusion at times existed in his mind concerning the general *modus operandi* of natural selection, through which he attributed to it a *causal* power as well as a mere sifting effect. Both Lyell and Wallace took him to task for this double use of the term and, therefore, in the third edition of the "Origin" he attempted to clear up this point by means of this statement:

"Several writers have misapprehended or objected to the term natural selection. Some have even imagined that natural selection even *induces* variability, whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life." [1]

Nevertheless, almost side by side with this explanation, we find in the last edition of the "Origin" the following sentences which were allowed to come down from the first edition: "Natural Selection will *modify* the structure of the young in relation to the parent, and of the parent in relation to the young." [2] "Natural Selection .... will *destroy* any individuals departing from the proper type." [3] If Darwin had adopted the simile of a sieve, so effectively used by de Vries, he would have drawn nearer to the recognition of the fact of "selection *between* species," even if he had not been prepared to assent to de Vries's counter proposition that there is no "selection *within* the species." He might also have escaped some of his apprehensions concerning the fate of adaptation, which he thought to be endangered by a belief in saltation; for the fact is that adaptedness is only another name for fitness, and this is a quality inherent in the organism and precedent to selection — that is to say, natural selection merely sifts out for preservation the *adapted* or fit, allowing the unadapted or unfit to perish. Now, it is impossible to see why forms both adapted and unadapted to their environment may not arise through mutation and thus be offered to the operation of selection. In fact Mr. Darwin has supplied us with a good illustration of a case under one of these heads in a rather naïve passage which has run through every edition of the "Origin," to the following effect:

---

[1] "Origin of Species," 3d ed., 1861, p. 84.
[2] *Ibid.*, 6th ed., 1882, p. 67.
[3] *Ibid.*, p. 81.

"One of the most remarkable features in our domesticated races is that we see in them adaptation, not indeed to the animal's or plant's own good, but to man's use or fancy. Some variations useful to him have probably arisen suddenly, or by one step; many botanists, for instance, believe that the fuller's teasel, with its hooks, which can not be rivaled by any mechanical contrivance, is only a variety of the wild Dipsacus; and this amount of change may have suddenly arisen in a seedling." [1]

Surely, if Mr. Darwin could have looked at this case with a perfectly free mind, he must have perceived that the teasel's adaptation to man's needs would not have fallen if man had failed to exercise his power of selection; and that the adaptation was not weakened by the fact that it arose by a mutation. But that he was unconsciously biased in this matter is shown by an extract from a letter written to Asa Gray, in 1860, in which he says:

"I reflected much on the chance of favorable monstrosities (*i. e.*, great and sudden variation) arising. I have, of course, no objection to this, indeed it would be a great aid, but I did not allude to the subject [*i. e.*, in the 'Origin'] for, after much labor, I could find nothing which satisfied me of the probability of such occurrences. There seems to me in almost every case too much, too complex, and too beautiful adaptation, in every structure, to believe in its sudden production." [2]

The idea involved in this passage is that adaptation is *produced* — rather than *preserved* — by natural selection and that, as natural selection must, according to Mr. Darwin's curious prepossession, act only upon slow and small changes of character, adaptation itself must necessarily be in every case a matter of gradual growth. This sort of argument appears to justify the fear shared by both Lyell and Hooker that Darwin was at times disposed to stake his whole case on the maintenance of an unnecessary assumption. Hooker wrote him as early as 1859 or 1860 that he was making a hobby of natural selection and overriding it, since he undertook to make it account for too much. [3] Darwin mildly protested that he did not see how he could do more than he had done to disclaim any intention of accounting for everything by natural selection. [4] In this discussion, however, it is apparent that while Darwin was overloading the theory of natural selection with a responsibility for the origin of the adapted or fit, he was at the same time unduly limiting it to only one class of the fit, namely those which had arisen by slow degrees. If he had taken the position that natural selection could and would operate upon any kind or any degree of variability, he need not to have imagined that his main doctrine was in jeopardy.

[1] "Origin of Species," 6th ed., p. 22.
[2] "Life and Letters," 1887, Vol. II, p. 333.
[3] "More Letters," 1903, Vol. I, p. 135.
[4] *Ibid.*, Vol. I, pp. 172, 213.

But though Mr. Darwin could be stirred by attack to a vigorous defense, and sometimes even to an *over*-defense, of natural selection, he contended, at other times, with equal vigor, that his main interest was with variation, however produced, which was the necessary basis of the whole evolutionary process. He admitted, however, that the cause of variation was to him inexplicable and, like all beginnings, it remains to this day a deep mystery. Darwin said of it:

"Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part has varied." [1]

In another place he remarks:

"When we reflect on the millions of buds which many trees have produced before some one bud has varied, we are lost in wonder as to what the precise cause of each variation can be." [2]

He never definitely undertook to solve this mystery, though he reflected and reasoned on it much. The nearest he came to formulating a law concerning it was the expression of his conviction that variability was more a matter of organic constitution than a result of external agencies. Thus he declares:

"If we look to such cases as that of a peach tree which, after having been cultivated by tens of thousands during many years in many countries, and after having annually produced millions of buds, all of which have apparently been exposed to precisely the same conditions, yet at last suddenly produces a single bud with its whole character greatly transformed, we are driven to the conclusion that the transformation stands in no *direct* relation to the conditions of life." [3]

From examples like this Mr. Darwin deduced a "general rule that conspicuous variations occur rarely, and in one individual alone out of millions, though all may have been exposed, as far as we can judge, to nearly the same conditions" [4] and while this is, in a general way, in accordance with the admission of de Vries that although mutations are "not so very rare in nature," [5] the numbers "under observation are as yet very rare," [6] we shall see a little later that Mr. Darwin's deduction is not strictly accurate, since it excludes the idea of a whole genus or species or variety mutating at once.

While on this subject, I may mention that Mr. Darwin anticipated the

[1] "Origin of Species," 6th ed., p. 131.
[2] "Animals and Plants Under Domestication," 2d ed., Vol. II, p. 281.
[3] *Ibid.*, 2d ed., Vol. I, p. 441. See also, *ibid.*, Vol. II, pp. 277, 279, 282.
[4] *Ibid.*, Vol. II, p. 276.
[5] "Species and Varieties, their Origin by Mutation," 2d ed., p. 597.
[6] *Ibid.*, p. 8.

doctrine of the mutationists to the effect that "when the organization has once begun to vary, it generally continues varying for many generations." [1] But as to variability having periods of activity, Mr. Darwin's opinion seems to have been unsettled. In a letter to Weismann, in 1872, he remarks on the strangeness "about the periods or endurance of variability," [2] but in a letter to Moritz Wagner, in 1876, he says:

"Several considerations make me doubt whether species are much more variable at one period than at another except through the agency of changed conditions. I wish, however, that I could believe in this doctrine, as it removes many difficulties." [3]

Practically this is the dilemma of the mutationists of the present day: they are not in a position to prove that plants and animals have periods of mutation, but they assume that it must be so, because the belief "removes many difficulties."

One of Darwin's perplexities, however, has been explained away, as I have already pointed out, by the discovery that mutation is not confined to a single case out of millions of individual forms, nor even to a single generation out of a long genetic line, but that, as in the case of the Œnotheras (evening primroses), a whole genus is likely to be in a mutating condition at the same time, producing from each of several species numberless individual mutants, which are themselves often in a mutating condition, the parent stock meanwhile remaining perfectly constant. Such has been the case with *Œnothera* (*Onagra*) *Lamarckiana*, which, while throwing off, since it has been under scientific observation, in large numbers not less than a dozen elementary species and retrograde varieties, has bred true to its original type through at least one hundred and sixteen years, although there is considerable proof that it is itself a mutant from *Œnothera grandiflora*, and none whatever for the assertion, often made, that it is a hybrid. As at least nine of its mutants have also bred true through many generations in pedigree cultures and doubtless had been constant forms for a long time in a state of nature, there appears to be no ground for Darwin's fear that, granting the occurrence of mutation, the mutants would be liable to speedy extermination through inability to propagate. Of course this would not be the case with even a single self-fertilizing plant and it would not be true with animal mutants if, like plant mutants, they were produced in numbers by the mutating stock. As to swamping by intercrossing, it has been shown that, under Mendel's law, in the extreme case of the production of a solitary mutant obliged to cross with the parent form, if it possesses characteristics

---

[1] "Origin of Species," 6th ed., p. 5.
[2] "Life and Letters," 1886, Vol. III, p. 155.
[3] *Ibid.*, p. 158.

having a certain relation to the parent, it can establish a race like itself and even supplant the parent form, if it is only *as well* fitted for the battle of life as is the progenitor.[1]

If Darwin had known these facts he would not have written, or he would have greatly amended, the following passage:

"He who believes that some ancient form was transformed suddenly through an internal force or tendency into, for instance, one furnished with wings, will be almost compelled to assume, in opposition to all analogy, that many individuals varied simultaneously. It can not be denied that such abrupt and great changes of structure are widely different from those which most species apparently have undergone. He will further be compelled to believe that many structures beautifully adapted to all the other parts of the same creature and to the surrounding conditions, have been suddenly produced; and of such complex and wonderful co-adaptations, he will not be able to assign a shadow of an explanation. He will be forced to admit that these great and sudden transformations have left no trace of their action on the embryo. To admit all this is, as it seems to me, to enter into the realms of miracle, and to leave those of science." [2]

Of course Mr. Darwin was not entirely oblivious to the fact that every important advance in knowledge must have the appearance, at first, of a move into a region of mystery and uncertainty. The lapse of time and the growth of familiarity with it are necessary to the reclamation of a *terra incognita*.

Before leaving this branch of my subject, I desire to call your attention to the very interesting fact that Mr. Darwin himself once conducted a long series of experiments which, it can hardly be doubted, resulted in the production of mutants and that he just missed the discovery of principles which are now the basis of scientific pedigree cultures and are occupying the attention of investigators of the problems of variation and heredity. In a letter to J. H. Gilbert, dated February 16, 1876, Mr. Darwin writes:

"Now, for the last ten years I have been experimenting in crossing and self-fertilizing plants; and one indirect result has surprised me much, namely, that by taking pains to cultivate plants in pots under glass during several successive generations, under nearly similar conditions, and by self-fertilizing them in each generation, the colour of the flowers often changes, and, what is very remarkable, they became in some of the most variable species, such as Mimulus, Carnation, &c., quite constant, like those of a wild species. This fact and several others have led me to the suspicion that the cause of variation must be in different substances absorbed from the soil by these plants when their powers of absorption are not interfered with by other plants with which they grow mingled in a state of nature." [3]

---

[1] See Lock's "Variation, Heredity and Evolution," 1906, p. 205.

[2] "Origin of Species," 6th ed., p. 204. See also, *ibid.*, p. 202.

[3] "Life and Letters," 1886, Vol. III, p. 343.

The point I particularly wish you to notice in this case is that Mr. Darwin was employing practically the methods now used by Professor de Vries, Professor MacDougal and others who are engaged in species testing, by growing naturally variable or mutating plants under conditions of rigid control, so as to exclude crossing or, as de Vries calls it, *vicinism*. In this view of the matter, it would be interesting to know what percentage of Mr. Darwin's plants exhibited the new and constant characters and through how many generations his mutants were found to breed true, for then we could compare his results with those of investigators of our day. But his attention was centered upon the endeavor to find a cause for the abrupt variations and not on the formulation of laws of their action. Apparently he considered isolation to be the principal secondary cause or favoring condition, upon which view the obvious comment is that it requires no great stretch of imagination to conceive of similar isolation as occurring in nature and thus favoring mutation among uncultivated forms.

Having now hastily reviewed the oscillations in Darwin's opinions concerning the kinds, the causes and the laws of variation with relation to the origin of species, it is not my purpose to enter upon a discussion of the present-day mutation theory, which has grown out of a closer study, and a more scientific treatment, of the problems of variation and heredity than were attempted, or were perhaps possible, in Darwin's time. It is desirable, however, to compare Darwin's views with generalizations from the mutation theory, which we can do, well enough for our present purpose, by merely recalling the seven laws which de Vries claims to be the logical outcome of his twenty years of cultural experiments upon plants. They are, with slight modifications as to wording and order, as follows:

1. New elementary species appear suddenly without intermediate steps.
2. New forms spring laterally from the main stem.
3. New elementary species attain their full constancy at once.
4. Some of the new strains are elementary species, while others are to be considered as retrograde varieties.
5. The same new species are produced in a large number of individuals.
6. Mutations take place in nearly all directions and are due to unknown causes.
7. Species and varieties have originated by mutation, but are, at present, not known to have originated in any other way.

Now, looking back over what Darwin wrote concerning variation, I can not believe that he would seriously have disputed any of de Vries's propositions except the last. All would have had to stand or fall with that. He recognized the fact that new species had sometimes appeared suddenly without intermediate steps and that the new forms had sprung laterally from the main stem. I think he also substantially admitted that such new species attained their full constancy at once. As to the fourth affirmation of de Vries, with reference to elementary species and retrograde varieties, Darwin had no knowledge, for the distinction is original with de Vries. Darwin believed, as a general proposition, that "species are only strongly marked and permanent varieties, and that each species first existed as a variety," [1] but, of course, in admitted cases of mutation this can not be true; and if Darwin had been obliged to concede de Vries's seventh proposition, the fourth might well have been allowed to go with it. The same is doubtless the case concerning de Vries's fifth law, which sets forth in effect that similar mutants are thrown off by many individuals of the same species at about the same time. As we have already seen, Mr. Darwin was convinced that if, for example, he were to admit the origin by mutation of a species of flying animal, for the reasons urged by Mr. Mivart, he would be compelled to assume "that many individuals varied simultaneously." I, therefore, do not see that he would have been interested, from a theoretical point of view, in disputing either of the two last-named declarations of de Vries except in connection with his seventh and last law, to which I shall presently refer. The sixth law of de Vries, which affirms that mutations take place in nearly all directions, is practically the equivalent of Darwin's first law that all organisms vary continually and in every part of their structure, provided it is agreed that mutations are only quantitatively different from Darwin's "individual variations," which was Darwin's own view. In so far as Darwin admitted the occurrence of mutation at all, he must have agreed that it could proceed in any direction. But now we come to the conclusion of de Vries which we know Darwin would not have accepted, at least in its entirety. As we have seen, he was compelled to concede that what we now call mutation had occasionally taken place and become the starting point of new races, but he was none the less unshaken in the conviction that this process was exceptional and extraordinary, and that, as a rule, a new species originated by the gradual building up of minute and even insignificant deviations from the average characters of an old species, which deviations we now call fluctuations. We know with what tenacity he held this view to the end of his life. For the doctrine of "insensible gradations," which touched mainly a minor premise in his general argument for evolution, Mr. Darwin was, unhappily, almost willing to relinquish the essence of the whole matter, which was his claim to the discovery of a *vera causa* in the evolutionary process. Notwithstanding the prior claim of Patrick Matthew, and the partial anticipation by Alfred R. Wallace and others, the establish-

---

[1] "Origin of Species," 6th ed., 1882, p. 412.

ment of the theory of natural selection was Mr. Darwin's most original and greatest achievement. Time has proven that he could have afforded to stand upon the general validity and applicability of this theory though every step in his argument in its favor had needed review and modification; for each passing year but adds to the impregnable mass of proofs by which it is affirmed and supported. Properly regarded, the mutation theory does not antagonize nor weaken the doctrine of natural selection — on the contrary it merely offers itself as a helpful substitute for, or adjunct to, one of Darwin's subordinate steps in the approach to a consistent philosophy of the origin of species, leaving the last great cause of evolution as efficient as ever. It is, therefore, one of the tragedies of science that in this matter Darwin should have been ready to surrender his main position rather than to receive and to join forces with those who were coming to his aid, but whom he failed to recognize as friends.

[ANNALS N. Y. ACAD. SCI., Vol. XIII, No. 12, Part III, pp. 453–559. May, 1909.]

RECORDS OF MEETINGS

OF THE

NEW YORK ACADEMY OF SCIENCES.

January, 1908, to December, 1908.

BY EDMUND OTIS HOVEY, *Recording Secretary.*

BUSINESS MEETING.

JANUARY 6, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, Vice-President Grabau presiding.

In the absence of the Recording Secretary, Charles P. Berkey was elected secretary *pro-tem.*

On motion the business meeting was adjourned to 8:15 P. M., Monday, January 13.

CHARLES P. BERKEY,
Secretary pro-tem.

SECTION OF GEOLOGY AND MINERALOGY.

JANUARY 6, 1908.

Section met at 8:30 P. M., Vice-President Grabau presiding.

Sixteen persons were present.

The minutes of the last meeting of the Section were read and approved.

A special proposition in favor of arranging for a joint meeting of geologists and mineralogists of neighboring societies and institutions was presented. A motion to approve the plan and lay the matter before the Council for action was passed.

The following program was then offered:

A. W. Grabau, A Revised Classification of the North American Siluric System.

Alexis A. Julien, On Determination of Mineral Constitution through Recasting of Analyses.

Summary of Papers.

Professor **Grabau** said in abstract: A review of the successive modifications of the classification of the Siluric system in North America brings out the fact that the process of refining has been largely by separating from this system divisions not properly belonging to it. Thus Dana in 1863 (first edition of the Manual) included the Cambric and Ordovicic as "Lower Silurian," dividing it into Potsdam, Trenton and Hudson, and dividing the "Upper Silurian" into Niagara, Salina and Lower Helderberg.

In the 4th edition of the Manual (1895) the Cambric, Ordovicic and Siluric Systems are recognized as distinct, though the name "Lower Silurian" is still preferred for the Ordovicic. The three-fold division of the Siluric is into: (1) Niagara, (2) Onondaga (Salina) and (3) Lower Helderberg. In 1899, Clarke and Schuchert published their revised classification of the New York series, which has been pretty generally adopted. In this the Helderbergian, exclusive of the Manlius, was separated as Lower Devonic, while the remainder of the Siluric (Niagara and Onondaga (or Salina) of Dana, 1895) was divided into the Oswegan (Oneida conglomerate — Shawangunk grit and Medina sandstone), the Niagaran (Clinton, Rochester, Lockport and Guelph) and the Cayugan (Salina, Rondout and Manlius). Since then Grabau and Hartnagel have independently demonstrated that the Oneida is the equivalent of late Medina, and the Shawangunk, of Salina. In 1905, Grabau suggested the Richmond age of the lower 1100 feet of the Medina of western New York (Science XXII, p. 259, Oct. 27, 1905) uniting the upper with the Clinton. These relations were more fully discussed in 1906 (Bull. 92, N. Y. State Museum) and again in 1907 before the Geological Society of America, New York meeting, after a prolonged investigation of the Appalachian deposits. This relationship is now fully established, and the dividing line between Ordovicic and Siluric is drawn at the base of Upper Medina or Medina proper. For the red Medina shales, now recognized as of Ordovicic age, the name Queenstown beds is proposed, from the town of that name on the Niagara river opposite Lewiston, where these beds are partly exposed.

Recent studies by Grabau and Scherzer in southern Michigan and adjoining regions in Canada and Ohio have demonstrated the existence of about 900 feet of fossiliferous strata above the Salina, to which it is proposed to restrict the name Monroe. These will be fully discussed in a forthcoming paper, where the correlation of the eastern attenuated Upper Siluric beds will be given. The fauna of the Upper Monroe, above the Sylvania sandstone, is a remarkable mixture of Siluric and Devonic types, as recently demonstrated before the Michigan Academy of Sciences, the Chicago meeting of Section E, American Association for the Advancement of Science, and the Albuquerque meeting of the Geological Society of America. The following classification of the Siluric System of North America is proposed as most expressive of the relationships indicated by the facts now known:

Upper Siluric or Monroe (900 feet)	Upper Monroe	
	Middle Monroe (Sylvania sandstone the only known representative)	
	Lower Monroe	
Middle Siluric or Salina (1000 feet)	Represented so far as known only by non-marine sediments	
Lower Siluric or Niagara (500 feet)	Guelph (probably to be placed in with the Middle Siluric)	
	Lockport dolomite	
	Rochester shales	
	Clinton	Clinton shales and limestones
		Medina sandstone
		Oneida conglomerate

This paper was illustrated with lantern slides.

Dr. **Julien's** paper appears in full as pages 129–146 of this volume.

The paper was illustrated with several ingeniously prepared charts and aroused much interest, but, because of the lateness of the hour, the discussion was postponed to the next regular meeting of the Section.

The Section then adjourned.

Charles P. Berkey,
Secretary.

ADJOURNED BUSINESS MEETING.

January 13, 1908.

By adjournment from January 6, 1908, the Academy met at 8:15 P. M. at the American Museum of Natural History, President Cox presiding.

The minutes of the regular meetings of December 2, 1907, and January 6, 1908, were read and approved.

The following candidates for election to Active Membership in the Academy, recommended by Council, were duly elected:

Leo H. Baekeland, Ph.D.,	Yonkers-on-Hudson, N. Y.,
Mrs. Chester Griswold,	23 West 48th St.,
Robert H. Lowie, Ph.D.,	American Museum of Natural History,
Charles Louis Pollard, A. M.,	New Brighton, S. I.,
Charles St. John Warner,	29 Broadway.

The Recording Secretary then reported the following deaths among the membership of the Academy:

Lord Kelvin, an Honorary Member since 1876,
Rev. M. E. Dwight, an Active Member since 1905,
T. J. Hurley, an Active Member since 1907,
Wm. H. S. Wood, an Active Member since 1885.

The Recording Secretary then read the following communication:

"Notice is hereby given in pursuance of Section 5 of Chapter XI of the By-laws of the Academy that the undersigned propose an amendment to Chapter VI, Section 3 of the said By-laws by the addition thereto, at the end thereof, of the following words: *and any Active Member or Fellow who has paid annual dues for twenty-five years or more may, upon his written request, be made a life member and be exempt from further payment of dues.*"

(Signed).

C. F. Cox,
N. L. Britton,
E. O. Hovey.

The above amendment to the By-laws will be acted upon at the next business meeting of the Academy.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF BIOLOGY.

JANUARY 13, 1908.

Section met at 8:25 P. M., Vice-President Chapman presiding.
The minutes of the last meeting of the Section were read and approved.
The following program was then offered:

Henry F. Osborn, THE DISTRIBUTION OF THE MASTODON AND MAMMOTH IN NORTH AMERICA WITH DESCRIPTION OF THE WARREN MASTODON.

Louis Hussakof, HUNTING FOSSIL FISHES IN THE DEVONIAN OF OHIO AND CANADA.

Ernest Thompson Seton, THE BIOLOGICAL RESULTS OF AN EXPEDITION TO THE BARREN GROUNDS.

The papers read by Professor Osborn and Dr. Hussakof were illustrated with lantern slides.

The Section then adjourned.

ROY W. MINER,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

JANUARY 20, 1908.

Section met at 8:15 P. M., Vice-President Hering presiding.
The minutes of the last meeting of the Section were read and approved.
The following program was then offered:

Lamb, Rosanoff and Breithut, A NEW METHOD OF MEASURING PARTIAL VAPOR PRESSURES IN BINARY MIXTURES.

The paper was well discussed.
The Section then adjourned.

WILLIAM CAMPBELL,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

JANUARY 27, 1908.

Section met at 8:15 P. M., in conjunction with the American Ethnological Society, at the American Museum of Natural History, General J. G. Wilson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

R. H. Lowie, THE THEORY OF NATURE MYTHOLOGY.
V. Stefánsson, THE MACKENZIE RIVER ESKIMO.

Both papers were illustrated with lantern slides.

The Section then adjourned.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

FEBRUARY 3, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, Vice-President Grabau presiding at first, but resigning the chair to President Cox who arrived a few minutes later.

The minutes of the adjourned meeting of January 13 were read and approved.

The following candidates for Active Membership in the Academy, recommended by Council, were duly elected:

H. Sanburn Smith,	Lackawanna Steel Co., 2 Rector St.,
Felix Arnold, Ph.D.,	34 St. Nicholas Ave.,
Homer D. House,	New York Botanical Garden,
V. Stefánsson,	Care of American Geographical Society.

The Recording Secretary then announced the following deaths in the Membership of the Academy:

Professor Charles A. Young, an Honorary Member for 30 years,
Morris K. Jesup, an Active Member for 15 years,
Professor William Stratford, an Active Member for 13 years and for some time Corresponding Secretary.

Council recommended the following minute with reference to Mr. Jesup:

In recognition of the great services rendered to Natural Science in this city by the late Morris K. Jesup, the New York Academy of Sciences adopts the following minute:

Mr. Jesup has been a member of the Academy since 1893. He has been much interested in its welfare, and was foremost in welcoming it to the American Museum of Natural History, where its meetings have been held since 1903, where its library is deposited, and where its present efficiency as a scientific association of broad scope and influence has been developed.

As president of the Board of Trustees of the American Museum of Natural History, he has been indefatigable in building up the resources and collections of the Museum and in establishing it as one of the great institutions of its kind in the world.

His influence on the development of Science in New York has been most beneficent; the Academy deeply deplores his loss.

In accordance with the notice given at the business meeting of 13 January, 1908, the following amendment to the By-laws of the Academy was proposed:

Add to Chapter VI, Section 3, of the By-laws of the Academy, at the end thereof, the following words: *and any Active Member or Fellow who has paid annual dues for twenty-five years or more may, upon his written request, be made a life member and be exempt from further payment of dues.*

On motion, the amendment was unanimously adopted, a quorum of members of the Academy being present.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

February 3, 1908.

Section met at 8:15 P. M., Vice-President Grabau presiding.

The minutes of the last meeting of the Section were read and approved.

Sixty persons were present.

Announcement was made of the issue of a circular letter inviting the geologists and mineralogists of New England, New York, New Jersey and eastern Pennsylvania to participate in a joint meeting April 6.

The following program was then offered:

E. O. Hovey, THE ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, ALBUQUERQUE, NEW MEXICO, DECEMBER 30–31, 1907.

Charles P. Berkey, A REVISED CROSS-SECTION OF RONDOUT VALLEY ALONG THE LINE OF THE CATSKILL AQUEDUCT.

James F. Kemp, PRESENT TREND OF INVESTIGATIONS ON UNDERGROUND WATERS.

SUMMARY OF PAPERS.

Dr. **Julien's** paper presented at the last meeting of the section was discussed briefly by the author who showed two newly prepared charts of minerals not shown at the former meeting. Remarks were made by Professor J. F. Kemp.

Dr. **Hovey** gave an account of the chief points of interest in connection with the meeting at Albuquerque and a brief summary of the papers.

Dr. **Berkey** said in abstract: The explorations of the Board of Water Supply of New York City have now been made so complete across the Rondout Valley, a distance of five miles, that it is possible to construct by the aid of this data probably the most accurate cross-section of the rock structure yet known in New York State. There are twelve distinct formations of stratified rock involved, all of which will be cut by the projected pressure tunnel. One marked unconformity in the series separates the Ordovician Hudson River slates from the overlying conglomerates, shales, sandstones and limestones of Silurian and Devonian age. There are three faults of considerable displacement, together with smaller ones and minor foldings. In the effort to determine the variations of these formations as to thickness, depth from surface, displacements, physical conditions, water content and capacity, the presence of caves and relative solubility, and the position and depth of the buried channels beneath the drift cover, the available figures are so abundant that the section may be considered accurate within a few feet for a considerable proportion of the whole width of the valley and to a depth of 300 to 400 feet.

Several drawings illustrating these features in detail, originally prepared for the Chief Engineer of the Board of Water Supply, were shown by permission, and the successive stages in interpretation of results were pointed out. The paper was also illustrated with lantern slides and charts.

Professor **Kemp** said in abstract: Within a few years there has been a marked change on the question of the sources and amount of underground water. Although as recently as 1900, in the most important discussion of the influence of ground water, all supplies other than meteoric were eliminated as of negligible importance, it is now becoming increasingly more probable that some of these supplies are of magmatic origin. There is a tendency to place much more emphasis upon the interpretation of ore bodies in the light of possible influence of magmatic waters.

To an equal extent the earlier opinions as to the total amount of underground water have been modified. It has been customary to express this as a sheet of water over the surface of the globe of so many feet in depth. Delesse, in 1861, estimated it 7500 feet; Schlichter, 1902, 3000 to 3500 feet; Van Hise, 1904, 226 feet; Fuller, 1906, 96 feet. Ground waters of meteoric origin would seem therefore to be of very moderate amount, and the depths to which they penetrate are probably correspondingly reduced. It may readily be believed that their efficiency and universality in mineralization has been overestimated.

The Section then adjourned.

Charles P. Berkey,
Secretary.

SECTION OF BIOLOGY.

February 10, 1908.

Section met at 8:15 P. M., Vice-President Chapman presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

N. L. Britton, The Genus *Ernodea* Swartz: a Study of Species and Races.

Bashford Dean, Accidental Resemblance and its Possible Importance in the Origin of Species.

C. William Beebe, Preliminary Report of Some Recent Experiments with Birds in the New York Zoölogical Park.

Frank M. Chapman, The Bird's Wing in Flight as Revealed by Photography.

The papers by Professor Dean and Mr. Chapman were illustrated by lantern slides. An active discussion followed the reading of each paper.

The Section then adjourned.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

February 17, 1908.

By permission of Council no meeting was held.

William Campbell,
Secretary.

SPECIAL MEETING.

February 18, 1908.

Dr. Leland O. Howard of Washington, D. C., delivered a lecture upon

"Some Recent Discoveries in Insect Parasitism, and the Practical Handling of Parasites."

The lecture was given through coöperation with the New York and Brooklyn Entomological Societies.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

February 24, 1908.

Section met in conjunction with the New York Branch of the American Psychological Association at 4 P. M. at the Psychological Laboratory of Columbia University, and at 8:15 P. M. at the American Museum of Natural History, Vice-President Meyer presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Afternoon Session.

The usual afternoon session was adjourned to hear the following lecture at Columbia University:

E. B. Titchener, THE LAWS OF ATTENTION.

Evening Session.

H. C. Warren, FEELING AND OTHER SENSATIONS.
Warner Brown, TIME IN VERSE.
H. L. Hollingworth, THE TIME OF MOVEMENT.
Adolf Meyer, THE CONCEPT OF SUBSTITUTIVE ACTIVITY AND THE RELATION OF MENTAL REACTION TYPES TO PSYCHIATRIC NOSOLOGY.

SUMMARY OF PAPERS.

Professor **Titchener** discussed the question as to the number of distinguishable levels of clearness which are simultaneously present in the same consciousness. After a comprehensive review of the literature and a careful examination of the doctrines which hold to three or four levels, the lecturer concluded that there was no real evidence of more than two distinct levels: that of clearness, or attention, and that of obscurity, or inattention. For example, in looking at one of the common puzzle pictures, in which a face is concealed, the moment the face appears to the observer the picture as a whole, which up to that moment had been clear, drops at once into obscurity, and there is no appearance of a gradual fading into obscurity through a series of intermediate gradations. It is true, however, that both at the level of obscurity and, more certainly still, at the level of clearness there may exist slight differences in the prominence of the different elements present. This is illustrated by the differing prominence of the different elements of a rhythm even though all lie in the field of attention. There may also, as between different states of consciousness, be differences in the level of clearness and in that of obscurity; the narrower the field of attention, the greater is the disparity between the level of clearness and the level of obscurity.

Professor **Warren** said that the supposed radical distinction between feeling and sensation was supported by three separate claims. (1) *Evidence from introspection.* This is inconclusive. Admitting the vast difference of sort between so-called feelings and visual sensations, for example, there appears quite as vast a difference of sort between visual, auditory and other "external" sensations. (2) *Distinction between external and internal elements.* This affords no better criterion. The hedonic tone of a visual sensation, for example, has just as definite a physical basis as its brightness or color characters. Organic conditions are less clear-cut than external stimuli, but difference in *degree* of clearness is no reason for dividing experience into two elemental *sorts.* Moreover, a distinction based on source should recognize activity experience also. The speaker prefers the terms external, organic and kinesthetic sensations to a more radical division into sensations, feelings and activity experiences. (3) *Different genetic rôles of presentation and affection.* "External" sensations lead more readily to thought and "knowledge about" things than internal. But this is due to the relative vagueness of the latter. Definite, vivid experiences lead to perception, judgment, reasoning; indefinite, vague experiences lead to nothing beyond themselves. Yet any experience, even of discomfort or well-being, may at times become focused in attention and form the basis of a judgment. The distinction between presentative and affective is, therefore, not really based on the nature of stimuli. Intellectual experience is the result of a distinctive mental function which acts (in favorable circumstances) on sensory experiences of any sort. The three claims for a radical dichotomy of experience are thus found to be unsatisfactory. All simple experience is essentially one in nature.

Mr. **Brown,** in his paper, said that a large number of graphic records of the voice had been made the basis of the report. The material embraced nonsense verses and typical verses of English poetry. The former failed to show any differences of *tempo* between the four common rhythms, and the differences of internal time relations of the feet were not found to be those usually accepted. Syllables in trochees are nearly equal in length, but the accented is shorter. The accented syllable of the dactyl is not longer than the corresponding short syllable of the anapest. If two short syllables are taken as equivalent to one, no sharp line can be drawn between two-syllable and three-syllable rhythms in respect to time. In lines of poetry the conventional alternation of long and short syllables is frequently reversed, leaving the time structure chaotic. The feet approximate equality only in the very simplest verse. There is no regular connection between accent and duration. None of the three-syllable rhythms took the form given by the dactyl in nonsense verse. The general conclusion was that the ear is incompetent to judge, and that the impression of temporal regularity in verse is strictly illusory.

Mr. **Hollingworth** described an instrument designed to record simultaneously and graphically the extent, duration and force of a rectilinear arm movement. To the car of the Cattell-Fullerton extent of movement apparatus is attached a signal magnet, which controls the vibrations of an enlarged Pfeil time marker. On a smoked paper, stretched on a horizontal frame, the writing point traces the extent of the movement and records the time in twentieths of a second. The interruptions are made by means of a reed oscillator. The car pulls against a set of springs, which are adjustable, so that the force may be varied independently of the extent, but correlated with it empirically. A pulley attachment provides for the use of weights instead of springs. The traditional method of controlling the extent of a movement by impact against an upright is found to cause a large positive constant error which is a function of the force of impact, and the magnitude of which increases the variable error. When the movement was blocked at one centimeter from the starting-point, the varying speeds, indicated in mm. per tenth of a second, gave the following results:

Speed	68	100	110
Constant error	+138 mm.	+174 mm.	+171 mm.
Variable error	30 "	42 "	41 "

When stopped at two centimeters:

Speed	32	120	138
Constant error	+100 mm.	+158 mm.	+166 mm.
Variable error	24 "	38 "	32 "

When stopped at three centimeters:

Speed	103	155
Constant error	+ 90 mm.	+132 mm.
Variable error	24 "	28 "

In order to eliminate this factor a sound hammer, introduced at optional points along the track, serves as a signal for stopping the movement. The movement is thus terminated by the subject himself and becomes a unit, commensurable with any other free movement.

Dr. **Meyer,** in his paper, noted as a characteristic sign of our times in psychopathology, as in other biological and extrabiological domains, the surrender of the quest for the final nature of events in terms of physicochemical materialism. The chase for the noumenon, or *Ding an sich,* has lost its charm. We realize that much of what is expressed in psychology or psychopathology in terms of nerve-cells is pseudo-scientific tautology, the facts on which the claims are based being extra neurological, and the inferences being often enough not only unverifiable, but directly opposed by what we know in terms of nerve histology and nerve physiology. This form of scientific mythology serves its purpose if it stimulates, but it ought not to be accepted as solution. It seems infinitely wiser to reduce events not to static principles, but to simpler events, and to study the laws of modifiability of the active factors and of the results. The notion of the "lesion" is helpful where facts are accessible; otherwise, it plays the rôle of a noumenon. Events are defined by the situation, the reaction and the final adjustment, and the rôle played by parts of the event or part of the mechanism. Abnormal events may be best accounted for by modification either of infrapsychical (simple physiological) or of mental (physiological-psychological) factors. Since the mental events constitute adjustive actions with a scale of efficiency or lack of efficiency, we can distinguish the well-planned act, poorly supported by faulty physiological mechanisms, from inadequately planned, inferior reactions; and the latter we designate as substitutive activities, to denote that the fault lies more in the deficiency of the mental adaptation itself than that of the tool of the same. The advantage lies in the fact that we do not telescope the facts into a schematic artifact devoid of a time component, with a craving for uncontrollable nerve-cell notions, but our attention remains faithful to the field in which things happen. The tendency of an overbelief in the value of noumena is further illustrated in the notion of a "disease," as soon as it figures as more than an empirical unit, satisfying the identification of certain combinations of manifestations, or of some issues of treatment, or not infrequently of a desire for protection against demands of responsibility concerning the outcome. The "disease" notion is hardly conspicuous in the plainest events of pathology, in injuries, intoxications and even infection, but the nearer we get to the ill-defined, the more the term "disease entity" gets a noumenal overimportance. Consumption used to be a protective term covering up the inefficiency of management of tubercular infection; *dementia præcox* is to-day such a term covering up medical inefficiency in dealing with the so-called deterioration processes. Within their proper field and plainly realized limitations, the maintenance of these noumena has a great advantage for orderly thinking, but, like the neo-vitalistic modes of presentation of biological facts, they would be most detrimental if considered as more than formulas or starting-points of more fundamental work. For didactic and practical work the differentiation of unfavorable developments from harmless or from constitutional recurrent, but non-deteriorating, disorders is equally important for the physician and for the families. Hence the importance of a distinction of *dementia præcox* and manic-depressive insanity. But for progress in the understanding, a constructive knowledge of events has to supersede the purely formal method of what can only be a preliminary grouping, until the pertinent cases can be said to present experiments of nature with clearly known components, traced to simpler events rather than to artificial elements of physchology or neurology.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

March 2, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, Vice-President Grabau presiding. Dr. Charles P. Berkey was appointed secretary *pro-tem* in the absence of the Recording Secretary.

The minutes of the last meeting were read and approved.

The following candidates for election to Active Membership in the Academy, recommended by Council, were duly elected:

J. H. Anderson, 54 St. Nicholas Ave.,
A. H. Scholle, 2020 Broadway.

Council reported that the following had applied for Life Membership, under Chapter VI, Section 3, of the By-laws:

Pierre de P. Ricketts, 104 John St.,
Elwyn Waller, 7 Franklin Place, Morristown, N. J.

Council reported the following deaths:

Isidor Wormser, an Active Member for 1 year,
E. S. F. Arnold, M.D., a Fellow and Active Member for 28 years.

Council reported the following resolutions with reference to Professors Underwood and Stratford:

Professor Underwood served the Academy as Vice-President and in other official relations, and was at the time of his death a member of the Council as delegate from the Torrey Botanical Club, an affiliated society. He was deeply interested in the work of the Academy, and his contributions were greatly valued and esteemed by his associates. He was beloved by the members of the Council, and his death is regarded not only as a great loss to botanical science, but as a personal bereavement.

It is resolved that this memorial be spread upon the minutes and be communicated to his family.

N. L. Britton, *Chairman,*
J. F. Kemp,
H. H. Rusby.

The Academy records with sorrow the death of Professor William Stratford, a member of long standing and a former Corresponding Secretary. He was a prominent member of the faculty of the College of the City of New York, having served on its teaching staff for over 41 years. Born in 1844, he graduated with A. B. at the City College in 1865 and later took the degrees of M. D. and Ph.D. at New York University; he became tutor in Natural History in the City College in 1866, under Professor J. C. Draper, whom he succeeded as head of the department in 1886. He was a well known member of scientific organizations in New York, was a recognized expert in biological microscopy, conducting important experiments in the early days of photo-micrography and devising new combinations in the mathematics of lenses. In his work in the City College, he early introduced laboratory methods and developed its museum, enriching its paleontological materials with the fruits of several expeditions to the Rocky Mountains. He is best known as a teacher and as the devoted friend of those whose interest in Natural History led them beyond the door of the class room. His private laboratory was always filled with volunteer students, and he was generous, even to a fault, in giving them his time, means, apparatus,— everything he had. And he followed the career of each of "his men" with the keenest interest. He was never too busy to do them favors, no matter the cost, and the only reward he asked was to see them become prominent as teachers, physicians, biologists.

BASHFORD DEAN, *Committee.*

The secretary read a letter from Dr. Joseph D. Hooker, expressing his appreciation of his election to Honorary Membership in the Academy.

The Academy then adjourned.

CHARLES P. BERKEY,
Secretary pro-tem.

SECTION OF GEOLOGY AND MINERALOGY.

MARCH 2, 1908.

Section met at 8:30 P. M., Vice-President Grabau presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Robert T. Hill, GEOLOGICAL PROBLEMS OF THE WINDWARD ISLANDS.
Roswell Johnson, THE MID-CONTINENT OIL FIELDS.

SUMMARY OF PAPERS.

Mr. **Johnson** said in abstract: The production of oil in Oklahoma and Kansas, generally called the mid-continental oil field, has forged ahead during the year 1908, so that the production now surpasses that of any other field in the United States, and the production of Oklahoma exceeds that of any other state. The mid-continent production is given at 47,566,906 barrels by Professor E. Haworth, in the Engineering and Mining Journal. Its nearest rival, California, is estimated in the same journal to have produced 40,000,000 barrels. The oil is of intermediate grade, being used as fuel oil only in exceptional areas or in cases of local congestion. While inferior to Appalachian and Lima oil, it is superior to that of Illinois. The production might have been greater had it not been for the lack of sufficient pipe lines to transport the product and the consequent low prices. With this limitation removed, the production will doubtless reach considerably higher figures in the future. One pool in one township, the Glenn Pool, made the phenomenal record of 19,632,337 barrels in the year, being much more than the production of the entire Texas and Louisiana field in the same time. This establishes it as the greatest pool yet found in America. The oil has so far been chiefly derived from sandstones within the Cherokee shales of Middle Carboniferous age in Kansas and Northern Oklahoma. Recently, horizons in the underlying strata, which are so extensively developed in eastern Oklahoma, have been found to be productive of a lighter oil, comparing with the Pennsylvania oil in its paraffin content. These finds are especially encouraging, since there is in this region a very favorable deformation of the strata. This is the result of two sets of folds at an angle to each other. One set, running about north and south, was caused by the Ozark uplift. The other set, running east and west, was caused by the folding of the Ouachita Mountains to the south.

In general the mode of occurrence and the horizon of the oil and gas in the mid-continent field is similar to that of the Appalachian field and contrasts strongly with the heavy-oil fields of the Gulf Coast and California.

Professor **Hill's** paper was illustrated by maps and drawings; that of Mr. Johnson by charts showing geologic structure and comparative productivity. Both papers were listened to with much interest.

The Section then adjourned.

Charles P. Berkey,
Secretary.

SECTION OF BIOLOGY.

March 9, 1908.

Section met at 8:15 P. M., Professor E. B. Wilson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Amadeus W. Grabau, Recapitulation as Viewed by a Paleontologist.
William M. Wheeler, Desert Ants.
Homer D. House, The North American Species of the Genus *Ipomœa.*

The papers read by Professors Grabau and Wheeler were illustrated with lantern slides.

The paper by Mr. House forms pages 181–263 of this volume.

The Section then adjourned.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

March 16, 1908.

Section met at 8:15 P. M., Vice-President Hering presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

William Campbell, Notes on Metallography applied to Engineering.

Summary of Paper.

Professor **Campbell,** in his paper, briefly reviewed the methods of preparing specimens, development of structure, microscopic examination and photographing the specimen. The structure of metals, ingotism and grain structure, the effects of strain and of annealing were demonstrated, and the constitution of alloys, mattes, speisses, etc., taken up. The carbon-iron series, the graphite-austenite and cementite-austenite groups were discussed and illustrated. Examples of structure were given; wrought iron *vs.* low carbon steel, good and bad material; working and annealing of medium carbon steel; rails and examples of their failure; steel tyres and shelling out; the structure of hypereutectic steels and their change with heat treatment; cast iron, gray, mottled, white, spiegeleisen; cementation and blister steel; malleableizing and the formation of temper carbon.

The application of metallography to economic geology was shown by demonstrating the paragenesis of certain mixed sulphide ores, of silver ores from Cobalt, Ont., of the Butte copper ores, of typical "enrichment zones." The constitution of so-called nickeliferous pyrrhotites and of certain complex opaque minerals was shown. Many lantern slides were used to illustrate the paper.

The Section then adjourned.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

March 23, 1908.

Section met at 8:15 P. M., in conjunction with the American Ethnological Society, at the American Museum of Natural History, General J. G. Wilson presiding.

The following program was offered:

Arthur O. Lovejoy, Fire Cults: their Distribution and Characteristic Features, with an Hypothesis Respecting their Origin and Meaning.

Robert H. Lowie, The Psychology of Dreams.

Summary of Papers.

Professor **Lovejoy** said in abstract: While the most wide-spread of the observances relating to the sacred fire is the custom of maintaining, either upon the domestic hearth or in a communal shrine, a fire that, except upon periodic ceremonial occasions, is never permitted to go out — a practise which by itself might be regarded as a mere convenience or necessity, invested in the course of time with supernatural or magical import — there are other fire-observances, occurring usually among the same peoples, which also have a bearing on the significance of the fire-cult. Especially significant is the annual or cyclic ceremony of extinguishing the old fire and kindling new by some archaic method, as the central and most solemn rite in the transition to a new year, *e. g.*, at the planting of the first seed or the first eating of the new crop (Rome, Celtic Ireland, Eskimos, Iroquois, Muskoki, Aztecs, Ouichuas and others). Widely diffused are also the customs of passing new-born children over or around the fire (*cf.* Greek myths of children rendered immortal by this means); of leaping through fires at certain seasonal festivals, as the Roman Palilia, the Johannisfeuer celebrations, etc.; of employing fire as a fertility charm for crops and herds; of celebrating essential parts of the marriage ceremony before the household fire; of using fire in initiation rites. An analysis of these observances and a consideration of the reasons actually given for certain of them by Iroquois and Maori makes it probable that the sacred fire was by many races conceived, not as a practical convenience, or as an unmotivated ancient custom, or as a device for frightening away demons, or as a negative purifying agency merely, but as a vehicle of life force or magical energy — *manitou*, *wakonda* or *mana*; that the health and prosperity of the household or tribe was believed to depend in part on the fire's perpetuity, vitality and purity; and that the fire, like all natural forces, was thought of as subject to periodicity, to a tendency to grow old and weak, and accordingly as in need of periodic renewal.

Dr. **Lowie** called attention to the services which scientific dream psychology can render to the ethnologist. A knowledge of the investigations carried on in this field will enable him to view critically the plausible but inaccurate dicta of popular psychology. Knowing, for example, the theory of dreams advanced by Delage, the ethnologist will not naïvely accept the assumption of Wundt and Radestock that dreams of recently deceased relatives have largely influenced the development of belief in a hereafter. A positive benefit is derived when mythological figures of obscure origin, such as dwarfs, gorgons, etc., are derived from the distorted images of some dreams — Wundt's Fratzenträume — as a conceivable source. From a purely psychological point of view, the speaker urged the desirability of fuller dream-records, especially in regard to varieties of hypnagogic experience.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

April 6, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, President Cox presiding.

The minutes of the last meeting were read and approved.

The following candidate for Active Membership, recommended by Council, was duly elected:

Richard F. Böhler, 115th St. and Amsterdam Ave.

The Recording Secretary read an application made by Dr. R. H. Lowie for an appropriation of $300 from the Esther Herrman Research Fund, for assistance in carrying out an investigation among the Indians of the northwestern portion of Canada. The application had been investigated and approved by Dr. Clark Wissler, Curator of Ethnology at the Museum. Dr. E. O. Hovey, also, applied for an appropriation of $110 from the Esther Herrman Research Fund for the purchase of thermometric instruments for use in prosecuting studies of volcanic phenomena in the Lesser Antilles. On motion the requests were referred to Council with approval.

The Recording Secretary then read letters from Professors James Ward and William Bateson, expressing their appreciation of the honor conferred upon them by their election as Honorary Members of the Academy.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

April 6, 1908.

The Section held two sessions for the presentation of papers. The first was held at 2 P. M. at Columbia University, with the Department of Geology. The second session, at 8:15 P. M., was held at the American Museum of Natural History.

By invitation of Dr. A. W. Grabau, Chairman of the Section, Professor J. J. Stevenson presided over the first session. Attendance, 40.

The following program was then offered:

George H. Perkins, State Geologist of Vermont,
The Cambrian Rocks of Vermont.

James F. Kemp, Columbia University,
Recent Advances in our Knowledge of the Magnetite Bodies at Mineville.

Edgar T. Wherry, University of Pennsylvania,
Newark Copper Deposits of Eastern Pennsylvania.

J. Volney Lewis, Rutgers College,
PETROGRAPHY OF THE NEWARK INTRUSIVE DIABASE OF NEW JERSEY.

Douglas Wilson Johnson, Harvard University,
THE ORIGIN OF BEACH CUSPS.

William G. Reed, Jr., Harvard University,
DEVELOPMENT OF NANTASKET BEACH, BOSTON HARBOR. A STUDY IN ORIGIN WITH A RESTORATION OF ORIGINAL FEATURES.

Charles P. Berkey, Columbia University,
THE ACID EXTREME OF THE CORTLANDT SERIES, NEAR PEEKSKILL, NEW YORK.

J. E. Hyde, Columbia University,
STRUCTURE OF THE BRACHIAL SUPPORT OF *Camarophorella,* A MISSISSIPPIAN MERISTELLOID BRACHIOPOD.

Amadeus W. Grabau, Columbia University,
A REVISED CLASSIFICATION FOR THE NORTH AMERICAN LOWER PALEOZOIC.

The afternoon program was finished at 6 o'clock, and those in attendance repaired to the Faculty Club where dinner was served and where an hour was spent in a social way.

The evening session was called to order by Vice-President Grabau, who introduced Professor B. K. Emerson of Amherst College as the chairman of the evening.

The following program was presented:

T. A. Jaggar, Jr., Massachusetts Institute of Technology,
THE EVOLUTION OF BOGOSLOF VOLCANO IN BERING SEA.

Ellsworth Huntington, Yale University,
SOME CURVES ILLUSTRATING COINCIDENT VOLCANIC, SEISMIC AND SOLAR PHENOMENA.

Henry S. Washington, New York City,
THE VOLCANOES AND ROCKS OF PANTELLERIA.

Edmund Otis Hovey, American Museum of Natural History,
THE GIBEON METEORITE AND OTHER RECENT ACCESSIONS OF THE AMERICAN MUSEUM.

Summary of Papers.

Professor **Perkins** said in abstract: So far as satisfactorily determined, the Cambrian of Vermont occupies a narrow strip from north to south through the State between the Green Mountains and Lake Champlain. In some places the beds reach the shore of that lake and form the boldest of the headlands.

Northward the Cambrian extends to the Gulf of St. Lawrence and south through New York to middle Alabama.

It is probable that there are derivatives from Cambrian strata in and east of the Green Mountains, but none have been certainly identified. So far as studied, all the beds belong to the Olenellus zone of Walcott, or Lower Cambrian. By a very interesting and extensive fault and overthrust Cambrian strata were lifted and thrown over the Utica. In all there are not less than 10,000 feet of Cambrian beds in western Vermont. These beds consist of 1,000 feet of more or less silicious limestone, and the other rocks are shales, sandstones, quartzites, conglomerates, of very diverse color, composition and texture. In a few places the red sandrock beds change to a thick, bedded, brecciated, calcareous rock, which, when worked, is the Winooski or Champlain marble, — a mottled red and white stone used in many large buildings all over the country.

Few of the beds are fossiliferous, but some abound in trilobites, Olenellus, Ptychoparia, etc., and a few brachiopods, worm burrows, trilobite and other tracks, etc., are also found. In all, the number of species is not large, and probably not more than fifty have been found. Of these, trilobites form the larger number, brachiopods coming next.

Most of the beds are thin, but some have a thickness of several feet. A large portion of the species from the Vermont beds were described, many of these not having been found elsewhere.

The great beds of roofing slate which are extensively worked in southwestern Vermont are included in the Cambrian.

Remarks with reference to this subject were made by Professors Hitchcock, Grabau and Kemp.

Professor **Kemp** showed a series of cross-sections illustrating in detail the structural features of the deposits discussed in his paper.

Professor **Wherry** said in abstract: The Newark series in eastern Pennsylvania is divisible into five formations and attains a total thickness of over 20,000 feet. In the upper part there is a large trap sheet, about 1,500 feet thick, which shows the character of an intrusive sill.

Copper was first mined in this region at Bowman Hill, on the Delaware, by the Dutch from New Amsterdam, about 1650; but the most important early operation was the Old Perkiomen Mine, at Schwenksville, opened about 1700.

Three types of deposit are known: those connected with trap sills, those in fissure veins, and those in unaltered shales. Deposits of the first type show grains and streaks of bornite and chalcopyrite, while brecciated fissures are filled with these ores and various accessory minerals. The magmatic origin of the metals in these cases is clear enough, but the source of the films of malachite and chrysocalla occasionally found in the undisturbed and unaltered sedimentary rocks is as yet obscure. Though perhaps none of these deposits is sufficiently rich to repay working, they are not without their interesting features.

The paper was accompanied by illustrations.

Professor **Lewis** said in abstract: The intrusive trap that forms the Palisades of the Hudson extends in outcrops several hundred feet thick from west of Haverstraw, N. Y., southward to Staten Island and, somewhat intermittently, westward across New Jersey to the Delaware River, having an aggregate length of outcrop of about 100 miles.[1] It is everywhere a medium- to fine-grained, dark gray, heavy rock, with dense aphanitic facies.

The typical coarser rock contains, in the order of abundance, augite, plagioclase feldspars, quartz, orthoclase, magnetite and apatite. The first two occur in ophitic to equant granular textures and the next two in graphic intergrowths which sometimes constitute as much as one-third of the rock. In the contact facies, micropegmatite disappears and scattering crystals of olivine occur.

A highly olivinic ledge, 10 to 20 feet thick and about 50 feet from the base of the sill, is exposed in the outcrops northward from Jersey City for about 20 miles. The olivine crystals, which constitute 15 to 20 per cent. of the rock, occur as poikilitic inclusions in the augite and feldspar.

Chemically, the trap ranges from less than 50 per cent. to more than 60 per cent. of silica, with a corresponding variation in alumina, ferric oxide and the alkalis, while ferrous iron, lime and magnesia vary inversely. The augite is rich in these latter constituents and poor in alumina, giving a great preponderance of the hypersthene and diopside molecules. The feldspars range from orthoclase and albite to basic labradorite. Doubtless there is always more or less anorthoclase, also, since all feldspar analyses show potash.

While there is considerable range in the proportions of the minerals, augite usually comprises about 50 per cent. of the rock, the feldspars about

[1] J. Volney Lewis, Structure and Correlation of the Newark Trap Rocks of New Jersey, Bull. Geol. Soc. of Amer., Vol. 18, pp. 195–210; also Origin and Relations of the Newark Rocks, Ann. Report State Geologist of N. J. for 1906, pp. 97–129.

40 per cent., quartz 5 per cent. and the ores 5 per cent., constituting a quartz-diabase, with normal-diabase and olivine-diabase facies. In the quantitative system it is chiefly a camptonose (III, 5, 3, 4), with the acidic dacose (II, 4, 2, 4) facies. The olivinic ledge is *palisadose* (IV, 1^2, 1^2, 2), the name here suggested for this hitherto unnamed subrang.

Slight basic concentration at the contacts, possibly according to Soret's principle, followed by differentiation by gravity during crystallization of the main mass, especially by the settling of olivine and the ores and the rising of the lighter feldspars in the earlier and more liquid stages of the magma, accounts for the facies observed and their present relations.

Professor **Johnson** said in abstract: Two theories have been advanced to account for the origin of beach cusps. According to one theory, the cusps result from the accumulation of seaweed along the shore and the breaking of water through the seaweed barrier, removing sand and gravel where the break occurs and moulding the remaining deposits into cuspate forms. According to the second theory, the cusps are formed where intersecting waves reach the shore. There are serious theoretical objections to both these theories and still more serious practical objections. Experiments show that cusps can be formed in the laboratory by parallel waves which are, in turn, parallel to the beach; and numerous observations seem to show that they are generally so formed in nature. The cause of cusp formation is to be found in the physical properties of fluids descending an inclined plane, as will be shown more fully in a forthcoming paper.

Professor **Reed** said in abstract: Nantasket Beach consists of several drumlins tied together and to the mainland by a complex system of tombolos. Some of the drumlins show sea cliffs now abandoned by the waves. From the relations of these cliffs and the more ancient of the beaches, the initial drumlins have been reconstructed. The effect of marine action in cliffing the drumlins and stringing out the eroded material in successive tombolos has been followed through, step by step, until the conditions of to-day have been reached.

The study shows that Nantasket Beach is not the result of the accidental tying together of a few islands without system, but that it represents one stage in a long series of evolutionary changes which have occurred in orderly sequence and in accordance with definite physiographic laws.

Professor Reed's paper was illustrated and was followed by remarks by Professor Grabau.

Dr. **Berkey** said in abstract: The rocks of the Corlandt series are known, through the work of the late Professor J. D. Dana and that of Professor H. S. Williams, to occupy an area on the Hudson River just south of Peekskill, N. Y., and to include a very wide range of granitoid medium to basic types of igneous rocks.

The writer has had opportunity to see much of these rocks and their field relations during the past three years. It seems certain that they represent a case of magmatic differentiation that includes not only the Cortlandt series, as outlined by Dana and Williams, but two or three occurrences of typical granite as well. The granite area borders the basic varieties on the northeast side. Actual contacts of the larger masses are not to be seen, but an occasional dike of granite cuts the adjacent diorite and gabbros, indicating a relationship as one of the latest developments. Furthermore, the granite shows its consanguinity by its heavy soda content, soda-lime feldspar predominating. It is, however, a very acid granite and introduces a considerably greater range of rock variety, becoming the acid extreme of the Cortlandt series.

Mr. **Hyde** said in abstract: The genus *Camarophorella* has heretofore been known only by a single species from the Kinderhook at Burlington, Iowa, and has always been referred to the family Pentameridæ, order Protremata, in which only the simplest type of brachial support is known. Recently obtained material of a second species from Sciotoville, Ohio, transfers it to the sub-family Meristellinæ, in the order Telotremata. This material is of unusual interest in that it throws a new light on the method of development of the jugum in certain Athyroid types. It has been supposed that this portion of the brachidium was formed in the phylogeny of the group by the growth of two jugal processes, one on the basal whorl of each cone, and that these united into the shape of an inverted V or U, from the apex of which a short stem was continued which in time bifurcated, the arms then lengthening and reuniting with the base of the stem. The material referred to shows certainly that, in this form at least, the inverted V or U was formed and that the remainder of the structure was laid down, probably in a single plate on the surface of the U and not by any such process as outlined above.

Professor **Jaggar** said in abstract: The island consists of four prominent peaks, old Bogoslof at the south, McCulloch Peak steaming actively in the middle, Metcalf Cone (sometimes called Perry Peak) adjacent to McCulloch in the north and New Bogoslof or Fire Island ("Grewingk"), a flat table rock at the northwest end of the group. These are now all connected by continuous gravel and sand strips, where in one place there was a broad channel and seven fathoms of water a year ago.

McCulloch Peak and Metcalf Cone are both products of the slow pushing up from beneath the waves of a mass of refractory lava, semi-solid, crusting and breaking into blocks as it rises, with only the central portions retaining a semblance of fluidity.

In 1796 Old Bogoslof rose. In 1884 New Bogoslof, Fire Island, came into being, and the waves joined the two with bars. In 1891 New Bogoslof was still steaming. In 1906 Metcalf Cone was reported midway between Old and New Bogoslof. In July, 1907, Metcalf Cone had broken in two, and the breaches between the islands were again connected with continuous land. On September 1, 1907, McCulloch Peak exploded and was wholly destroyed.

No such extraordinary story of growth and alteration of an island in the sea has ever been told in the records of science before, and the changes of the later stages are unique in the annals of vulcanology.

In connection with this paper, sketches were shown illustrating the remarkable differences in outline of this island at different intervals from 1826 to 1907. It was also illustrated with lantern slides. Remarks in connection with the subject made by Professor C. H. Hitchcock and Dr. Henry S. Washington.

Professor **Huntington** said in abstract: In discussions of the possibility of some relationship between sunspots and earthquakes or volcanoes, attention has usually been concentrated upon sunspot maxima. Jensen, an Australian, however, has plotted the most important earthquakes and volcanic eruptions for the last century and more, and on comparing his data with the sunspot curve for the same period finds that there seems to be a grouping of the terrestrial phenomena at or near the time of sunspot minima. In order to test the validity of his conclusions, another set of data as to earthquakes and volcanoes, prepared by Mr. R. W. Sayles for quite a different purpose, has been taken and similarly compared with the sunspot curve. In this case, as in the other, the grouping of terrestrial phenomena at times of sunspot minima is evident. In order to get rid of the personal equation, which enters so largely into such studies, and in order to get rid of temporary or local irregularities, all the data of both Sayles and Jensen have been averaged together. By repeated averaging of results as to the frequency and intensity of both earthquakes and volcanoes, the whole body of facts given by the two investigators, for a period of 117 years in one case and 147 in the other, has been combined into a single curve representing the progress of volcanic and seismic phenomena during the average sunspot cycle for the same period. On comparing this curve with the average sunspot curve, it appears that the minimum of the one coincides exactly with the maxima of the other and *vice versa*, and that times of increase in the one set of phenomena are times of decrease in the other. The coincidence cannot possibly be accidental, for the repeated process of averaging would prevent the two curves from agreeing unless there were a genuine cause of agreement. The remarkable nature of the coincidence suggests that there is some common cause at work, producing a maximum occurrence of earthquakes and volcanoes upon the earth and a minimum occurrence of spots on the sun.

The data used do not claim to be exhaustive, and the results are advanced as suggestive, rather than conclusive.

This paper was illustrated with diagrams.

Dr. **Washington** said in abstract: The island of Pantelleria is entirely volcanic in origin. Its geologic structure has been variously interpreted, and the views of the speaker differ in some important respects from those of other observers, notably Foerstner and Bergeat. There is supposed to have been formed first a large volcano, covering practically the whole area and submarine in its first stages. This was composed of rather siliceous soda-trachytes and later green pantellerites. The central and upper parts of this cone disappeared, probably by explosion, in analogy with the history of many other volcanoes, leaving a large central caldera, surrounded by an encircling somma with steep inner scarps and gentle outer slopes. Within the caldera arose the cone of the second period, now represented by Montagna Grande, the summit of which is the culminating point of the island, and Monte Gibele on the southeast. The lava of these is a very uniform soda-trachyte. The crater of Monte Gibele seems to have been the original eruptive center for the joint mass, but later the block of Montagna Grande was separated from the Gibele cone by a fault, with considerable tilting of the fault block. On the western and northern sides of this block there were formed several small parisitic cones, which gave vent to flows of black, glassy pantellerite. These and the trachytic flows of the Gibele volcano nearly filled the whole floor of the original caldera, the only portion left uncovered being a small elliptical lake, which is thus regarded as a residuum of the old caldera floor and not an eruptive center. The next phase of eruptive activity was confined to the northwestern part of the island, and the lavas are entirely feldspar-basalts, forming several small cinder cones, with flows of scoriaceous basalt. Eruptive activity on the island proper seems to have ceased and is now evident only in some fumaroles and hot springs. The rocks show a wide range in chemical composition, but belong to but few distinct types. They are characterized by high soda, giving rise to the presence of abundant soda-microcline, ægirite, and the triclinic cossyrite among the more salic types, and by the high amount of titanium among the basalts.

The paper was based on a visit made in 1905 and was illustrated with lantern slides.

After the reading of the papers, there were a few general remarks by Professor Kemp and others, and arrangements were made for a field excursion to the "trap" sheets of New Jersey.

The Section then adjourned.

Charles P. Berkey,
Secretary.

SECTION OF BIOLOGY.

April 13, 1908.

Section met at 8:15 P. M., Dr. C. Stuart Gager presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Edmund B. Wilson, A Review of the Types of Sexual Differences of the Chromosomes.

Clinton G. Abbott, The Probable Cause of the "Bleating" of Snipe.

Ralph W. Tower, The Production of Sound in the Drum-fish, the Sea-Robin and the Toad-fish.

The papers by Professor Wilson and Mr. Abbott were illustrated by lantern slides and that of the latter by experiments as well. Professor Tower's paper was read by title and has been published as pages 149–180 of this volume.

The Section then adjourned.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

April 20, 1908.

By permission of Council no meeting was held.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

April 27, 1908.

Section met in conjunction with the New York Branch of the American Psychological Association at 4 P. M. at the Psychological Laboratory of

Columbia University, and at 8:15 P. M. at the American Museum of Natural History, Vice-President Meyer presiding.

The following program was offered:

Afternoon Session.

R. S. Woodworth,	Imagery of Time Relations.
H. H. Woodrow,	Reaction Time as Influenced by the Irregular Recurrence of the Stimulus.
Will S. Monroe,	Memories for Faces.
Edward L. Thorndike,	Practise as a Purely Intellectual Function.

Evening Session.

H. A. Carr,	Some Involuntary Illusions of Depth.
H. D. Marsh,	Psychological Implicates of Certain Linguistic Expressions.
A. C. Armstrong,	The Idea of Feeling in Rousseau's Religious Philosophy.
Max Eastman,	The Pragmatic Meaning of Pragmatism.

Summary of Papers.

Professor **Woodworth** noted the disproportion between our rich supply of time concepts and our meager perceptual experience of time, and proposed to test the hypothesis that time concepts were really composed of spatial concepts or images suffused with a temporal feeling. Mathematically, time can be represented by a point, or better, a line or plane, moving along a line or axis, the present being any chosen position of the moving point, the past to the left, and the future to the right. All units and relations of time could be accurately represented in such a scheme. On examining a considerable number of persons, he found that such spatial representations of time occurred, though seldom, if ever, in a mathematically consistent form. Spatial forms for the year, as well as for the centuries, and for past and future, were not uncommon, being apparently considerably more common than the somewhat similar "number forms," though often less distinct and less clearly conscious. But such time forms are not universally present; they have been found in about half of the forty individuals so far questioned. Of those who do not have them, some think of time concretely, *i. e.*, in terms of events or changes; while others employ what seem to be purely abstract concepts of time.

Mr. **Woodrow** stated that the object of his report was to show that reaction times for regularly recurring stimuli are considerably less than for irregular, providing the interval between the regularly recurring stimuli is not too long. As regards the effect of the interval, it was found that if the stimuli were irregular, there was very little difference in the reaction time for intervals varying from 0.8 sec. to 10.0 secs., while if the stimuli were given in regular succession the reaction time remained nearly constant for intervals from 0.8 sec. to about 4.0 secs., but increased with intervals longer than 4.0 secs., and at 7.0 secs. was nearly as long for totally irregular stimuli.

Professor **Monroe**, in presenting the results of experimental work, said that he had used photographs as the material to be remembered, and that, by varying the conditions, he had determined several of the factors which contribute to the remembering or forgetting of a face once seen.

Professor **Thorndike** reported an experiment in which 28 individuals multiplied mentally 95 examples, each consisting of a three-place number with no figure under 3, to be multiplied by a three-place number with no figure under 3. The work was done so as to occupy approximately sixteen days. Measuring the efficiency of the process inversely by the time taken (with an addition for each error of one-tenth of the time per example), it was found that the median improvement for the 28 individuals was such as to give a reduction to 42 per cent. of the initial time. Some individuals improved two and a half times as much as others. The physiological limit for the function in question was, of course, not reached by any one in so short an experiment, but one individual, and possibly another also, did reach a point from which, within the limit of the experiment, no further improvement was made. The apparent differences in the change of rate of improvement were very great. On the supposition that the change of rate of improvement was due to one general law plus disturbing factors, the speaker showed what this law would be on each of the two most likely hypotheses. The variability amongst individuals increased in the course of the experiment, at least so far as concerns the differences between the upper quarter and the lower quarter of the 28 individuals. It would appear, therefore, that the experiment offered evidence that the influence of the environment is to accentuate rather than relieve initial inequalities of intellect. The experiment also offered evidence that within the field of so-called attention the influence of improvement in one mental function spreads little to other functions than it.

Dr. **Carr** gave a descriptive account of 48 cases gathered from a census of 350 students. The phenomenon consists of illusory transitions of the distance location of visual objects in the course of normal experience. The most pronounced fact was the lack of uniformity. The experiences were described under such headings as: the kind of illusion, extent of visual field involved, character, direction, magnitude and rate of movement, changes in size and distinctness of the perceptual objects, degree of control possible; and such essential conditions as: fatigue, mental absorption, ocular defects, steady fixation, etc. No explanation was attempted.

Dr. **Marsh** showed how the study of the frequency of occurrence of sweeping terms, extensive and intensive, in diverse writings, could be made to yield valuable "internal evidence" regarding the authorship, and especially regarding personal and social characteristics. The intensive series of words included such positives as all, every, always, whoso, whatsoever, etc., and such negatives as no (adjective), none, nothing, no more, never, etc. The frequency of these words per 1,000 lines was determined for practically every book of the Bible, and it was found possible, with this single series of words, to follow most of the conclusions of the "higher critics" regarding disputed writings, both as to whole books and as to parts of books; and this with a high degree of reliability. Supplemented by an intensive series, this method would apparently work well.

A comparison of the first ten books of the Old Testament with the longest ten in the New Testament showed 33 per cent. more positives and 50 per cent. less negatives in the Old Testament. The following interpretations of this difference are suggested.

1. Biologically, it means lower *vs.* higher development, doing *vs.* thinking, prophet and law, warrior and deed in the earlier period *vs.* teacher and preaching, thinker and doctrine in the later period. Faith, the product of bodily action, tends to exaggeration by positives; while doubt, due to mental activity, tends to exaggeration by negatives.

2. Sociologically, it means great social solidarity *vs.* relative individuality. The Hebrews, as selected and protected by Almighty Jehovah, developed a strong national pride and unanimity of thought and action; and this "crowd-spirit" — in the scientific sense — accounts for many irresponsible generalizations, since their prodigious national pride "not only idealized but magnified the past" in many references to it.

3. Psychologically, it means spontaneous imitation *vs.* intellectual initiative. Imitation tends to exclusions of negatives, while increasing intellectual horizon brings questionings and oppositions to accepted views. Sections rich in positives, as the writings of Paul and the first twelve chapters of Joshua, often indicate strong individualities, men of unrivaled force of character, of energetic action against great opposition. The masterful man in deed is likely, we infer, to put these things strongly in expression.

Professor **Armstrong** said in abstract: Rousseau's religious philosophy was based on inner sentiment. The *sentiment intérieur* is subjective in the sense of the individual and in the sense of the inward. From both its individuality and its inwardness proceeds its certitude — which Rousseau highly values — and which depends also on a farther characteristic, the immediacy of the "inner light." Nevertheless, the *sentiment intérieur* is not exclusively affective in its nature, and, when purely emotional, may vary through a wide range of affective experience. At its lowest level it amounts to the satisfaction of desire by religious ideas and principles. Or it may become shallow sentimentalism, as in the second half of the *Nouvelle Héloise*. A third and higher stage is the phase of pure religious aspiration, while in a fourth form it develops into an appreciation of religious values. This evaluating factor in Rousseau's religious thinking has been neglected, but it can be shown by quotation from many of his writings. In general, it is evident that the idea of feeling in Rousseau requires careful analysis before well-grounded inferences can be drawn from his doctrine concerning either psychological or historical or constructive questions.

Mr. **Eastman** said that pragmatism, in intellectualist terms, is skepticism with its logical consequences developed; and in pragmatist terms, the rejection of metaphysics as a serious discipline. This was shown to be consistent with the origin of pragmatism in the biological attitude, which was developed in the writings of such philosophic scientists as Huxley and Clifford. It was then shown that as a dialectic implication of Mr. James's definition of meaning, metaphysics proper becomes not the most divine science, but the most meaningless science. It was stated that his failure to grasp this negative aspect of his definition is what gives obscurity to the whole contents and procedure of his book; it is what gives rise to the technical error of thinking that pragmatism is a confused and unthinkable theory, and the popular error of thinking it is a philosophy which consists in congratulating yourself upon your own prejudices.

The Section then adjourned.

R. S. Woodworth,
Secretary.

SPECIAL MEETING.

April 30, 1908.

The following public lecture was given through coöperation with the Linnæan Society of New York and the American Museum of Natural History:

Richard Kearton, Caterham, England, Wild Birds at Home.

Edmund Otis Hovey,
Secretary.

BUSINESS MEETING.

MAY 4, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, Vice-President Grabau presiding in the absence of President Cox.

Dr. Charles P. Berkey was appointed Secretary *pro-tem.* in the absence of the Recording Secretary.

There being no business to transact, the Academy adjourned.

CHARLES P. BERKEY,
Secretary pro-tem.

SECTION OF GEOLOGY AND MINERALOGY.

MAY 4, 1908.

Section met at 8:15 P. M., Vice-President Grabau presiding.

Fifteen persons were present.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

J. E. Hyde, THE WAVERLY SERIES OF OHIO.
W. O. Crosby, BEACH CUSPS AND RELATED PHENOMENA.
George F. Kunz, NOTES ON JADE.

SUMMARY OF PAPERS.

Mr. **Hyde** said in abstract: The Waverly series of Ohio comprises six well-defined formations, which are named as follows, in descending order:

Logan formation,
Black Hand formation,
Cuyahoga formation,
Sunbury shale,
Berea grit,
Bedford shale.

Of these, the three lowermost extend, with little change in nature, entirely across the State from the northeast corner to the Ohio River. The three upper formations are sometimes removed entirely or in part by the erosion plane which separates the Coal-Measures from the Mississippian formations, but when present are far more variable and show the results of control by local factors during sedimentation.

At present all we know concerning the age of these formations is based almost entirely on the work of Professor C. L. Herrick. Fossils, when present at all, are confined almost entirely to the upper half of the series. The Logan at present is correlated with the Burlington and Keokuk formations or Osage of the Mississippi Valley; the Black Hand and possibly the upper part of the Cuyahoga, with the Kinderhook. Little is known of the faunas of the lower half, as very few fossils have been found. From collections made in the Ohio River, it seems likely that the Osage fauna came in from the southwest and appeared at the point while the Kinderhook forms still lingered in the central part of the State.

Professor **Crosby** indicated the possible dependence of many pitting and grooving effects upon an oscillatory movement of water and air.

Dr. Kunz announced the death of Dr. E. S. F. Arnold and moved that a committee be appointed to draft resolutions. The following were appointed on this committee: Messrs. Kunz, Levison and Berkey.

The Section then adjourned.

Charles P. Berkey,
Secretary.

SECTION OF BIOLOGY.

May 11, 1908.

Section met at 8:15 P. M., Vice-President Chapman presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Frank M. Chapman, An Ornithological Trip to Southern Florida.
N. L. Britton, Recent Botanical Explorations in Jamaica.
Marshall A. Howe, Some Types of Coralline Algæ.

All of the papers were illustrated with lantern slides and a brief discussion followed the reading of each, after which Mr. C. W. Beebe, of the New York Zoölogical Park, gave a preliminary account of his recent expedition to Venezuela.

The Section then adjourned.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

May 18, 1908.

Section met at 8:15 P. M., Vice-President Hering presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

J. P. Simmons, Note on a Curious Effect Produced by the Explosion of Detonating Gas.

William Campbell and R. F. Böhler, The Heat Treatment of Carbon Tool Steels.

Charles Lane Poor, An Investigation of the Figure of the Sun and of Possible Variations in its Size and Shape.

Charles Lane Poor, The Photoheliometer.

Summary of Papers.

Mr. **Simons** said in abstract: When a mixture of oxygen and hydrogen is exploded in a tube, the inside of which is coated with a thin layer of water, perfect rings are formed. The same phenomenon has been noticed when the same kind of a gas mixture is exploded in a tube, the inside of which is coated with a thin layer of wax. This is a heating effect, since the rings formed in the tube covered with wax are made apparent by the melting of the latter substance. This periodic heating is probably due to compressions arising from either sound or explosion waves.

Professor **Campbell** and Mr. **Böhler,** in their paper, first classified the various constituents of unhardened and hardened high carbon steels; namely, cementite, pearlite, ferrite, graphite, austenite, martensite, troostite, osmondite and sorbite, and gave in tabular form the views of the different authorities on their constitution. The plan of study embraced (1) heating to various temperatures and (*a*) slow cooling, (*b*) quenching, (*c*) tempering; (2) the effects of forging temperature and quenching temperature, to see whether the structure gave any evidence whether overheating had taken place during forging at the works of the manufacturer or during reheating for hardening at the user's, in the case of faulty material; also whether this persisted after tempering. Only the maximum forging temperature left any traces after quenching and this was much above that used in practise.

Tables and curves showing variation of physical properties with heat-treatment were given, and the various structures were illustrated by numerous lantern slides.

Professor **Poor's** papers were read by title, and the "Investigation of the Figure of the Sun, etc." has been printed as pages 385–424 of this volume.

The Section then adjourned.

William Campbell,
Secretary.

BUSINESS MEETING.

October 5, 1908.

The Academy met at 8:20 P. M. at the American Museum of Natural History, President Cox presiding.

The minutes of the regular meetings of 6 April and 4 May were read and approved.

The following candidates for election to the Academy, recommended by Council, were duly elected:

For Active Membership:

Henry Smith Pritchett, 22 East 91st St.,
H. A. C. de Rubio, care of Maitland, Coppell & Co., 52 William St.

For Associate Membership:

Harold Chapman Brown, Columbia University.

Council reported the death of the following members of the Academy:

George Chapman Caldwell, Corresponding Member for 32 years,
W. H. Chandler, Corresponding Member for 30 years,
Albert de Lapparent, Corresponding Member for 8 years,
Albert B. Prescott, Corresponding Member for 29 years,
Thomas Fitch Rowland, Life Member for 2 years,
George H. Yeaman, Active Member for 1 year.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

October 5, 1908.

Section met at 8:15 P. M., Vice-President Grabau presiding.

Thirty persons were present.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

W. O. Crosby, Outline of the Geology of Long Island.

James F. Kemp, The Production of Low Grade Copper Ore in the West.

Charles P. Berkey, Limestones Interbedded with the Fordham Gneiss of New York City.

Amadeus W. Grabau, Continental Formation of the American Paleozoic.

Summary of Papers.

Professor Crosby's paper has been published as pages 425–429 of this volume.

Professor **Kemp** presented a brief description of the recent development of the so-called "low-grade" copper mines in Bingham Cañon, Utah, and at Ely, Nevada. By means of maps, the geographical situation was made clear and the geological relations were outlined. The ores consist of bodies of silicified and brecciated porphyry, impregnated with chalcocite. They are mined by means of steam shovels, in huge open cuts. They range in copper from less than two to two and a half per cent. copper. The operation and processes of the mills and smelters was briefly outlined. The paper was based upon visits made the past summer.

Professor **Berkey**, in 1907, published a discussion of the "Structural and Stratigraphic Features of the Basal Gneisses of the Highlands," based upon work in that area for the New York State Survey. The conclusions announced were that the oldest gneisses of the Highlands are essentially the same in origin, age and character as the Fordham of New York City. At the same time numerous small occurrences of very impure crystalline limestone were interpreted as interbedded members of this old series associated closely with especially quartzose and micaceous facies of the formation, all together indicating a metamorphic recrystallization of an original sedimentary series. The limestones of the area, therefore, are separable into at least two widely different types — one type belonging to and of the same age as the Fordham, all of the others much later and possibly themselves complex.

At that time, however, no interbedded limestones were known as such in New York City, the type locality of the true Fordham. The author announced the discovery of such beds at three different points within the city during the past summer. One of these at Jerome Park Reservoir and 205th Street had been previously mapped and heretofore interpreted as a small in-fold, a closely pinched syncline, involving some of the overlying Inwood Limestone in the closed trough. Recent excavations at this locality show that the calcareous beds stand almost vertical and are perfectly conformable to the banded structure of the rather micaceous Fordham on both sides. The total width of the calcareous beds is about 27 feet. Nearly central is a 7 × 10 foot bed of much more massive limestone than either flank. Altogether there are no less than 26 alternating measurable bands or layers of serpentinous and chondroditic coarsely crystalline dolomite limestone and a quartzose schist. Of the thirteen bands of quartzose schist, eight are on one side of the large central limestone bed and five on the other. The thicknesses of the successive corresponding bands on opposite sides likewise do not agree. These facts are taken as sufficient evidence that the occurrence is a true interbed. The mineral chondrodite is abundant.

The other two cases are even more decisive as to relation. They are both on 196th Street, east of Jerome Avenue. In one the narrow limestone bed is part of a simple anticline in which the association of beds is such as to exclude any possible connection with an overlying formation. Two other beds are separated from each other and this by typical micaceous Fordham.

The Fordham, therefore, at its type locality does carry interbedded limestones similar to those in the gneisses of the Highlands, and these beds are much older and entirely distinct from the overlying Inwood.

Professor **Grabau** said in abstract: Since the early ideas regarding the formation of sedimentary rocks developed in the British Isles, it is not surprising that geologists have so generally come to regard all strata as either marine sediments or deposits found in fresh-water lakes. Only when the extensive desert areas of the world came under the observation of geologists, chiefly from the continent of Europe, was an attempt made to interpret the history of stratified rocks by an application of the new lithogenetic processes thus observed. In this work German stratigraphers have taken the lead, though physiographers were among the first to insist on the more rational interpretation demanded by the characteristics and structure of the formations in question. While the Jura-Trias rock beds of western North

America have been more or less generally, though by no means invariably, accepted in this country as representative of continental sedimentation, an interpretation more recently extended to some of the western representatives of these formations, and while in recent years the Tertiary formations of the interior have slowly come to be regarded as river and eolian rather than lake deposits, the Paleozoic sediments of North America are still referred to as of marine or estuarine origin by most American geologists. A noteworthy exception to this widespread adherence to inherited ideas is shown in the recent studies of Barrell and others, in which the continental origin of certain American Paleozoic strata was clearly demonstrated.

The following table gives those formations which in part or in whole show evidence of continental (chiefly fluvial and eolian) rather than a marine origin. In a few cases, as in the Oriskany, a continental (eolian) formation has been remarked by the transgressing sea, so as to secondarily have a marine character impressed upon it.

Permic.	
Donkard formation.	Cimmaron and other Red beds in part.
Carbonic.	
Monongahela	Weber and
Connamaugh	Bingham quartzytes, etc.
Alleghany	generally with a number
Kanawha	of marine inter-
Pottsville	calations.
Mississippic.	
Mauch Chunk	
Pocono	Waverly in part.
Devonic.	
Catskill	
Oneonta	
Sherburne (typical)	
Oriskany — Esopus (in part).	
Siluric.	
Sylvania sandstone.	
Saline formations including Longwood shale series and Shawangunk conglomerate.	
Tuscarora,— Clinch — upper Medina (in part).	
Ordovicic.	
Juniata — Bays — Queenston.	
Tyrone ("Oneida" in part of Pennsylvania geologists)	

St. Peter Sandstone — Ogden Quartzite — Eureka Quartzite.
Cambric.
Potsdam, in part, Basal sands and conglomerates of many regions.

The Section then adjourned.

Charles P. Berkey,
Secretary.

SECTION OF BIOLOGY.

October 12, 1908.

Section met at 8:15 P. M., Vice-President Chapman presiding.

The program consisted of the following illustrated lecture given through coöperation with the American Museum of Natural History:

Dr. Hans Gadow, The Volcano of Jorullo, Mexico; History, Features, Repopulation of the District by Animals and Plants.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

October 19, 1908.

Section met at 8:15 P. M., Vice-President Hering presiding.

The minutes of the last meeting of the Section were read and approved.

As a quorum was not present, the nomination of the Chairman of the Section was postponed. On account of the poor attendance, the advisability of holding bi-monthly meetings was discussed.

The Section then adjourned.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

October 26, 1908.

Section met in conjunction with the American Ethnological Society at 8:15 P. M., General Wilson presiding.

The following program was offered:

R. H. Lowie, An Ethnological Trip to the Chipewayan Indians.
Paul Radin, An Ethnological Trip to the Winnebago Indians.

Summary of Papers.

Dr. **Lowie** briefly described the experiences of a summer expedition under the auspices of the American Museum of Natural History. He first visited the Chipewayan Indians of Lake Athabasca, who present a curious mixture of primitiveness and civilization. Essentially primitive in their economic life, subsisting primarily by fishing and the chase, they have become fundamentally modified in both industrial and mental life by the overshadowing influence of the Hudson's Bay Company and the Catholic missionaries. A very different condition was found among the Assiniboine of Montana, who, though largely devoted to agricultural pursuits under the United States government, preserve to a considerable extent the essential characteristics of Indian belief and religious practice. The speaker described their ceremonial organization, which presents many homologies to the military societies of other Plains tribes.

Mr. **Radin** stated that the Winnebago Indians had lost most of their native industries; they live now in frame houses; they retain only three of their dances; they have no clan ceremonial, though they still give clan names and recognize the "upper" or "heavenly" clans and the "lower" or "earthly" clans. The myths regarding the origins of the clans have much similarity to one another. Only the thunder bird and the bear clans seem to have had any special functions. The bear clan comprised the warriors and had the right of punishment. There are set names for the children, which must be given in every family. Taboo exists against the maternal aunt, but the opposite is in force towards the paternal uncle.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

November 2, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, President Cox presiding.

The minutes of the regular meeting of 5 October were read and approved.

Council reported the death of the following members of the Academy:

Morgan Dix, Active Member for 31 years,
James D. Hague, Active Member for 1 year,
Haslett McKim, Active Member for 11 years.

The Recording Secretary then read a letter from Professor H. H. Rusby, recommending that the Academy devote part of its meetings during the coming year to debating the essential principles espoused by Darwin and the data on which he based them. The Academy showed by the remarks of members that Professor Rusby's recommendations were received with approval.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

November 2, 1908.

Section met at 8:15 P. M., Vice-President Grabau presiding.

Sixty persons were present.

The minutes of the last meeting of the Section were read and approved.

The chairman announced that it would be necessary to nominate at this meeting both a chairman and a secretary of the Section,— the chairman to be also one of the Vice-Presidents of the Academy.

The name of Professor J. J. Stevenson was proposed by members J. F. Kemp and E. O. Hovey for the office of Chairman of the Section. A motion that the Secretary should cast the ballot of the Section for Professor Stevenson was carried. After the ballot was cast, Professor Stevenson was declared duly nominated.

Dr. Charles P. Berkey was then renominated to the office of Secretary of the Section and was duly elected.

Announcement was then made of the courses of lectures on Physiography, to be given at Columbia University by Professor Penck of Berlin, beginning Wednesday, November 4, 1908.

The following program was then offered:

Edmund Otis Hovey, A Contribution to the History of Mt. Pelé, Martinique.

Summary of Paper.

Dr. **Hovey** described, with the aid of many lantern slides, the conditions on and near Mt. Pelé during the visits of the author in May–July, 1902, February–April, 1903, and April–May, 1908, and illustrated particularly the devastation wrought by the early eruptions, the disposition and distribution of material thrown out by the volcano, the building up of the spine of 1902–1903 and its subsequent destruction, the advance of erosion since the cessation of eruptions and the restoration of vegetation in St. Pierre and upon the flanks of the mountain. The paper also described the area of fumaroles in the valley of the Rivière Claire and gave the arguments for the probability of these being true fumaroles. Temperature observations were made also in the great fissures of the new cone, where, by means of an electric pyrometer, temperatures as high as 515° C. (959° F.) were obtained.

The Section then adjourned.

Charles P. Berkey,
Secretary.

SECTION OF BIOLOGY.

November 9, 1908.

Section met at 8:15 P. M., Vice-President Chapman presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Barnum Brown, Paleontological Explorations of the American Museum During the Summer of 1908.

Raymond C. Osburn, Collecting Bryozoa at the Tortugas and Beaufort Stations.

Frank M. Chapman, Notes on the Fish Hawk.

The following business was then transacted:

Mr. Frank M. Chapman was nominated to the Council for Chairman of the Section and Vice-President of the Academy for the year 1909.

The Section then adjourned.

Roy W. Miner,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

November 16, 1908.

Section met at 8:15 P. M., Vice-President Hering presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

E. F. Kern, On the Electrolytic Refining of Iron.

William Campbell, Use of Metallography in Certain Problems in Ore-dressing.

William Campbell, A Visit to Nova Scotia; the Collieries and the Iron and Steel Plants.

Summary of Papers.

Dr. **Kern** first reviewed the previous work on this subject. First, electroplating iron upon the surface of engraved copper plates to obtain a hard facing; then the work of Burgess and Hambueschen, of Gee, of Neuburger and von Klobukow, of Skrabel, of Maximowitsch, of Cowper-Coles. The electrolytes which have been most generally used are neutral solutions of ferrous sulphate or ferrous chloride containing respectively the sulphates or chlorides of ammonium. Smoother deposits were obtained by the presence of magnesium sulphate in an electrolyte and ferrous ammonium sulphate; by stirring the electrolyte; at a temperature of 60–70° C. Oxidation retarded by addition of glycerine. Precipitation of basic salts prevented by adding just sufficient acid to clear the solution. The iron deposited was a hard brittle crystalline mass, over 99.9 % pure.

From experiments performed in the Department of Metallurgy at Columbia University, it was found that neutral ferrous fluosilicate electrolytes are not suitable, as they are slowly decomposed, with the separation out of silica.

Good deposits were obtained from neutral electrolytes containing either 8 % iron as $Fe\,SO_4$ or 6 % Fe and 3 % Na as sulphates or 8 % Fe and 4 %

Na as chlorides, with a current density of 10 to 20 amps. per sq. ft. and a temperature of 50° C, the E. M. F. for the first solution was 0.8 to 0.95 volts, for the second 0.5 to 0.85 volts, for the third 0.4 to 0.5 volts.

The paper concluded with a discussion of the costs of electrolytic refining of iron.

Dr. **Campbell**, in the course of his paper, showed that the structure of certain magnetic lead ores from the Frisco Mine, Idaho, was a fine-grained complex containing magnetite, quartz, calcite and other gangue, blende and galena, which were deposited in about that order. Zinc-lead middlings from the jigs were concentrated by Dings separators into zinc-rich which passed through and lead-rich which was taken out by the magnets.

The structure of a zinc ore from the Graphic Mine, Kelly, N. M., at ground-water level, was shown to be mainly rosettes and compact masses of specular hematite with zinc blende in the interstitial spaces. Some pyrite and chalcopyrite occurred and the order of deposition was seen to be pyrite, hematite, chalcopyrite, blende and a little gangue.

The unsuccessful attempts to concentrate nickel magnetically in nickeliferous pyrrhotites was shown to be in part due to the fine condition of the pentlandite. Slides illustrating the structure of ores from Sudbury, St. Stephens, N. B., Gap Mine, Pa., Sohland, Germany, and Scandinavian localities were shown.

Dr. **Campbell,** in his second paper, said in abstract: The visit was made with the Canadian Mining Institute during the summer. The collieries of the Dominion Coal Company at Glace Bay and of the Nova Scotia Steel Company at Sydney Mines were shown. At the Dominion Iron and Steel Company the various piers, with mechanical unloaders for ore from Newfoundland, the loading of steel rails, etc., were seen. Four blast-furnaces, ore-beds for winter stock, blowing engines, etc., two Bessemer converters, ten open-hearth furnaces, rail mill, rod mill, coke ovens and coal washery. The Nova Scotia Steel and Coal Company has coal and ore piers at North Sydney, with two steam Wellman Seaver Morgan ore unloading cranes. Wabana ore from Bell Is., N. F., averages 55 % Fe. One blast-furnace, 200 tons a day. Three 40-ton Basic open hearth furnaces and one rolling furnace of 180 tons used as mixer. Ingots are sent to the rolling mills at New Glasgow. The coke ovens and coal washer were also visited.

The further business of the evening consisted of the nomination of Sectional officers for 1909. Professor D. W. Hering was duly nominated to the Council for Vice-President and Chairman. Professor W. Campbell was elected Secretary.

The Section then adjourned.

William Campbell,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

November 23, 1908.

Section met in conjunction with the New York Branch of the American Psychological Association at 4 P. M. at Schermerhorn Hall, Columbia University, Professor Pillsburg presiding, and at 8:15 P. M. at the American Museum of Natural History, Professor Woodworth presiding.

The following program was offered:

Afternoon Session.

H. H. Woodrow, The Meaning of Rhythmical Grouping.
H. L. Hollingworth, The Indifference Point.
J. V. Breitwieser, The Effect of Varying Resistance on Reaction Time.

Evening Session.

F. J. E. Woodbridge, Mental Operations and Their Material.
W. P. Montague, Consciousness and Energy.

Summary of Papers.

Mr. **Woodrow** performed, in connection with his paper, experiments on auditory rhythm in which the intensity, duration and intervals of the sounds were independently and systematically varied, and the judgment of the observer was required as to the sort of rhythm perceived. By comparison of the results of this experiment with another in which judgment of intervals was called for, it was found that the two sorts of judgment correspond so closely as to lead to the conclusion that the rhythmical grouping is essentially a matter of time judgment.

Mr. **Hollingworth** said in abstract: The point at which the positive constant error in the reproduction of small magnitudes (here extents of arm movement) passes over into the negative error in the reproduction of large magnitudes was found to depend on the series of magnitudes used. When only one magnitude is used in a series of reproductions, no great constant error appeared, whatever the magnitude. When a series of magnitudes was used together, the indifference point lay always near the middle of the series. Whatever the absolute magnitudes in the series, it always contains an indifference point, and this can be displaced upwards by adding to the series at its upper end, and downward by adding to its lower end.

Mr. **Breitwieser** said in abstract: Resistances, varying from 50 to 6000 grammes, were introduced into the reactor's key in the reaction time experiment, with the result that the reaction was quickest with the least resistance, and progressively slower as the resistance was increased. Tapping tests were made with the same gradations of resistance, and with the same result. A key was devised which permitted measurement of the excess of muscular pressure on the key in making the reaction; the greater excesses seemed to go with the quicker reactions, but the excess diminished with practise.

Professor **Woodbridge** advocated the view that a single sense organ, with the reacting apparatus attached to it, did not furnish the material for anything that could be called mind, or that could be distinguished from physical processes. The coöperation and correlation of the activities connected with two or more sense organs constitute mental operations.

Professor **Montague** set forth the outlines of a doctrine identifying consciousness with potential energy. His presentation was followed by a discussion, which brought out difficulties in the conception, as well as facts in its favor.

The Section then adjourned.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

December 7, 1908.

The Academy met at 8:15 P. M. at the American Museum of Natural History, President Cox presiding.

The minutes of the last meeting were read and approved.

The following candidates for election as Active Members, recommended by the Council, were duly elected:

Severo Y. Aguirre,	Chihuahua, Mexico,
William M. Campbell,	New York University,
Roy C. Andrews,	American Museum of Natural History.

Announcement was then made that the annual meeting of the Academy would be held at the Hotel Endicott at 6:45 P. M., December 21, followed by the annual dinner.

The Academy then adjourned.

Edmund Otis Hovey,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

DECEMBER 7, 1908.

Section met at 8:15 P. M., Vice-President Grabau presiding.

Eighty persons were present.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

James F. Kemp, OUR KNOWLEDGE OF THE FILLED CHANNEL OF THE HUDSON IN THE HIGHLANDS AND THE SUBMERGED GORGE ON THE CONTINENTAL SHELF.

Charles P. Berkey, A SUMMARY OF AN INVESTIGATION INTO THE STRUCTURAL GEOLOGY OF SOUTHERN MANHATTAN AND THE CONDITION OF THE EAST RIVER CHANNEL.

Edmund Otis Hovey, SOME OF THE LATEST RESULTS OF EXPLORATIONS IN THE HUDSON RIVER AT NEW YORK CITY.

SUMMARY OF PAPERS.

Professor **Kemp** gave a summary of the results of borings in the channels and buried valleys of the Hudson and its tributaries, all pointing to a former elevation of this portion of the continent. The speaker showed that a much greater depth is now known in the Hudson itself at Storm King Mountain than at any other point in the whole drainage system except on the submerged continental shelf, where soundings have proven a very deep gorge which probably represents the Pre-Pleistocene Hudson channel.

Dr. **Berkey** exhibited the results indicated in his paper on a large scale map of Southern Manhattan. The work is based upon personal examination of several hundred drill borings with an attempt to identify the rocks penetrated. It seems certain that southern Manhattan is not wholly schist, as formerly mapped, but that the east side is made up of the usual succession of folded Fordham gneiss, Inwood limestone and Manhattan schist.

The East River channel is, in comparison with the Hudson, a very unimportant one. In this lower portion, it is essentially a very small drowned tributary.

Dr. **Hovey** exhibited and discussed borings made by the engineers for the Pennsylvania Railroad Tunnel across the Hudson on the line of Thirty-second Street. He showed that bed rock has been found at approximately

300 feet in each of three deep holes. The middle one of these is on the state line in mid-river and the other two lie at about equal distances on either side, the total space being over 2,000 feet. The profile is uniform and gentle in slope, except at the margins. But the interesting question is whether or not a narrow inner gorge may occur. Seeing that the proven depth of channel in the Highlands is at least 350 feet deeper than so far discovered at New York City, the Hudson problem must still be considered an open one.

Remarks were made by Mr. Cook and by Mr. Jacobs, engineer for the Pennslyvania Tunnel Company, and by Mr. Flinn, Department Engineer of the New York City Board of Water Supply on the general problem of the Hudson gorge.

The Section then adjourned.

CHARLES P. BERKEY,
Secretary.

SECTION OF BIOLOGY.

DECEMBER 14, 1908.

Section met at 8:15 P. M., Dr. F. A. Lucas presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

W. T. Hornaday, AN EXPLORATION OF THE PINACATE LAVA REGION IN NORTHWESTERN MEXICO.

L. Hussakof, ON A NEW SPECIES OF GOBLIN SHARK (*Scapanorhynchus*) FROM JAPAN.

Mary C. Dickerson, WOODS LIFE IN THE NEW ENGLAND WINTER.

The Section then adjourned.

ROY W. MINER,
Secretary.

ANNUAL MEETING.

DECEMBER 21, 1908.

The Academy met for the Annual Meeting on Monday, December 21, 1908, at 7:15 P. M. at the Hotel Endicott, President Cox in the chair.

The minutes of the last Annual Meeting, December 16, 1907, were read and approved.

Reports were presented by the Recording Secretary, the Corresponding Secretary, the Librarian and the Editor, all of which, on motion, were ordered received and placed on file. They are published herewith.

The Treasurer presented a detailed report showing a net cash balance of $193.56 on hand at the close of business November 30, 1908. On motion, this report was received and referred to the Finance Committee for audit.

The following candidates for Honorary Membership and Fellowship, recommended by Council, were duly elected:

Honorary Members.

Professor Eduard Strasburger of Bonn, Germany,
Professor Kakichi Mitsukuri, Director of the College of Science, Imperial University, Tokyo, Japan,
Professor Wilhelm Ostwald of the Royal Society of Natural Sciences of Leipzig, Germany.

Fellows.

Charles P. Berkey, Ph.D., Columbia University,
Charles L. Pollard, Ph.D., Staten Island Assn. of Arts and Sciences.

The Academy then proceeded to the election of officers for the year 1909, Mr. C. William Beebe and Dr. George F. Kunz having been appointed as tellers. The ballots prepared by the Council according to the By-laws were distributed, and after the votes had been counted the following officers were declared unanimously elected, thirty-three votes having been cast by members of the Academy entitled to vote:

President, Charles F. Cox.
Vice-Presidents, J. J. Stevenson (Section of Geology and Mineralogy), Frank M. Chapman (Section of Biology), D. W. Hering (Section of Astronomy, Physics and Chemistry), Maurice Fishberg (Section of Anthropology and Psychology).
Recording Secretary, Edmund Otis Hovey.
Corresponding Secretary, Hermon Carey Bumpus.
Treasurer, Emerson McMillin.
Librarian, Ralph W. Tower.
Editor, Edmund Otis Hovey.
Councilors (to serve 3 years), Franz Boas, Henry E. Crampton.
Finance Committee, Charles F. Cox, George F. Kunz, Frederick S. Lee.

The members of the Academy and their friends, to the number of seventy-three, then sat down together at dinner, after which the retiring President, Mr. Charles F. Cox, delivered his formal address upon "Charles Darwin and the Mutation Theory." This address has been published as pages 431–451 of this volume.

After a vote of thanks, which was put with apt remarks by former-President Henry F. Osborn, the Academy adjourned.

Edmund Otis Hovey,
Secretary.

REPORT OF THE RECORDING SECRETARY.

During the year 1908, the Academy held 8 business meetings and 28 sectional meetings, at which 96 stated papers and 4 lectures were presented on the following subjects:

Geology,	31	papers,	1	lecture,
Mineralogy,	7	"		
Biology,	8	"		
Entomology,	2	"	1	"
Ornithology,	4	"	1	"
Paleontology,	7	"		
Zoölogy,	2	"		
Botany,	2	"	1	"
Ethnology,	2	"		
Archeology and Anthropology,	3	"		
Psychology,	19	"		
Astronomy,	2	"		
Chemistry,	7	"		

Four public lectures by noted home and foreign scientists have been given at the Museum to the members of the Academy and the Affiliated Societies and their friends. These lectures were as follows:

"Some Recent Discoveries in Insect Parasitism and the Practical Handling of Parasites." By Dr. Leland O. Howard, of Washington, D. C. (Through coöperation with the New York and Brooklyn Entomological Societies.) Attendance, 75.

"Wild Birds at Home." By R. Kearton, Esq., of Caterham, England. (Through coöperation with the Linnæan Society of New York and the American Museum of Natural History.) Attendance, 159.

"The Volcano of Jorullo, Mexico; History, Features, Repopulation of the District by Animals and Plants." By Professor Hans Gadow, of Cambridge, England. (Through coöperation with the American Museum of Natural History.) Attendance, 153.

"Mechanical Response of Plants." By Sir Jagadis Chunder Bose, M. A., D. Sc., of Calcutta, India. (Before the Torrey Botanical Club.) Attendance, 103.

An event of note to those interested in geology and related subjects was the spring conference which was held on Monday, the 6th of April, by the Section of Geology and Mineralogy. Invitations to participate were sent to societies, institutions and individual geologists in New England, New York, New Jersey and eastern Pennsylvania, and the response was so general that two sessions were required for the presentation of the 19 papers offered. The afternoon session was held at Columbia University and the evening session at the American Museum of Natural History.

Considerable energy has been expended during the year in preparation for the celebration, on the 12th of February, 1909, of the centenary of the birth of the famous naturalist, Charles Darwin, and the semi-centennial of the "Origin of Species," information as to which has been sent, from time to time, to the members of the Academy and the Affiliated Societies. Much remains to be done, but your officers anticipate an event of more than usual importance to the local scientific public.

At the present time the membership of the Academy includes 460 Active Members, 11 of whom are Associate Active Members, and 126 Fellows. The election of 2 Fellows is pending. There have been 12 deaths during the year, 35 resignations, 7 names have been dropped from last year's roll on account of not completing membership, 1 has been transferred to the list of Non-resident Members and 1 Associate has been dropped on account of non-payment of dues. The new members elected during the year number 18, two of whom have not yet completed their membership. As the membership of the Academy a year ago was 500, there has been a net loss of 40 during 1908. Announcement is made with regret of the loss by death of the following members:

Rev. M. E. Dwight,	Active	Member	(3 years),
Wm. H. S. Wood,	"	"	(23 "),
Thomas Jefferson Hurley,	"	"	(1 year),
Morris K. Jesup,	"	"	(15 years),

Prof. William Stratford,	Active Member (13 years),
Isador Wormser,	" " (1 year),
Dr. E. S. F. Arnold,	" " (28 years),
Thomas F. Rowland,	Life Member since 1906,
George H. Yeaman,	Active Member (1 year),
Rev. Dr. Morgan Dix,	" " (31 years),
James D. Hague,	" " (1 year),
Rev. Haslett McKim,	" " (11 years).

Respectfully submitted.

Edmund Otis Hovey,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the past year the usual biennial request for information was sent out to the special list of Honorary and Corresponding Members, and replies were received from 163, leaving 30 from whom nothing has been heard.

We have lost by death during the past year the following Honorary Members:

Lord Kelvin,	Elected in 1876,
Prof Charles A. Young,	" " 1878,
Prof Wolcott Gibbs,	" " 1899,
Prof. Wm. K. Brooks,	" " 1898,
Prof. Asaph Hall,	" " 1889,

and the following Corresponding Members:

Prof. Daniel C. Gilman,	Elected in 1876,
Prof. Albert de Lapparent,	" " 1900,
Prof. Albert B. Prescott,	" " 1876,
Col. Aimé Laussedat,	" " 1890.

There are at present upon our rolls 45 Honorary Members and 142 Corresponding Members.

Respectfully submitted,

Henry E. Crampton,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The library of the New York Academy of Sciences has received during the year ending December, 1908, through exchange and donation, 454 volumes, 32 separata and 1863 numbers. These have been duly acknowledged, accessioned and placed on the shelves for reference. Special acknowledgement is herewith made to the Academies and Societies who have made gifts of available lacunæ to help complete broken files of their publications in our library. Chief among these may be mentioned 40 volumes from La Société des Naturalistes de Varsovie, and 71 volumes from the Sociedade de Geographia, Lisbon.

The library may be consulted by members and the public between the hours of 9:30 A. M. and 5 P. M. daily, and it is desired that the members assist in further extending its use.

Respectfully submitted,

RALPH W. TOWER,
Librarian.

REPORT OF THE EDITOR.

The Editor reports that during the past fiscal year Part III, completing Volume XVII, was distributed and that Parts I and II and two papers in Part III of Volume XVIII have been printed and distributed. Part I was devoted to the records of the addresses delivered at the Linnæan Celebration of 23 May, 1907, together with greetings communicated by sister organizations at home and abroad. Part II contained the following papers:

"New Species and Genera of the Lepidopterous Family Noctuidæ for 1907 (Part II)." By John B. Smith.

"On Determination of Mineral Constitution through Recasting of Analyses." By Alexis A. Julien.

"The Chester, New York, Mastodon." By E. O. Hovey.

"Production of Sound in the Drumfishes, the Sea-Robin and the Toadfish." By Ralph W. Tower.

"The North American Species of the Genus Ipomœa." By Homer Doliver House.

Records of Meetings, 1906. By W. M. Wheeler.

Records of Meetings, 1907. By E. O. Hovey.

The two articles of Part III were:

"An Investigation of the Figure of the Sun and of Possible Variation in its Size and Shape." By Charles Lane Poor.

"An Outline of the Geology of Long Island." By W. O. Crosby.

The part and volume will be completed by the records of the Recording Secretary for 1908 and the index of the whole volume.

The Annual Directory of the Members of the Academy and its Affiliated Societies was issued as of 31 January, 1908.

Respectfully submitted,

EDMUND OTIS HOVEY,
Editor.

REPORT OF THE TREASURER.

December 17, 1907 –November 30, 1908.

Dec. 17, 1907.	Cash in bank at beginning of fiscal year		$1,954.82
	Cash received during fiscal year and reported as follows:		
1908,	January 13,	$2,481.62	
	February 3,	882.21	
	March 2,	554.25	
	October 6,	3,007.28	
	November 2,	104.80	
	November 30,	919.50	7,949.66
	Total cash on hand and received		$9,904.48
	Paid out on vouchers during fiscal year and reported as follows:		
	February 3,	$4,061.46	
	March 2,	261.68	
	October 6,	4,373.45	
	November 2,	775.99	
	November 30,	238.34	9,710.92
	Total disbursements		
	Balance on hand		$193.56

Recapitulation of deposits:

In Union Square Savings Bank	$285.64
Emerson McMillin & Co.— Debit	92.08
	$193.56

Respectfully submitted,

EMERSON MCMILLIN,
Treasurer.

RECEIPTS.

December 17, 1907–November 30, 1908.

Balance on hand, December 17, 1907		$1,954.82
Income from investments:		
Interest on mortgages	$878.05	
" " bonds	1,010.00	
" " bank balances	94.06	
Sale of bond	1,057.50	3,039.61
Life Membership fees		200.00
Active Membership dues, 1903	10.00	
" " " 1904	30.00	
" " " 1905	60.00	
" " " 1906	90.00	
" " " 1907	160.00	
" " " 1908	3,305.00	
" " " 1909	10.00	3,665.00
Associate Membership dues, 1906	3.00	
" " " 1907	12.00	
" " " 1908	27.00	42.00
Sales of publications		94.93
Subscriptions to Darwin celebration		760.50
" " Annual meeting & dinner		142.00
Post Office refund		5.62
Total		$9,904.48

DISBURSEMENTS.

December 17, 1907–November 30, 1908.

Investments	$3,138.75
Publications, on account of Annals	1,850.23
Recording Secretary's office expenses, including publication of *Bulletin*	1,877.94
Darwin celebration	1,020.00
Lecture Committee	150.00
General expenses	245.45
Esther Hermann Research Fund	1,010.00
Headquarters Committee	265.05
Annual meeting and dinner	153.50
Cash on hand	193.56
Total	$9,904.48

Balance Sheet, November 30, 1908.

Investments	$36,602.50	Permanent Fund	$17,802.75
Cash on hand	193.56	Publication Fund	3,000.00
		Audubon Fund	2,360.95
		Building Fund	10,400.00
		Newberry Fund	1,046.25
		Income of Permanent Fund	1,031.57
		Income of Building Fund	408.96
		Income of Newberry Fund	279.01
		General Income	466.57
	$36,796.06		$36,796.06

Examined and approved,

George F. Kunz,
Frederick S. Lee, } *Auditing Committee.*
C. F. Cox,

THE ORGANIZATION OF THE NEW YORK ACADEMY OF SCIENCES.

THE ORIGINAL CHARTER.

AN ACT TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK.

Passed April 20, 1818.

WHEREAS, The members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State — therefore,

1. *Be it enacted by the People of the State of New York represented in Senate and Assembly*, That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are constituted a body corporate and politic, by the name of LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever; and may have a common seal, with power to alter the same from time to time; and shall be capable of purchasing, taking, holding, and enjoying to them and their successors, any real estate in fee simple or otherwise, and any goods, chattels, and personal estate, and of selling, leasing, or otherwise disposing of said real or personal estate, or any part thereof, at their will and pleasure: *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars: *Provided*, however, that the funds of the said Corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this act, and those only.

2. *And be it further enacted*, That the said Society shall from time to time, forever hereafter, have power to make, constitute, ordain, and estab-

lish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted*, That Samuel L. Mitchill shall be the President; Casper W. Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper, Recording Secretary; Benjamin P. Kissam, Treasurer, and John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, Curators; severally to be the first officers of the said Corporation, who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted*, That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,
Dep. Sec'y.

ALBANY, *April* 29, 1818.

ORDER OF COURT.

ORDER OF THE SUPREME COURT OF THE STATE OF NEW YORK TO CHANGE THE NAME OF

THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK

TO

THE NEW YORK ACADEMY OF SCIENCES.

WHEREAS, in pursuance of the vote and proceedings of this Corporation to change the corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden & Hubbard, acting as the attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz:

At a special term of the Supreme Court of the State of New York, held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present—HON. GEO. C. BARRETT, *Justice.*

In the matter of the application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of the New York Academy of sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and chief officer of said Corporation, to authorize it to assume the corporate name of the New York Academy of Sciences, duly setting forth the grounds of said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit, *The Albany Evening Journal*, and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York, in which county said Corporation had its business office, to wit, in *The Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Browne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the managers of said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name as prayed in said petition: Now on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876,

A copy.

WM. WALSH, *Clerk*.

Resolution of THE ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, The order hath been published as therein required, and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the corporate name thereof, from and after the adoption of the vote and resolution hereinabove referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

THE AMENDED CHARTER.

March 19, 1902.

Chapter 181 of the Laws of 1902.

An Act to amend chapter one hundred and ninety-seven of the laws of eighteen hundred and eighteen, entitled "An act to incorporate the Lyceum of Natural History in the City of New York," a Corporation now known as The New York Academy of Sciences and to extend the powers of said Corporation.

(Became a law March 19, 1902, with the approval of the Governor. Passed, three-fifths being present.)

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section I. The Corporation incorporated by chapter one hundred and ninety-seven of the laws of eighteen hundred and eighteen, entitled "An act to incorporate the Lyceum of Natural History in the City of New York," and formerly known by that name, but now known as The New York Academy of Sciences through change of name pursuant to order made by the supreme court at the city and county of New York, on January fifth, eighteen hundred and seventy-six, is hereby authorized and empowered to raise money for, and to erect and maintain, a building in the city of New York for its use, and in which also at its option other scientific societies may be admitted and have their headquarters upon such terms as said Corporation may make with them, portions of which building may be also rented out by said Corporation for any lawful uses for the purpose of obtaining income for the maintenance of such building and for the promotion of the objects of the Corporation; to establish, own, equip, and administer a public library, and a museum having especial reference to scientific subjects; to publish communications, transactions, scientific works, and periodicals; to give scientific instruction by lectures or otherwise; to encourage the advancement of scientific research and discovery, by gifts of money, prizes, or other assistance thereto. The building, or rooms, of said Corporation in the city of New York used exclusively for library or scientific purposes shall be subject to the provisions and be entitled to the benefits of subdivision seven of section four of chapter nine hundred and eight of the laws of eighteen hundred and ninety-six, as amended.

Section II. The said Corporation shall from time to time forever hereafter have power to make, constitute, ordain, and establish such by-laws and regulations as it shall judge proper for the election of its officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of officers and members thereof; for collecting dues and contributions towards the funds thereof; for regulating the times and places of meeting of said Corporation; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for managing or directing the affairs or concerns of the said Corporation: and may from time to time alter or modify its constitution, by-laws, rules, and regulations.

SECTION III. The officers of the said Corporation shall consist of a president and two or more vice-presidents, a corresponding secretary, a recording secretary, a treasurer, and such other officers as the Corporation may judge necessary; who shall be chosen in the manner and for the terms prescribed by the constitution of the said Corporation.

SECTION IV. The present constitution of the said Corporation shall, after the passage of this act, continue to be the constitution thereof until amended as herein provided. Such constitution as may be adopted by a vote of not less than three-quarters of such resident members and fellows of the said New York Academy of Sciences as shall be present at a meeting thereof, called by the Recording Secretary for that purpose, within forty days after the passage of this act, by written notice duly mailed, postage prepaid, and addressed to each fellow and resident member at least ten days before such meeting, at his last known place of residence, with street and number when known, which meeting shall be held within three months after the passage of this act, shall be thereafter the constitution of the said New York Academy of Sciences, subject to alteration or amendment in the manner provided by such constitution.

SECTION V. The said Corporation shall have power to consolidate, to unite, to co-operate, or to ally itself with any other society or association in the city of New York organized for the promotion of the knowledge or the study of any science, or of research therein, and for this purpose to receive, hold, and administer real and personal property for the uses of such consolidation, union, co-operation, or alliance subject to such terms and regulations as may be agreed upon with such associations or societies.

SECTION VI. This act shall take effect immediately.

STATE OF NEW YORK,

OFFICE OF THE SECRETARY OF STATE.

I have compared the preceding with the original law on file in this office, and do hereby certify that the same is a correct transcript therefrom, and the whole of said original law.

Given under my hand and the seal of office of the Secretary of State, at the city of Albany, this eighth day of April, in the year one thousand nine hundred and two.

John T. McDonough,
Secretary of State.

CONSTITUTION.

Adopted, April 24, 1902, and Amended at Subsequent Times.

Article I. The name of this Corporation shall be The New York Academy of Sciences. Its objects shall be the advancement and diffusion of scientific knowledge, and the center of its activities shall be in the City of New York.

Article II. The Academy shall consist of five classes of members, namely: Active Members, Fellows, Associate Members, Corresponding Members and Honorary Members. Active Members shall be the members of the Corporation who live in or near the City of New York, or who, having removed to a distance, desire to retain their connection with the Academy. Fellows shall be chosen from the Active Members in virtue of their scientific attainments. Corresponding and Honorary Members shall be chosen from among the men of science of the world who have attained distinction as investigators. The number of Corresponding Members shall not exceed two hundred, and the number of Honorary Members shall not exceed fifty.

Article III. None but Fellows and Active Members who have paid their dues up to and including the last fiscal year shall be entitled to vote or to hold office in the Academy.

Article IV. The officers of the Academy shall be a President, as many Vice-Presidents as there are sections of the Academy, a Corresponding Secretary, a Recording Secretary, a Treasurer, a Librarian, an Editor, six elected Councilors and one additional Councilor from each allied society or association. The annual election shall be held on the third Monday in December, the officers then chosen to take office at the first meeting in January following.

There shall also be elected at the same time a Finance Committee of three.

Article V. The officers named in Article IV shall constitute a Council, which shall be the executive body of the Academy with general control over its affairs, including the power to fill *ad interim* any vacancies that may occur in the offices. Past Presidents of the Academy shall be *ex-officio* members of the Council.

Article VI. Societies organized for the study of any branch of science may become allied with the New York Academy of Sciences by consent of the Council. Members of allied societies may become Active Members of the Academy by paying the Academy's annual fee, but as members of an allied society they shall be Associate Members with the rights and privileges of other Associate Members, except the receipt of its publications. Each allied society shall have the right to delegate one of its members, who is also an Active Member of the Academy, to the Council of the Academy, and such delegate shall have all the rights and privileges of other Councilors.

Article VII. The President and Vice-Presidents shall not be eligible to more than one re-election until three years after retiring from office; the Secretaries and Treasurer shall be eligible to re-election without limitation. The President, Vice-presidents and Secretaries shall be Fellows. The terms of office of elected Councilors shall be three years, and these officers shall be so grouped that two, at least one of whom shall be a Fellow, shall be elected and two retired each year. Councilors shall not be eligible to re-election until after the expiration of one year.

Article VIII. The election of officers shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

Article IX. Ten members, the majority of whom shall be Fellows, shall form a quorum at any meeting of the Academy at which business is transacted.

Article X. The Academy shall establish by-laws, and may amend them from time to time as therein provided.

Article XI. This Constitution may be amended by a vote of not less than three fourths of the fellows and three fourths of the active members present and voting at a regular business meeting of the Academy, provided that such amendment shall be publicly submitted in writing at the preceding business meeting, and provided also that the Recording Secretary shall send a notice of the proposed amendment at least ten days before the meeting, at which a vote shall be taken, to each Fellow and Active Member entitled to vote.

BY-LAWS.

As Adopted, October 6, 1902, and Amended at Subsequent Times.

Chapter I.

OFFICERS.

1. *President.* It shall be the duty of the President to preside at the business and special meetings of the Academy; he shall exercise the customary duties of a presiding officer.

2. *Vice-Presidents.* In the absence of the President, the senior Vice-President, in order of Fellowship, shall act as the presiding officer.

3. *Corresponding Secretary.* The Corresponding Secretary shall keep a corrected list of the Honorary and Corresponding Members, their titles and addresses, and shall conduct all correspondence with them. He shall make a report at the Annual Meeting.

4. *Recording Secretary.* The Recording Secretary shall keep the minutes of the Academy proceedings; he shall have charge of all documents belonging to the Academy, and of its corporate seal, which he shall affix and attest as directed by the Council; he shall keep a corrected list of the Active Members and Fellows, and shall send them announcements of the meetings of the Academy; he shall notify all Members and Fellows of their election, and committees of their appointment; he shall give notice to the Treasurer and to the Council of matters requiring their action, and shall bring before the Academy business presented by the Council. He shall make a report at the Annual Meeting.

5. *Treasurer.* The Treasurer shall have charge, under the direction of the Council, of all moneys belonging to the Academy, and of their investment. He shall receive all fees, dues and contributions to the Academy, and any income that may accrue from property or investment; he shall report to the Council at its last meeting before the Annual Meeting the names of members in arrears; he shall keep the property of the Academy insured, and shall pay all debts against the Academy the discharge of which shall be ordered by the Council. He shall report to the Council from time to time the state of the finances, and at the Annual Meeting shall report to the Academy the receipts and expenditures for the entire year.

6. *Librarian.* The Librarian shall have charge of the library, under the general direction of the Library Committee of the Council, and shall conduct all correspondence respecting exchanges of the Academy, He shall make a report on the condition of the library at the Annual Meeting.

7. *Editor.* The editor shall have charge of the publications of the Academy, under the general direction of the Publication Committee of the Council. He shall make a report on the condition of the publications at the Annual Meeting.

Chapter II.

COUNCIL.

1. *Meetings.* The Council shall meet once a month, or at the call of the President. It shall have general charge of the affairs of the Academy.

2. *Quorum.* Five members of the Council shall constitute a quorum.

3. *Officers.* The President, Vice-Presidents and Recording Secretary of the Academy shall hold the same offices in the Council.

4. *Committees.* The Standing Committees of the Council shall be: (1) an Executive Committee consisting of the President, Treasurer, and Recording Secretary; (2) a Committee on Publications; (3) a Committee on the Library, and such other committees as from time to time shall be authorized by the Council. The action of these committees shall be subject to revision by the Council.

Chapter III.

FINANCE COMMITTEE.

The Finance Committee of the Academy shall audit the Annual Report of the Treasurer, and shall report on financial questions whenever called upon to do so by the Council.

Chapter IV.

ELECTIONS.

1. *Active Members.* (*a*) Active Members shall be nominated in writing to the Council by at least two active Members or Fellows. If approved by the Council, they may be elected at the succeeding business meeting.

(*b*) Any Active Member who, having removed to a distance from the city of New York, shall nevertheless express a desire to retain his connection with the Academy, may be placed by vote of the Council on a list of Non-resident Members. Such members shall relinquish the full privileges and obligations of Active Members. (*Vide* Chapters V and X.)

2. *Associate Members.* Workers in science may be elected to Associate Membership for a period of two years in the manner prescribed for Active Members. They shall not have the power to vote and shall not be eligible to election as fellows, but may receive the publications. At any time subsequent to their election they may assume the full privileges of Active Members by paying the dues of such Members.

3. *Fellows, Corresponding Members and Honorary Members.* Nominations for Fellows, Corresponding Members, and Honorary Members may be made in writing either to the Recording Secretary or to the Council at its meeting prior to the Annual Meeting. If approved by the Council, the nominees shall then be balloted for at the Annual Meeting.

4. *Officers.* Nominations for Officers, with the exception of Vice-

Presidents, may be sent in writing to the Recording Secretary, with the name of the proposer, at any time not less than thirty days before the Annual Meeting. Each section of the Academy shall nominate a candidate for Vice-President, who, on election, shall be Chairman of the section; the names of such nominees shall be sent to the Recording Secretary properly certified by the sectional secretaries, not less than thirty days before the Annual Meeting. The Council shall then prepare a list which shall be the regular ticket. This list shall be mailed to each Active Member and Fellow at least one week before the Annual Meeting. But any Active Member or Fellow entitled to vote shall be entitled to prepare and vote another ticket.

Chapter V.

DUES.

1. *Dues.* The annual dues of Active Members and Fellows shall be $10, payable in advance at the time of the Annual Meeting; but new members elected after May 1 shall pay $5 for the remainder of the fiscal year.

The annual dues of elected Associate Members shall be $3, payable in advance at the time of the Annual Meeting.

Non-resident Members shall be exempt from dues, so long as they shall relinquish the privileges of Active Membership. (*Vide* Chapter X.)

2. *Members in Arrears.* If any Active Member or Fellow whose dues remain unpaid for more than one year, shall neglect or refuse to pay the same within three months after notification by the Treasurer, his name may be erased from the rolls by vote of the Council. Upon payment of his arrears, however, such person may be restored to Active Membership or Fellowship by vote of the Council.

3. *Renewal of Membership.* Any Active Member or Fellow who shall resign because of removal to a distance from the City of New York, or any Non-resident Member, may be restored by vote of the Council to Active Membership or Fellowship at any time upon application.

Chapter VI.

PATRONS, DONORS AND LIFE MEMBERS.

1. *Patrons.* Any person contributing at one time $1000 to the general funds of the Academy shall be a Patron and, on election by the Council, shall enjoy all the privileges of Active Members.

2. *Donors.* Any person contributing $50 or more annually to the general funds of the Academy shall be termed a Donor and, on election by the Council, shall enjoy all the privileges of Active Members.

3. *Life Members.* Any Active Member or Fellow contributing at one time $100 to the general funds of the Academy shall be a Life Member and shall thereafter be exempt from annual dues; and any Active Member or Fellow who has paid annual dues for twenty-five years or more may, upon his written request, be made a life member and be exempt from further payment of dues.

Chapter VII.

SECTIONS.

1. *Sections.* Sections devoted to special branches of Science may be established or discontinued by the Academy on the recommendation of the Council. The present sections of the Academy are the Section of Astronomy, Physics and Chemistry, the Section of Biology, the Section of Geology and Mineralogy and the Section of Anthropology and Psychology.

2. *Organization.* Each section of the Academy shall have a Chairman and a Secretary, who shall have charge of the meetings of their Section. The regular election of these officers shall take place at the October or November meeting of the section, the officers then chosen to take office at the first meeting in January following.

3. *Affiliation.* Members of scientific societies affiliated with the Academy, and members of the Scientific Alliance, or men of science introduced by members of the Academy, may attend the meetings and present papers under the general regulations of the Academy.

Chapter VIII.

MEETINGS.

1. *Business Meetings.* Business meetings of the Academy shall be held on the first Monday of each month from October to May inclusive.

2. *Sectional Meetings.* Sectional meetings shall be held on Monday evenings from October to May inclusive, and at such other times as the Council may determine. The sectional meeting shall follow the business meeting when both occur on the same evening.

3. *Annual Meeting.* The Annual Meeting shall be held on the third Monday in December.

4. *Special Meetings.* A special meeting may be called by the Council, provided one week's notice be sent to each Active Member and Fellow, stating the object of such meeting.

CHAPTER IX.

ORDER OF BUSINESS.

1. *Business Meetings.* The following shall be the order of procedure at business meetings:

   1. Minutes of the previous business meeting.
   2. Report of the Council.
   3. Reports of Committees.
   4. Elections.
   5. Other business.

2. *Sectional Meetings.* The following shall be the order of procedure at sectional meetings:

   1. Minutes of the preceding meeting of the section.
   2. Presentation and discussion of papers.
   3. Other scientific business.

3. *Annual Meetings.* The following shall be the order of procedure at Annual Meetings:

   1. Annual reports of the Corresponding Secretary, Recording Secretary, Treasurer, Librarian, and Editor.
   2. Election of Honorary Members, Corresponding Members, and Fellows.
   3. Election of officers for the ensuing year.
   4. Annual address of the retiring President.

CHAPTER X.

PUBLICATIONS.

1. *Publications.* The established publications of the Academy shall be the *Annals* and the *Memoirs.* They shall be issued by the Editor under the supervision of the Committee on Publications.

2. *Distribution.* One copy of all publications shall be sent to each Patron, Life Member, Active Member and Fellow, *provided,* that upon enquiry by the Editor such Members or Fellows shall signify their desire to receive them.

3. *Publication Fund.* Contributions may be received for the publication fund, and the income thereof shall be applied toward defraying the expenses of the scientific publications of the Academy.

Chapter XI.

GENERAL PROVISIONS.

1. *Debts.* No debts shall be incurred on behalf of the Academy, unless authorized by the Council.

2. *Bills.* All bills submitted to the Council must be certified as to correctness by the officers incurring them.

3. *Investments.* All the permanent funds of the Academy shall be invested in United States or in New York State securities or in first mortgages on real estate, provided they shall not exceed sixty-five per cent. of the value of the property, or in first mortgage bonds of corporations which have paid dividends continuously on their common stock for a period of not less than five years. All income from patron's fees, life membership fees and donor's fees shall be added to the permanent fund.

4. *Expulsion, etc.* Any Member or Fellow may be censured, suspended or expelled, for violation of the Constitution or By-Laws, or for any offence deemed sufficient, by a vote of three fourths of the Members and three fourths of the Fellows present at any business meeting, provided such action shall have been recommended by the Council at a previous business meeting, and also, that one month's notice of such recommendation and of the offence charged shall have been given the Member accused.

5. *Changes in By-Laws.* No alteration shall be made in these By-Laws unless it shall have been submitted publicly in writing at a business meeting, shall have been entered on the Minutes with the names of the Members or Fellows proposing it, and shall be adopted by two-thirds of the Members and Fellows present and voting at a subsequent business meeting.

MEMBERSHIP OF THE

NEW YORK ACADEMY OF SCIENCES.

31 DECEMBER, 1908.

HONORARY MEMBERS.

1887. Prof. ALEXANDER AGASSIZ, Cambridge, Mass.
1898. Prof. ARTHUR AUWERS, Berlin, Germany.
1889. Prof. CHARLES BARROIS, Lille, France.
1907. Prof. WILLIAM BATESON, Cambridge, England.
1901. CHARLES VERNON BOYS, London, England.
1904. Prof. W. C. BRÖGGER, Christiana, Norway.
1887. Dr. WILLIAM HENRY DALLINGER, London, England.
1899. Sir GEORGE HOWARD DARWIN, Cambridge, England.
1876. Dr. W. BOYD DAWKINS, Manchester, England.
1902. Sir JAMES DEWAR, Cambridge, England.
1901. Prof. EMIL FISCHER, Berlin, Germany.
1876. Sir ARCHIBALD GEIKIE, Haslemere, Surrey, England.
1901. Prof. JAMES GEIKIE, Edinburgh, Scotland.
1898. Sir DAVID GILL, London, England.
1889. Prof. GEORGE LINCOLN GOODALE, Cambridge, Mass.
1894. Dr. ERNST HÄCKEL, Jena, Germany.
1899. Prof. JULIUS HANN, Vienna, Austria.
1898. Dr. GEORGE W. HILL, West Nyack, N. Y.
1907. Dr. J. D. HOOKER, Kew, England.
1896. Prof. AMBROSIUS A. W. HUBRECHT, Utrecht, Netherlands.
1901. Prof. WILLIAM JAMES, Cambridge, Mass.
1896. Prof. FELIX KLEIN, Göttingen, Germany.
1876. Prof. VIKTOR VON LANG, Vienna, Austria.
1898. Dr. E. RAY LANKESTER, London, England.
1880. Sir NORMAN LOCKYER, London, England.
1900. Prof. FRANZ LEYDIG, Tauber, Germany.
1908. Prof. KAKICHI MITSUKURI, Tokio, Japan.
1898. Prof. FRIDTJOF NANSEN, Christiana, Norway.
1891. Prof. SIMON NEWCOMB, Washington, D. C.

1908. Prof. Wilhelm Ostwald, Gross-Bothen, Germany.
1898. Prof. Albrecht Penck, Berlin, Germany.
1898. Prof. Wilhelm Pfeffer, Leipzig, Germany.
1900. Prof. Edward Charles Pickering, Cambridge, Mass.
1900. Prof. Jules Henri Poincaré, Paris, France.
1901. Sir William Ramsay, London, England.
1899. Lord Rayleigh, Witham, Essex, England.
1898. Dr. Hans H. Reusch, Christiana, Norway.
1887. Sir Henry Enfield Roscoe, London, England.
1887. Geheimrath Heinrich Rosenbusch, Heidelberg, Germany.
1904. Prof. Karl von den Steinen, Berlin, Germany.
1904. Dr. G. Johnstone Stoney, London, England.
1908. Prof. Eduard Strasburger, Bonn, Germany.
1896. Prof. Joseph John Thomson, Cambridge, England.
1900. Prof. Edward Burnett Tylor, Oxford, England.
1904. Prof. Hugo de Vries, Amsterdam, Netherlands.
1907. Prof. James Ward, Cambridge, England.
1904. Dr. Wilhelm Wundt, Leipzig, Germany.
1904. Geheimrath Ferdinand Zirkel, Leipzig, Germany.

CORRESPONDING MEMBERS.

1883. Dr. Charles Conrad Abbott, Trenton, N. J.
1898. Prof. Frank D. Adams, Montreal, Canada.
1891. Dr. José G. Aguilera, Mexico City, Mexico.
1890. William DeWitt Alexander, Honolulu, Hawaii.
1899. Dr. C. W. Andrews, London, England.
1876. Prof. John Howard Appleton, Providence, R. I.
1899. Dr. J. G. Baker, Kew, England.
1898. Prof. Isaac Bagley Balfour, Edinburgh, Scotland.
1878. Dr. Alexander Graham Bell, Washington, D. C.
1867. Edward L. Berthoud, Golden, Colo.
1897. Dr. Herbert Bolton, Bristol, England.
1899. Dr. G. A. Boulenger, London, England.
1874. T. S. Brandegee, San Diego, Calif.
1884. Prof. John C. Branner, Stanford University, Calif.
1894. Prof. Bohuslay Brauner, Prague, Bohemia.
1874. Prof. William Brewster, Cambridge, Mass.
1876 Prof. George Jarvis Brush, New Haven, Conn.
1898. Prof. T. C. Chamberlin, Chicago, Ill.
1876. Dr. Frank Wigglesworth Clarke, Washington, D. C.

1891. Prof. L. Clerc, Ekaterinburg, Russia.
1877. Dr. Theodore Comstock, Los Angeles, Calif.
1868. M. C. Cooke, London, England.
1876. Prof. H. B. Cornwall, Princeton, N. J.
1880. Charles B. Cory, Boston, Mass.
1877. Dr. Joseph Crawford, Philadelphia, Pa.
1866. Geheimrath Hermann Credner, Leipzig, Germany.
1895. Prof. Henry P. Cushing, Cleveland, O.
1879. T. Nelson Dale, Pittsfield, Mass.
1870. Dr. William Healey Dall, Washington, D. C.
1885. Prof. Edward Salisbury Dana, New Haven, Conn.
1898. Prof. William M. Davis, Cambridge, Mass.
1894. Pres. Ruthven Deane, Chicago, Ill.
1899. Prof. Charles Déperet, Lyons, France.
1890. Dr. Orville A. Derby, Rio Janeiro, Brazil.
1899. Dr. Louis Dollo, Brussels, Belgium.
1876. Henry W. Elliott, Lakewood, O.
1880. Prof. John B. Elliott, New Orleans, La.
1869. Dr. Francis E. Engelhardt, Syracuse, N. Y.
1879. Prof. Herman LeRoy Fairchild, Rochester, N. Y.
1879. Prof. Friedrich Bernhard Fittica, Marburg, Germany.
1885. Dr. Lazarus Fletcher, London, England.
1899. Prof. Eberhard Fraas, Stuttgart, Germany.
1879. Dr. Reinhold Fritzgartner, Tegucigalpa, Honduras.
1870. Prof. Grove K. Gilbert, Washington, D. C.
1858. Prof. Theodore Nicholas Gill, Washington, D. C.
1865. Prof. Charles A. Goessman, Amherst, Mass.
1888. Prof. Frank Austin Gooch, New Haven, Conn.
1868. Col. C. R. Greenleaf, U. S. A., San Francisco, Calif.
1883. Dr. Marquis Antonio de Gregorio, Palermo, Sicily.
1877. Prof. Paul Heinrich von Groth, Munich, Germany.
1869. R. J. Lechmere Guppy, Trinidad, British West Indies.
1898. Dr. George E. Hale, Mt. Wilson, Calif.
1882. Baron Ernst von Hesse-Wartegg, Lucerne, Switzerland.
1867. Prof. C. H. Hitchcock, Hanover, N. H.
1900. Dr. William Henry Holmes, Washington, D. C.
1890. Dr. H. D. Hoskold, Buenos Ayres, Argentine Republic.
1896. Prof. J. P. Iddings, Chicago, Ill.
1875. Malvern W. Iles, Dubuque, Ia.
1899. Prof. Otto Jäckel, Greifswald, Germany.
1876. Prof. Samuel W. Johnson, New Haven, Conn.

1876. Pres. David Starr Jordan, Stanford University, Calif.
1876. Prof. George A. Koenig, Houghton, Mich.
1899. Dr. Friedrich Kohlrausch, Marburg, Germany.
1888. Baron R. Kuki, Tokyo, Japan.
1890. Prof. Alfred Lacroix, Paris, France.
1876. Prof. John W. Langley, Cleveland, O.
1876. Prof. S. A. Lattimore, Rochester, N. Y.
1894. Prof. William Libbey, Princeton, N. J.
1899. Prof. Archibald Liversidge, London, England.
1876. Prof. George Macloskie, Princeton, N. J.
1876. Prof. John William Mallet, Charlottesville, Va.
1891. Prof. Charles Riborg Mann, Chicago, Ill.
1867. Dr. George F. Matthew, St. John, N. B., Canada.
1874. Charles Johnson Maynard, West Newton, Mass.
1874. Theodore Luqueer Mead, Oviedo, Fla.
1888. Seth E. Meek, Chicago, Ill.
1892. J. de Mendizábal-Tamborrel, Mexico City, Mexico.
1874. Dr. Clinton Hart Merriam, Washington, D. C.
1898. Prof. Mansfield Merriam, South Bethlehem, Pa.
1890. Dr. A. B. Meyer, Berlin, Germany.
1878. Prof. Charles Sedgwick Minot, Boston, Mass.
1876. Prof. William Gilbert Mixter, New Haven, Conn.
1890. Dr. Richard Moldenke, Watchung, N. J.
1895. Prof. C. Lloyd Morgan, Bristol, England.
1864. Dr. Edward S. Morse, Salem, Mass.
1898. George Murray, London, England.
——. Prof. Eugen Netto, Giessen, Germany.
1866. Prof. Alfred Newton, Cambridge, England.
1897. Dr. Francis C. Nicholas, New York, N. Y.
1882. Dr. Henry Alfred Alford Nicholls, Dominica, B. W. I.
1881. Prof. William H. Niles, Boston, Mass.
1880. Dr. Edward J. Nolan, Philadelphia, Pa.
1879. Frederick A. Ober, Hackensack, N. J.
1876. John M. Ordway, New Orleans, La.
1900. Prof. George Howard Parker, Cambridge, Mass.
1876. Stephen F. Peckham, New York, N. Y.
1888. Prof. George E. Post, Beirût, Syria.
1894. Prof. Edward Bagnall Poulton, Oxford, England.
1877. Prof. Frederick Prime, Philadelphia, Pa.
1868. Prof. Raphael Pumpelly, Newport, R. I.
1876. Prof. B. Alex. Randall, Philadelphia, Pa.

1888. T. Mellard Reade, Liverpool, England.
1876. Dr. Ira Remsen, Baltimore, Md.
1874. Robert Ridgway, Washington, D. C.
1886. Prof. William L. Robb, Troy, N. Y.
1876. Prof. Samuel P. Sadtler, Philadelphia, Pa.
1899. D. Max Schlosser, Munich, Germany.
1867. Prof. Paul Schweitzer, Columbia, Mo.
1898. Prof. W. B. Scott, Princeton, N. J.
1876. Prof. Samuel H. Scudder, Cambridge, Mass.
1894. Prof. W. T. Sedgwick, Boston, Mass.
1876. Andrew Sherwood, Portland, Ore.
1883. J. Ward Smith, Newark, N. J.
1895. Prof. Charles H. Smyth, Jr., Princeton, N. J.
1890. Dr. J. Selden Spencer, Tarrytown, N. Y.
1896. Dr. Robert Stearns, Los Angeles, Calif.
1890. Prof. Walter LeConte Stevens, Lexington, Va.
1876. Prof. Francis H. Storer, Boston, Mass.
1885. Rajah Sourindro Mohun Tagore, Calcutta, India.
1893. Dr. J. P. Thomson, Brisbane, Queensland, Australia.
1899. Dr. R. H. Traquair, Colinton, Scotland.
1877. Prof. John Trowbridge, Cambridge, Mass.
1876. Dr. D. K. Tuttle, Philadelphia, Pa.
1871. Dr. Henri Van Heurck, Antwerp, Belgium.
1900. Pres. Charles R. Van Hise, Madison, Wis.
1867. Prof. Addison Emery Verrill, New Haven, Conn.
1890. Brig. Gen. Anthony Wayne Vogdes, U. S. A. (retired), San Diego, Calif.
1898. Dr. Charles Doolittle Walcott, Washington, D. C.
1876. Leonard Waldo, New York, N. Y.
1900. Prof. Sho Watasé, Tokyo, Japan.
1897. Prof. Stuart Weller, Chicago, Ill.
1874. Dr. I. C. White, Morgantown, West Va.
1898. Prof. C. O. Whitman, Woods Holl, Mass.
1898. Prof. Henry Shaler Williams, Ithaca, N. Y.
1898. Prof. N. H, Winchell, Minneapolis, Minn.
1866. Prof. Horatio C. Wood, Philadelphia, Pa.
1899. Dr. A. Smith Woodward, London, England.
1876. Prof. Arthur Williams Wright, New Haven, Conn.
1876. Prof. Harry Crècy Yarrow, Washington, D. C.

PATRONS.

BRITTON, Prof. N. L., N. Y. Botanical Garden.
BROWN, Hon. ADDISON, 45 West 89th Street.
CASEY, Col. THOMAS L., U. S. A., Washington, D. C.
CHAPIN, CHESTER W. 34 West 57th Street.
FIELD, C. DE PEYSTER, 21 East 26th Street.
GOULD, EDWIN, Dobbs Ferry, N. Y.
GOULD, GEORGE J., 195 Broadway.
GOULD, Miss HELEN M., Irvington, N. Y.
HERRMAN, Mrs. ESTHER, 59 West 56th Street.
JULIEN, Dr. ALEXIS A., Columbia University.
LEVISON, W. GOOLD, 1435 Pacific Street, Brooklyn.
MEAD, WALTER H., 67 Wall Street.
SENFF, CHARLES H., 300 Madison Avenue.

ACTIVE MEMBERS.

31 DECEMBER, 1908.

Fellowship is indicated by an asterisk (*) before the name. Life Membership is shown by heavy-faced type. The names of Patrons are in capitals.

Adams, Edward D.
*ADLER, I., M.D.
*ALLEN, J. A., Ph.D.
ALLEN, JAMES LANE
*ALLIS, EDWARD PHELPS, Jr., Ph.D.
*AMEND, BERNARD G.
ANDERSON, A. A.
ANDERSON, A. J. C.
ANDERSON, J. H.
ANDREWS, ROY C.
Anthony, R. A.
ANTHONY, WILLIAM A.[1]
AREND, FRANCIS J.
Armstrong, S. T., M.D.
ARNOLD, FELIX, M.D.
ASTOR, JOHN JACOB
AVERY, SAMUEL P.
BAEKELAND, LEO H., Ph.D.
Bailey, James M.
Barhydt, Mrs. P. H.
BARNES, Miss CORA F.
BARRON, GEORGE D.
*BASKERVILLE, Prof. CHARLES.
BAUGH, Miss M. L.
BAXTER, M., Jr.
BEAL, WILLIAM R.
BEAN, HENRY WILLARD
BEARD, DANIEL C.

[1] Deceased.

***Beck, Fanning C. T.**
BECKHARD, MARTIN
*BEEBE, C. WILLIAM
BEERS, M. H.
BELLER, A.
BERGSTRESSER, CHARLES M.
*BERKEY, CHARLES P., Ph.D.
*BERRY, EDWARD W.
BETTS, SAMUEL R.
VAN BEUREN, F. T.
*BICKMORE, ALBERT S., Ph.D.
BIEN, JULIUS
*BIGELOW, Prof. MAURICE A., Ph.D.
BIGELOW, WILLIAM S.
BIJUR, MOSES
Billings, Miss Elizabeth
BILLINGS, FREDERICK
BIRDSALL, Mrs. W. R.
BIRKHAHN, R. C.
BISHOP, HEBER R.
BISHOP, SAMUEL H.
*BLAKE, J. A., M.D.
BLANK, M. I., M.D.
***Bliss, Prof. Charles B.**
*BOAS, Prof. FRANZ
BOETTGER, HENRY W.
BÖHLER, RICHÁRD F.
BOYD, JAMES
*BRISTOL, Prof. CHARLES L.
BRISTOL, JNO. I. D.
*BRITTON, PROF. N. L., PH.D.
*BROWN, HON. ADDISON
BROWN, EDWIN H.
*BROWNELL, SILAS B.
*BUMPUS, Prof. H. C., Ph.D.
*BURR, WILLIAM H.
BURR, WINTHROP
BUSH, WENDELL T.
*BYRNES, Miss ESTHER F., Ph.D.
*CALKINS, Prof. GARY N., Ph.D.
*CAMPBELL, Prof. WILLIAM, Ph.D.
CAMPBELL, Prof. WILLIAM M.
CANFIELD, R. A.
CASE, CHARLES L.
*CASEY, COL. THOMAS L., U. S. A.
*CASWELL, JOHN H.
***Cattell, Prof. J. McKeen, Ph.D.**
CHAMPOLLION, ANDRÉ
*CHANDLER, Prof. C. F., Ph.D.
CHAPIN, CHESTER W.
*CHAPMAN, FRANK M.
*CHEESMAN, TIMOTHY M., M.D.
CLARKSON, BANYER
CLINE, Miss MAY
COHN, JULIUS M.
COWLES, DAVID S.
*COLLINGWOOD, FRANCIS
Collord, George W.
COMBE, Mrs. WILLIAM
CONDIT, WILLIAM L.
Constant, S. Victor
DE COPPET, E. J.
CORNING, CHRISTOPHER R.
*COX, CHARLES F.
*CRAMPTON, Prof. HENRY E., Ph.D.
Crane, Zenas
CROSS, GEORGE D.
DAHLGREN, B. E., D.M.D.
*DAVENPORT, Prof. CHARLES B., Ph.D.
DAVIES, J. CLARENCE
DAVIES, WILLIAM G.
DAVIS, Dr. CHARLES H.
*DEAN, Prof. BASHFORD, Ph.D.
DEGENER, R.
Delafield, Maturin L., Jr.
DELANO, WARREN, Jr.
DEMOREST, WILLIAM C.
DE PUY, HENRY F.
DEVEREUX, W. B.
DEVOE, F. W.

DeWitt, William G.
Dickerson, Edward N.
Diefenthäler, C. E.
Dimock, George E.
Dix, Rev. Morgan, D.D.[1]
Dodge, Rev. D. Stuart, D.D.
Dodge, Miss Grace H.
*Dodge, Prof. Richard E., A.M.
Doherty, Henry L.
Donald, James M.
*Doremus, Prof. Charles A., Ph.D.
***Douglas, James**
Douglass, Alfred
Draper, Mrs. M. A. P.
Drummond, Isaac W., M.D.
*Dudley, P. H., Ph.D.
*Dunham, Edward K., M.D.
Dunn, Gano
Dunscombe, George Elsworth
Du Pont, H. A.
Durand, John S.
*Dutcher, William
*Dwight, Jonathan, Jr., M.D.
Dwyer, Thomas
Eickemeyer, Carl
***Elliott, Prof. A. H., Ph.D.**
Emmet, C. Temple
Eno, John C.
Eno, William Phelps
Estabrook, A. F.
*Eyerman, John
Fairchild, Charles S.
Fallon, G. W. R.
Fargo, James C.
Farmer, Alexander S.
*Farrand, Prof. Livingston, M.D.
Ferguson, Mrs. Juliana Armour
FIELD, C. DE PEYSTER
Field, William B. Osgood
*Finley, Pres. John H.
*Fishberg, Maurice, M.D.
*Flexner, Simon, M.D.
Foot, James D.
Ford, James B.
Fordyce, John A.
de Forest, Robert W.
Forster, William
Freund, Emil
Frissell, A. S.
Gallatin, Frederic
Gibson, R. W.
*Gies, Prof. William J.
GOULD, EDWIN
GOULD, GEORGE J.
GOULD, MISS HELEN M.
***Grabau, Prof. Amadeus W.**
*Gratacap, Louis P.
Greeff, Ernest F.
*Gregory, W. K.
Griggs, J. George
Griscom, C. A., Jr.
Griswold, Mrs. Chester
Guggenheim, William
von Hagen, Hugo
Hague, James D.[1]
Halls, William, Jr.
Hammond, James B.
Harriman, E. H.
Haupt, Louis, M.D.
Havemeyer, William F.
Heinze, Arthur P.
*Hering, Prof. Daniel W.
HERRMAN, MRS. ESTHER
*Herter, Christian A., M.D.
Hess, Selmar
Hewlett, Walter J.
Higginson, James J.
*Hill, Robert T.
Hirsch, Charles S.
*Hitchcock, Miss F. R. M., Ph.D.

[1] Deceased.

Hodenpyl, Anton G.
Hoe, Robert, Jr.
*Hollick, Arthur, Ph.D.
Holt, Henry
Hopkins, George B.
*Hornaday, William T., Sc.D.
Hotchkiss, Henry D.
House, Prof. Homer D.
***Hovey, Edmund Otis, Ph.D.**
*Howe, Prof. Henry M.
*Howe, Marshall A., Ph.D.
Hubbard, Thomas H.
Hubbard, Walter C.
Hughes, Hon. Charles E.
Hulshizer, J. E.
Huntington, Archer M.
Hustace, Francis
Huyler, John S.
Hyde, B. Talbot B.
Hyde, E. Francis
Hyde, Frederic E., M.D.
Hyde, Henry St. John
Iles, George
*Irving, Prof. John D.
Irving, Walter
von Isakovics, Alois
*Jacobi, Abram, M.D.
Jarvie, James N.
Jennings, Robert E.
Jesup, Morris K.[1]
Jones, Dwight A.
*JULIEN, ALEXIS A., Ph.D.
Kahn, Otto H.
***Kemp, Prof. James F., A.B., E.M.**
Kennedy, J. S.
Keppler, Rudolph
Kessler, George A.
Knapp, Herman
Kohlman, Charles
*Kunz, George F., M.A., Ph.D.
de Lagerberg, Julius
Lamb, Osborn R.
Lambert, Adrian V. S., M.D.
Langdon, Woodbury G.
Langeloth, J.
*Langmann, Gustav, M.D.
Lawrence, Amos E.
Lawrence, John B.
Lawton, James M.
*Ledoux, Albert R., Ph.D.
*Lee, Prof. Frederic S., Ph.D.
Lefferts, Marshall C.
*LEVISON, WALLACE GOOLD
Levy, Emanuel
Lichtenstein, Paul
Lieb, J. W., Jr.
*Linville, H. R., Ph.D.
Loeb, James
*Loeb, Prof. Morris, Ph.D.
Lounsbery, R. P.
Low, Hon. Seth, LL.D.
Lowie, Robert H., Ph.D.
*Lucas, F. A.
*Luquer, Prof. Lea McI.
*Lusk, Prof. Graham, M.D.
Luttgen, Walther
Lyon, Ralph
McCook, Col. J. J.
McKim, Rev. Haslett[1]
***McMillin, Emerson**
*MacDougall, Prof. Robert
Mack, Jacob
Macy, Miss Mary Sutton, M.D.
Macy, V. Everit
Mager, F. Robert
Mann, W. D.
Marble, Manton
Marcou, John B.

[1] Deceased.

Marling, Alfred E.
Marshall, Louis
Marston, E. S.
Martin, Bradley
***Martin, Prof. Daniel S.**
*Martin, T. Commerford
Martin, W. M.
***Matthew, W. D., Ph.D.**
Maxwell, Francis T.
MEAD, WALTER H.
Meigs, Titus B.
Mellen, C. S.
*Meltzer, S. J., M.D.
*Merrill, Frederick J. H., Ph.D.
Metz, Herman A.
*Meyer, Adolf, M.D.
Milburn, J. G.
de Milhau, Louis J.
Miller, George N., M.D.
*Miner, Roy Waldo
Mitchell, Arthur M.
Mitchell, Edward
Morewood, George B.
Morgan, J. Pierpont
*Morgan, Prof. Thomas H.
Morris, Lewis R., M.D.
Mortimer, W. Golden, M.D.
Myers, Joseph G.
Nimick, Mrs. A. K.
Oakes, Francis J.
Obrig, Adolph
Ochs, Adolph S.
Oettinger, P. J., M.D.
***Ogilvie, Miss Ida H., Ph.D.**
Olcott, E. E.
Olmsted, Mrs. Charles T.
***Osborn, Prof. Henry F., Sc. D., LL.D.**
Osborn, William C.
Osburn, Raymond C.
Owen, Miss Juliette A.
Owens, W. W.
Paddock, Eugene H.
Parish, Henry
*Parker, Prof. Herschel C.
Parsell, Henry V. A.
Parsons, Mrs. Edwin
*Parsons, John E.
Patton, John
Pearle, Robert
Pearsall, Thomas W.
Pedersen, F. M.
*Pellew, Prof. C. E., Ph.D.
Pennington, William
Perkins, William H.
Perry, Charles J.
*Peterson, Frederick, M.D.
*Petrunkevitch, Alexander, Ph.D.
Pettegrew, David L.
*Pfister, Prof. J. C.
Pfizer, Charles, Jr.
Philipp, P. Bernard
Phipps, Henry
Phoenix, Lloyd
Pickhardt, Carl
Pierce, Henry Clay
*Pitkin, Lucius, Ph.D.
Planten, John R.
Poggenburg, H. F.[1]
*Pollard, Charles L.
*Poor, Prof. Charles L.
Poor, Henry W.
Porter, Eugene H.
Post, Abram S.
*Post, C. A.
Post, George B.
*Prince, Prof. John Dyneley
Pritchett, Pres. Henry S.
Procter, William

[1] Deceased.

Proctor, George H.
*Prudden, Prof. T. Mitchell, M.D.
*Pupin, Prof. M. I., Ph.D.
Pyne, M. Taylor
Quackenbos, Prof. J. D., M.D.
Reilly, F. James
Richardson, Frederick A.
***Ricketts, Prof. P. de P., Ph.D.**
Riederer, Ludwig
Riker, Samuel
Robb, Hon. J. Hampden
Robert, Samuel
Roberts, C. H.
Rogers, E. L.
Rogers, H. H.
Rowland, Thomas F.[1]
de Rubio, H. A. C.
*Rusby, Prof. Henry H., M.D.
Russ, Edward
Sachs, Paul J.
Saul, Charles R.
Sauter, Fred.
Schermerhorn, F. A.
Schiff, Jacob H.
Scholle, A. H.
Schott, Charles M., Jr.
Scott, George S.
SENFF, CHARLES H.
Shaw, Mrs. John C.
Shepard, C. Sidney
*Sherwood, George H.
Shiland, Andrew, Jr.
Shultz, Charles S.
*Sickels, Ivin, M.D.
Sieberg, W. H. J.
Sloan, Benson B.
Smith, Elliott C.
*Smith, Ernest E., M.D., Ph.D.
*Smith, Prof. John B.
Smith, W. Wheeler
Snow, Elbridge G.
*Starr, Prof. M. Allen
Stefánsson, V.
Stetson, F. L.
Stevens, C. Amory
*Stevens, George T., M.D.
***Stevenson, Prof. John J., LL.D.**
Stokes, James
Straus, Isidor
Sturgis, Mrs. Elizabeth M.
*Stuyvesant, Rutherfurd
Taggart, Rush
***Tatlock, John**
Taylor, George
Taylor, William H.
Terry, James
Tesla, Nikola
Thaw, Benjamin
Thompson, Mrs. Frederick F.
Thompson, Lewis S.
*Thompson, Prof. W. Gilman
Thompson, Walter
*Thorndike, Prof. Edward L.
Thorne, Samuel
*Tower, R. W., Ph.D.
*Townsend, Charles H.
Tows, C. D.
*Trowbridge, Prof. C. C.
Tuckerman, Alfred, Ph.D.
Ullmann, E. S.
Van Slyck, George W.
Van Wyck, Robert A.
Vredenburgh, William H.
***Waller, Prof. Elwyn, Ph.D.**
Warburg, F. N.
Warburg, Paul M.
Ward, Artemas
Ward, John Gilbert
Warner, Charles St. John

[1] Deceased.

Washington, Henry S., Ph.D.
Waterbury, J. I.
Weir, Col. John
Wellington, Aaron H.
Wheeler, H. L.
*Wheeler, William Morton, Ph.D.
*White, Horace
*Whitfield, Prof. R. P.
Wicke, William
Wiggin, F. H., M.D.
Williams, R. H.
Wills, Charles T.
*Wilson, Prof. Edmund B., Ph.D., LL.D.
Wilson, Henry R.
Wilson, J. H.
Wilson, Miss M. B., M.D.
*Wissler, Clark, Ph.D.
Wolff, A. R.
Wood, Mrs. Cynthia A.
*Woodbridge, Prof. Frederick J. E.
*Woodhull, Prof. John F., Ph.D.
*Woodward, Prof. R. S.
*Woodworth, Prof. R. S.
Yeaman, George H.[1]
Younglove, John, M.D.
Zabriskie, George

ASSOCIATE MEMBERS.

Brown, Harold Chapman, Ph.D.
Brown, T. C.
Dublin, L. J.
Gordon, Clarence E.
Hunter, George W.
James, F. Wilton
Kellicott, W. E., Ph.D.
McGregor, James Howard
Montague, W. P., Ph.D.
Northup, Dwight
Stevenson, A. E.

NON-RESIDENT MEMBERS.

*Abbe, Dr. Cleveland
Buchner, Edward F.
Burnett, Douglass
Davis, William H.
English, George L.
Finlay, Prof. G. I.
Frankland, Frederick W.
Hoffman, S. V.
Kendig, Amos B.
*Lloyd, Prof. F. E.
*Mayer, Dr. A. G.
*Pratt, Dr. J. H.
*Ries, Prof. H.
Reuter, L. H.
*Sumner, Dr. F. B.
*van Ingen, Prof. G.

---

[1] Deceased.

GENERAL INDEX TO VOLUME XVIII.

Names of Authors and other Persons in **Heavy-Face Type**.

Titles of Papers in SMALL CAPS.

PUBLICATIONS

OF THE

NEW YORK ACADEMY OF SCIENCES

[Lyceum of Natural History, 1817–1876]

The publications of the Academy consist of two series, viz.:

(1) The **Annals** (octavo series), established in 1823, contain the scientific contributions and reports of researches, together with the records of meetings and similar matter.

A volume of the Annals will in general coincide with the calendar year and will be distributed in parts. The price of the current issues is one dollar per part or three dollars per volume. Prices of early issues will be given on application. Author's reprints are issued as soon as the separate papers are printed, the date appearing above the title of each paper.

(2) The **Memoirs** (quarto series), established in 1895, are issued at irregular intervals. It is intended that each volume shall be devoted to monographs relating to some particular department of Science. Volume I is devoted to Astronomical Memoirs, Volume II, to Zoölogical Memoirs, etc. The price is one dollar per part, as issued.

All publications will be sent free to Fellows and Active Members. The Annals will be sent to Honorary and Corresponding Members desiring them.

Publication of the **Transactions** of the Academy was discontinued with the issue of Volume XVI, 1898, and merged in the Annals.

Subscriptions and inquiries concerning current and back numbers of any of the publications of the Academy should be addressed to

The Librarian,
New York Academy of Sciences,
care of
American Museum of Natural History,
New York City.

CONTENTS OF VOL. XVIII, PART III.