PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

Vol. XVIII.

JULY 1878 TO MARCH 1880.

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VOL. XVIII. JULY TO DECEMBER, 1878. No. 102.

Stated Meeting, July 19, 1878.

Three members present.

Stated Meeting, August 16, 1878.

Present, 4 members.

Vice-President, Mr. FRALEY, in the Chair.

A letter accepting the appointment to prepare an obituary notice of Prof. Joseph Henry was received from Prof. Fairman Rogers.

A communication entitled "Saponin in its relations to Physiology, by B. F. Lautenbach, M.D., Ph.D., Prosector of Physiology in the University of Geneva," was presented by Mr. Platt, with a letter from the author.

A communication was received entitled, "Oil Well records in McKean and Elk Counties, Pa., by C. A. Ashburner."

Dr. Sadtler made a verbal explanation in reference to his comments on his correspondence with Prof. Morton (see minutes of May 17) in which he gave Prof. Morton credit for correctly quoting Dr. Sadtler's letter.

And the meeting was adjourned.

Stated Meeting, September 20, 1878.

Present, 5 members.

Vice-President, Mr. Eli K. Price, in the Chair.

Prof. Houston communicated the following notes:

1. On a new system of Electric Lighting, in which the sparks ("extra sparks") produced by interrupting feeble currents are utilized for the purpose of dividing the light.

2. On a new form of Electric Lamp, depending also on the development of the extra-spark, instead of the continuous arc.

These notes embodied the resnlts of the joint investigations of Prof. Thompson and himself.

Mr. Eli K. Price read a communication entitled "Nature's Reforesting," and offered the following resolution, which was adopted:

Resolved, That of the paper on "Nature's Reforesting" 300 extra copies, without cover, be printed at the expense of the Michaux Legacy.

The death of Mr. Henry Armitt Brown, at Philadelphia, Aug. 24th, aged 33 years, was announced by Mr. Price.

Pending nominations 857 to 870 were read.

The following persons, on scrutiny of the ballot boxes by the presiding officer, were declared duly elected members of the Society.

Hon. Carl Schurz, of Washington, D. C.

Mr. J. B. Knight, of Philadelphia.

Rev. Fredk. Augustus Muhlenberg, D.D. of Philadelphia.

Dr. Elliott Coues, U.S.A.

Dr. A. S. Packard, Jr., of Salem, Mass.

Mr. Joel Asaph Allen, of Cambridge, Mass.

Mr. Samuel H. Scudder, of Cambridge, Mass.
Rev. William Rudder, D.D., of Philadelphia.
Dr. Morris Longstreth, of Philadelphia.

Prof. Houston gave notice of his intention to move at the next meeting of the Society, certain corrections in the last page of the printed proceedings (p. 728), being the records of the meeting held June 21, 1878.

And the meeting was adjourned.

Stated Meeting, October 4, 1878.

Present, 13 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from the Rev. W. Rudder, D.D., dated Media, October 1; the Hon. Secretary of the Interior, Carl Schurz, dated Department of the Interior, Washington, October 2; the Rev. F. A. Muhlenberg, D.D., dated 4307 Walnut street, Philadelphia, October 2; Mr. J. A. Allen, dated Museum of Comparative Zoology, Cambridge, Mass. October 2; Dr. Elliott Coues, of the U. S. Geological and Geographical Surveys of the Territories, dated Washington, October 2; and Prof. James C. Watson, of the Observatory of the University of Michigan, dated Ann Arbor, September 18, 1878.

Photographs for the album were received from Mr. A. R. Wallace, dated Waldron Edge, Duppas Hill, Croydon, England, and from William H. Flower, F.R.S., of the College of Surgeons, London.

A letter was received from Mr. A. M. Fox, dated Penjerrich, Falmouth, September 4, 1878, respecting the decease of his father, Mr. R. W. Fox (July 25, 1877, aged 88), and the disposition of publications forwarded to him.

Letters of acknowledgment for publications of the Society received, were read, as follows: Royal Society of Tasmania, February 17 (95, 96); Physical Society of Berlin, June 16 (96, 98, 99); Natural History Society of Göttingen, June 15 (99, XV i, ii); Holland Society of Harlem, June 25 (100; List); Teyler Foundation of Harlem, July 6 (100; List); Royal Society of Luxembourg (100; List); Royal Institution, London, June 1 (III to XI; XVI, ii; 100); Society of Antiquaries, London, June 18 (100: List); Statistical Society, London, July 15 (100; List); Royal Observatory, Greenwich, July 19 (99, 100); Royal Society of Edinburgh, July 5 (100); Maine Historical Society, ——— (101); New Hampshire Historical Society, July 8 (101); Massachusetts Historical Society, July 9 (101; Cat. iii); Boston Public Library (101); Harvard College, July 9 (Cat. part iii); New York Hospital, July 8 (101); New York Historical Society, June 10 (101); Albany State Library, July 12 (Cat. part iii); U. S. Military Academy Library, July 16 (101); New Jersey Historical Society, July 8 (101; Cat. iii); Pennsylvania Historical Society, July 8 (101; Cat. iii); Franklin Institute, July 26 (Cat. iii); Mr. John Fulton, Johnstown, July 8 (101); Peabody Institute of Baltimore, July 31 (Cat. iii); Naval Observatory, Washington, July 8 (101); Dr. William Elder, Washington, July 22 (101); Georgia Historical Society, July 9 (101); Rantoul Literary Society, July 8 (101); Chicago Academy of Sciences, July 8 (101); Sig. Mariano Barcena, Mexico, July 8 (100).

Letters acknowledging the receipt of diplomas were received from the following members: Dr. D. G. Gilman, dated Amherst, July 10, 1878; Mr. Lorin Blodget, Philadelphia, July 8, 1878; Mr. Coleman Sellers, Philadelphia, July 8, 1878; Mr. George Stuart, Philadelphia, 1528 N. 18th street, July 29; Mr. John Fulton, Johnstown, Pa., July 8; and Dr. William Elder, Washington, D.C., July 22.

Letters announcing the transmission of publications to this Society were received from the Hungarian Academy of Sciences, Pest, July 16; the Natural History Society at Riga, January, 1878; Zoologico-Botanical Society at Vienna, April 29, 1878; Physical Society at Berlin, June 15, 1878; Holland Society of Sciences at Harlem, July, 1878; Royal Academy of Lisbon, February 7, 1878; Meteorological Office at London, July, 1878; Secretary of State of New Hampshire, August 10, 1878; Harvard College Observatory, Cambridge, August 17, 1878; Second Geological Survey of Pennsylvania, September 5, 1878; Coast Survey Office at Washington, August 17, 1878; Office of the Chief of Engineers, Washington, September 3, 1878; Department of the Interior, Washington, July 24, 1878; * Department of State at Washington, August 31, 1878; the Argentine National Observatory, April, 1878; and from the Argentine Scientific Society, Buenos Ayres.

Donations for the Library were received from the Mining Surveyors and Registrars of Victoria; Royal Academies at Berlin and at Brussels; Natural History Societies at Riga, Offenbach am M., Bremen and Boston; Anthropological Society, and Geological Institute at Vienna; Physical Society at Berlin; Holland Society at Harlem; Geographical Society and Revue Politique at Paris; Geographical Commercial Society at Bordeaux; Royal Geographical, Geological, Antiquarian, Zoological and Metereological Societies of London; Meteorological Office of the Royal Society; Prof. Richard Owen, and London Nature; Joseph Gurney Barclay, Esq. Peyton, Essex, Eng.; Geological Survey of New Hampshire; Museum of Comparative Zoology and Peabody Museum in Cambridge, Mass.; American Journal of Science and Art; Mr. Henry T. Eddy, of Princeton, N. J.; Princeton College; Franklin Institute; Journal of Pharmacy, Medical News, Penn Monthly; Second Geological Survey of Pennsylvania; American Journal Mathematics, Baltimore; Mr. Asaph Hall, of Washington; Kansas Agricultural Report, Topeka; Geographical and Statistical Society, Mexico; Ministerio de Fomento, Mexico; and the Argentine Scientific Society in Buenos Ayres.

Also previously, and not noted, from the Royal Danish

* Cartas de Indias from the Government of Spain.

Society; Mr. Albert S. Gatschet; the Editors of the Novara Expedition Reports, Vienna; Meteorological Central Institute of Vienna; Royal Academy at Munich; Dr. Carl Alfred Littel; Natural History Society at Stuttgard; Physical Œcon. Society at Königsberg; Prag Observatory; Annales des Mines; Nouvelle Société Indo-Chinoise at Paris; Dr. Le Grand; M. Joachim Barrande; M. A. Woeikof; Accademia dei Lincei, Rome; Sig. Allesandro Dorno; Turin Observatory; Revista Euskara at Pamplona; R. Academy, Lisbon; R. Academy, Madrid; Victoria Institute, Astronomical Society and Sir Edward Sabine, London; Natural History Society at Newcastle-upon-Tyne; Mauritius Expedition; Asiatic Society of Japan; Tasmanian Society; New Zealand Institute; Royal Cornwall Polytechnic Society; Geological Survey of Canada; Mr. Samuel H. Scudder; Connecticut Academy of Arts and Sciences; Harvard College Observatory; Editors of Psyche; Essex Institute; American Academy of Arts and Sciences, Boston; Mr. W. Ripley Nichols; American Oriental Society; Superintendent of Fairmount Park; Academy of Natural Sciences, Philadelphia; American Journal of the Medical Sciences; Peabody Institute, Baltimore; Official Army Register; Mr. Samuel Newcomb; U. S. Geological and Geographical Survey Bureau; Cincinnati Society of Natural History; and M. Barcena, of Mexico.

A letter was received from the Secretary of the R. Academia di Scienze, Littere ed Arti of Modena, dated July 30, requesting exchanges. On motion the name of this society was ordered to be placed on the list of correspondents to receive the publications.*

A letter was received from Mr. C. E. Billin, Secretary of the Engineers' Club of Philadelphia, requesting to receive the Society's publications. On motion the request was

* Note.—Jan. 5, 1877, we received from the "Societa Italiana (in 1782) della Scienze fondata da Anton-Mario Lorgna." Memoirs (4°) 2d Ser. I (1862), II (1866)—3d Series I, i (1867), ii (1868), II (1869–1876). Published in *Florence*.

granted and the Engineers' Club placed among the Society's correspondents to receive the Proceedings from the beginning of 1878 onward.

Letters requesting the supply of deficiencies in the series of the Society's publications were received from Trübner & Co., from the Boston Public Library, and the Naval Observatory, and were referred to the Librarian for action.

A request for subscription to the "American Catalogue," dated September 17, New York, 37 Park Row, was referred to the Librarian to consider and report.*

A letter was received from S. Guerrier, Emporia, Kansas, September 9, asking the worth of an old Bible (1602) described by its owner.

The committee to which was referred Prof. Haldeman's plates and descriptions of prehistoric remains in the cave near Chicques rock in Lancaster Co., Pennsylvania, reported in favor of their publication in the Transactions of the Society. On motion the report was accepted and the committee discharged. On motion the publication was ordered.

The Committee on Finance was requested to inquire into and report upon the expediency of publishing the two memoirs presented at recent meetings by Dr. Lautenbach, of Geneva, Switzerland.*

Dr. König exhibited and described a piece of chemical apparatus which he invented for the purpose of applying the use of sliding glass wedges, colored and transparent, and empirically graduated, to the optical extinction of the colors, simple or compound, of the blowpipe beads of the chromatic metals, ground to a given thickness and rendered transparent by a coating of balsam. The use of the glass wedge has been known; but this use of complimentary colors for producing the extinction of a given color, and for thus obtaining the exact degree on a scale marking the percentage of metallic elements contained in the bead, is new, and, as

* See Minute Book, Oct. 18, 1878.

Dr. König promised to show in a coming memoir, efficient for very precise determinations.

Prof. Houston desired to place on record an extension of the researches of Prof. Thompson and himself, on Electric Lighting, obtained by passing the Ruhmkorff discharge through glass tubes containing silica, carbonate of ammonia and similar substances.

Prof. P. E. Chase (detained from the meeting by illness) presented, through the Secretary, a communication entitled "Crucial Harmonies."

Mr. Lesley exhibited several plates of the Permean fossil plants discovered and described by Profs. Fontaine and White of the West Virginia University, at Morgantown, in the country west of the Monongahela River, and took occasion to speak of the progress made by Prof. James Hall, Dr. T. Sterry Hunt and others at the late Congress of Geologists opened on the 29th of August last at Paris, in harmonizing the geologies of Europe and America. He described the meetings of the Congress, and the appointment of national committees on classification and coloration, to report to Prof. Capellini six months previous to the next assembling of the International Congress of Geologists at Bologna in 1881.

Mr. Lesley laid on the table for examination some quasi coprolites, found by Mr. W. D. H. Mason in the roof slates of the Mammoth bed, as described in a letter dated Williamstown, July 29, 1878.

Pending nominations 864 to 870 were read.

Prof. Houston moved that the minutes on printed page 728 of No. 101 of the Proceedings be corrected. Owing to the lateness of the hour, and at the request of the Secretary, who reported the minutes, the subject was postponed for consideration at the next meeting.

And the meeting was adjourned.

Oil Well Records in McKean and Elk Counties, Pennsylvania.

By Chas. A. Ashburner, M.S. Assistant Geological Survey.

(Read before the American Philosophical Society, August 16, 1878).

The demand for accurate well records in the northern oil field has become very great, from the eagerness with which the producers have sought to find petroleum, outside of the limits of the Bradford development. Most of the explorers, from the way in which their wells are drilled by contractors, are unable to keep a complete and correct record of the rocks through which the drill passes, yet they are ever anxious to procure reliable records from other sources to aid them in their "wild cat" operations.

During the past two years I have been able to obtain through the assistance of Mr. M. M. Schultz of Wilcox, a number of extremely valuable and interesting records of wells drilled in the vicinity of that village. Mr. Schultz by his untiring perseverance has succeeded in getting records of no less than six wells drilled to an average depth of over eighteen hundred feet. All have been kept with the greatest care and most of them under his personal supervision.

No complete register of all the rocks passed through by the drill has ever been kept by any of the producers in the Bradford oil field. In December, 1877, Prof. Lesley appointed Mr. Arthur Hale, of the Survey, to the special work of obtaining a correct record of the Dennis & Co.'s Well, No. 1, which was about to be drilled on the high summit to the south-west of Bradford.

All of these records together with a more minute description and fuller discussion of the rocks drilled through, will be found in my forthcoming report of progress in McKean and Elk Counties. I have been induced to communicate to the Society a few of the more valuable well records for immediate reference prior to the publication of the report.

The position of the Olean Conglomerate above the mouth of each well is given in feet in order that a comparison may be made between the several sections. All the rocks of the section are not named for reasons which can be better appreciated when the report is published.

The Olean Conglomerate is the bottom of the Coal Conglomerate No. XII, or Millstone grit. The Bradford oil producing sand belongs without question to the Chemung Period, or the upper part of No. VIII.

C. W. Dennis & Co.'s Well, No. 1.

Owned by C. W. Dennis & Co., situated on the Roger's farm, three-fourths of a mile south 35° west of Bradford, Bradford Township, McKean County.

The record of this well was kept by Mr. Arthur Hale, aid to Mr. John F. Carll, Assistant Second Geological Survey of Pennsylvania.

The well was drilled in December 1877, and January 1878. Mr. Hale made the measurements with great accuracy, the method pursued, together with a fuller description of the facts obtained, will be published in the District report.

It is due Mr. Hale to state that the Dennis record is, without doubt, the longest *detailed and accurately measured* record of any oil well in the United States. Deeper wells have been drilled, but no record has ever been kept so accurate as this one to such a depth. Wherever the rock passed through by the drill was found to change a specimen was secured; in many cases a number of specimens of the same stratum were kept, in order that after a more careful study the horizons or divisions might be shifted the better to agree with the true succession of the strata.

I hope to deposit a duplicate series of specimens in the museum of the Philadelphia Academy of Natural Sciences, and it is hoped that duplicates may be deposited in other museums throughout the States. In view of this fact, I have given below the numbers of the specimens obtained of each stratum. The elevation of the top of the well above Ocean in feet is 2055. The elevation of the Bradford Station of the Bradford Branch of the Erie Railway being 1444 feet

Surface clays	4′ to	4′
Sandy shale, olive-gray, micaceous, muddy; spec. 1	11 "	15
S. S. gray, fine, micaceous, muddy; specs. 2, 3, 4, 5	23 "	48
Shale dark-gray, with thin micaceous sand shells, muddy; specs. 6, 7	19 "	67
S. S. gray, fine, soft, muddy; spec. 8	8 "	75
Slaty sandstone, bluish, fine, muddy; specs. 9, 10	23 "	98
Fine gray sand-shells and dark slates alternating, muddy; specs. 11, 12, 13	18 "	116
S. S. ashy gray, very fine micaceous, muddy; specs. 14, 15	16 "	132
Red shale, soft; spec. 16	6 "	138
S. S. olive gray fine micaceous; spec. 17	12 "	150
S. S. dark olive gray, fine micaceous; specs. 18, 19, 20	30 "	180
S. S. white, mixed with green and brown, fine; spec. 21	8 "	188
S. S. bluish gray, fine, micaceous, muddy; spec. 22	9 "	197
Red shale, "paint rock" top soft, bottom sandy and micaceous, specs. 23, 24, 25	18 "	215
S. S. gray, fine, mixed with slate, a few pebbles; specs. 26, 27	23 "	238
Slate, bluish; specs. 28, 29, 30, 31	22 "	260
Slate, bluish, with thin plates of fine sandstone; specs. 32, 33	15 "	275
Sandy slate, dark gray, fine, micaceous; specs. 34, 35, 36	16 "	291
Slate, bluish; specs. 37, 38, 39	24 "	315
S. S. gray, fine, micaceous; spec. 40	5 "	320
Red slate, micaceous, muddy; spec. 41, 42	8 "	328
S. S. olive gray, soft, micaceous, some slate; specs. 43, 44, 45	39 "	367
Red rock, mottled sandy shale, brown, green and gray; specs. 46, 47	15 "	382
Slate sandy, gray; spec. 48	8 "	390
S. S. dark, very fine; specs. 49, 50	10 "	400

S. S. gray, very fine, hard, drillings like flour; specs. 51–56 inclusive	35 to	435
Slate, sandy micaceous; specs. 57 to 63 inclusive	38 "	473
S. S. dark-gray, very fine, micaceous, flaky; spec. 64	6 "	479
S. S. bluish-gray, fine, hard, remnants of fossils; spec. 65	6 "	485
Slate, sandy in streaks, micaceous, fossil bands; specs. 66–76 inclusive	95 "	580
Dark-gray, thin-bedded S.S., fine, micaceous, slate partings, fossils; specs. 77 to 89 inclusive	71 "	651
S. S. gray, fine, flaky, micaceous, fossils; specs. 90, 91, 92	23 "	674
Slate; specs. 93, 94	12 "	686
S. S. dark-gray, slate partings, fossils; specs. 95, 96, 97, 98	26 "	712
Red rock, purplish, sandy, very fine, micaceous, fossils; specs. 99, 100	10 "	722
Sandy slate, dark, micaceous; specs. 101, 102, 103	20 "	742
S. S. fine, micaceous, alternating with slate and "chocolate" shale, fossils; specs. 104 to 113 inclusive	63 "	805
S. S. thin bedded, micaceous, slate partings, fossils; specs. 114 115	13 "	818
Slate, an occasional sand-shell with fossils; specs. 116 to 136 inclusive	125 "	943
S. S. brown and purplish, fine, hard, fossils; spec. 137	8 "	951
Slate, dark lead color	55 "	1006
"Red Rock," fine, purple and gray sandy slate; specs. 147, 148.	14 "	1020
Gray sand, shells and slate, fossils; specs. 149 to 153 inclusive.	24 "	1044
Slate; specs. 154, 155	12 "	1056
S. S. dark, hard, fine; spec. 156	3 "	1059
S. S. yellow-gray, drillings as fine as flour; specs. 157 to 163 inclusive	13 "	1072
Slate; specs. 164, 165	5 "	1077
S. S. yellow-gray, fine; spec. 166	4 "	1081
Slate, sandy; specs. 167, 168, 169	7 "	1088
S. S. dark-gray, fine, fossils; specs. 170, 171	6 "	1094
Slate; specs. 172 to 175 inclusive	17 "	1111
S. S. brown and gray, fine, soft with some slate (oil show); specs. 176 to 180 inclusive	14 "	1125
Slate; specs. 181 to 186 inclusive	23 "	1148
Slate, with dark sand shells; specs. 187 to 190 inclusive	15 "	1163
Slate; specs. 191, 192	13 "	1176
Slate, with gray sand shells; specs. 193, 194	5 "	1181
Slate; specs. 195, 196, 197	12 "	1193
Slate, with an occasional sand shell; specs. 198 to 206 inclusive.	44 "	1237
Slate, "blue slate"; specs. 207 to 219 inclusive	63 "	1300
S. S. brown, fine, flaky, slate partings, fossils; specs. 220 to 223 inclusive	17 "	1317
Slate; specs. 224 to 229 inclusive	28 "	1345

S. S. dark-gray, fine, close, hard; specs. 230, 231	6 to	1351
S. S. brownish-gray, fine, slate partings; specs. 232 to 237 inclusive	30 "	1381
Sand, shells and slate; specs. 238 to 242 inclusive	22 "	1403
Slate, sand shell at 1428'; specs. 243 to 254 inclusive	59 "	1462
Fine sand shells and slate alternating; specs. 255 to 261 inclusive	25 "	1487
Slate, sand shells at 1510', 1531', and 1573'; specs. 262 to 286 inclusive	118 "	1605
Slate, with sand shells; specs. 287 to 291 inclusive	27 "	1632
Slate; specs. 292 to 295 inclusive	32 "	1664
S. S. brown, fine, flaky. Bradford "3d" or oil producing sand; specs. 296 to 310 inclusive	54 "	1718
Slate and S. S.; spec. 311	1 "	1719

The top of the ridge directly above the Dennis Well, No. 1, is capped by the Sub-Olean Conglomerate, which lies from 50 to 70 feet below the bottom of the Olean Conglomerate; the top of the well is about 115 feet below this latter horizon.

The sandstone and conglomerate which caps the summits surrounding Bradford, and which is found broken up in large masses on the hill slopes, comes from the Olean Conglomerate.

Kinzua Well or "Dry Hole," P. C. L. and P. Co.

Owned by the Producers Consolidated Land and Petroleum Company of Bradford, situated on Kinzua Creek, near the mouth of Glad run, in warrant 3122, Hamlin Township, McKean County, and about five miles northeast of Kane. The land upon which this well is located together with the adjoining tracts are part of those originally belonging to the "McKean and Elk Land and Improvement Co.," General Thomas L. Kane, Supt.

The well was drilled in the Spring of 1877, and the record was furnished by Mr. L. C. Blakeslee, Superintendent P. C. L. and P. Co.

The elevation of the top of the well, as determined by Mr. J. W. Murphy of Wilcox, is 52 feet higher than Wilcox Well, No. 3, or 1718 feet above Ocean.

Surface clays, &c	32 to	32
Soft slate	78 "	110
Mud slate	95 "	205
Red rock	50 "	255
Slate rock	38 "	293
Red rock	57 "	350
Sand "shells" and red rock mixed	15 "	365
Slate	35 "	400
Sand "shell"	10 "	410
Slate	346 "	756
Mixed slate and hard slate rock	361 "	1017
Mixed slate and sand "shells."	358 "	1375

Hard slate mixed with sand and "pebble shell."	370 to 1745
Slate and sand alternating	40 " 1785

Drilled dry. Cased at	370′
Heavy sand "shell" at	1017′
Sand at	1745′
Slate "	1760′
Sand "	1768′
Slate "	1780′
Salt water found in sands at	1745′ and 1768′

Mr. Blakeslee reports that no "good show" of oil was found. A small gas vein was struck, position not stated. Elevation of the bottom of the Olean Conglomerate on the P. & E. R. R. four miles due south-west from the Kinzua Well is 1868 feet. The calculated elevation of the same horizon at the well is 1900 feet.

Wilcox Well, No. 2, or Schultz Gas Well.

Owned by M. M. Schultz & Co., situated on the west branch Clarion River, in warrant 2676, Sergeant Township, McKean County, and five miles north of Wilcox, a station on the Philadelphia and Erie Railroad, 104 miles east of the City of Erie. This well is 855 feet south, 17 degrees 30 minutes west, of Wilcox Well, No. 1, or the old Adams Well,* which was drilled in 1864. (?)

Drilling on this well was commenced about the first of the year (1876) and completed in the latter part of August of the same year. After the drilling was completed to a depth of 2004 feet, an "oil saver" was attached to the iron casing (5⅝ inch), and the gas issuing from the well was conveyed through a two inch pipe and discharged about two feet above the surface of the water, which partially filled the 250 barrel tank which had been erected. Sufficient oil was passed to show itself as a scum on the surface of the water.

Mr. Schultz conceived the idea of inserting into the well to a depth of 2000 feet, an inch pipe, and by closing the mouth of the casing to utilize the pressure of the gas to force the oil out through the inch tubing.

Mr. Schultz believed that the bulk of the oil which was found in the well was coming from the sand extending from 1795 to 1815 feet, in which the drillers reported that they had "struck" a small quantity of heavy green oil. In this event the immense volume of gas which was issuing from a depth of 1776 feet might more than counterbalance in its pressure the pressure of the oil from a lower horizon, and thus prevent it from filling the hole.

After the tubing was adjusted and the gas confined in the well as much

* For a complete record of this well, see a paper by Prof. Lesley in the Proceedings of the American Philosophical Society, Vol. X, page 238; also one in the Petroleum Monthly of a later date. A description of a very interesting action of this well is given in a paper named "Description of the Wilcox Spouting Water Well," which I read before the Society, Sept. 21, 1877.

as two to three barrels were forced out. Mr. Schultz thinks that the tubing during this time must have been entirely filled with oil to the exclusion of gas. In this case the pressure of the gas must have been sufficient to raise a column of oil one square inch in section and 2000 feet high. Of course, such an enormous pressure could only be temporary. The oil flowed from the tubing but for a few moments, the gas then probably became thoroughly mixed up with the oil which from its low temperature quickly congealed and effectually choked the pipe. After a few hours the gas ceased to flow entirely from the well and also from the adjoining well, No. 1. The gas commenced to flow again with greater energy after 36 hours of inactivity, from both wells, Nos. 1 and 2.

In the early part of 1877, the pressure of the gas seemed to increase suddenly. About the middle of May, four months after, the gas from both wells, Nos. 1 and 2, ceased to flow for the second time without any obstruction having been knowingly placed in its way. No gas was found to come from either well till July 14th, when it commenced to flow again. Up to the present time the amount of gas increases and diminishes at irregular intervals. The gas from this well was used as fuel in drilling well, No. 3.

The elevation of Wilcox Well, No. 2, is 1642 feet above Ocean on the corrected datum of the P. & E. R. R. which makes Wilcox Sation 1527.*

Loam and gravel	30 to	30
Gray slate	50 "	80
Gray slate	2½ "	82½
Gray sand	42½ "	125
Red shale	20 "	145
Gray sand	5 "	150
Red shale	25 "	175
Gray soapstone (shale and clay)	10 "	185
Red shale mixed with gray slate	155 "	340
Streak of soft red shale	15 "	355
Gray slate	62 "	417
White sand pebble rock containing gas and salt water	5 "	422
Gray slate	228 "	650
Dark gray slate	30 "	680
Gray slate and sand	75 "	755
Gray and red slate mixed	40 "	795
Gray slate	60 "	855
Gray slate and hard shell	5 "	860
Gray slate	5 "	865
Gray and red slate	20 "	885
Gray slate	25 "	910
Red and gray slate	5 "	915
Gray slate	30 "	945
Gray sand	5 "	950
Gray and red sand	5 "	955

* Report N, Second Geological Survey of Pennsylvania, p. 112.

Gray and red slate	15	to	970
Gray slate	15	"	985
Gray slate and sand	5	"	990
Gray slate	60	"	1050
Gray slate and sand	5	"	1055
Gray slate and sand	25	"	1080
Dark gray sand	15	"	1095
Very hard light gray sand	5	"	1100
Gray slate and sand containing small bivalve shells	20	"	1120
Gray slate and hard gray sand	5	"	1125
Gray slate and soft sand	10	"	1135
Hard gray sand	10	"	1145
Soft gray slate	27	"	1172
Gray sand	8	"	1180
Gray sand and slate	5	"	1185
Gray slate containing shells	15	"	1200
Gray sand containing first strong smell of oil 1205 to 1210	20	"	1220
Gray slate and hard shell	15	"	1235
Gray slate	15	"	1250
Gray slate containing shells	15	"	1265
Gray slate and clover seed sand	5	"	1270
Gray slate with hard shell	10	"	1280
Gray slate	10	"	1290
Gray slate and hard shell	25	"	1315
Light gray sand	10	"	1325
Coarse gray sand	5	"	1330
Slate	5	"	1335
Hard gray sand	5	"	1340
White sand	10	"	1350
Coarse gray sand	5	"	1355
Gray slate and shell	5	"	1360
Gray slate	30	"	1390
Gray sand	10	"	1400
Gray slate	20	"	1420
Gray slate containing shell	25	"	1445
Gray slate	15	"	1460
Gray slate containing shell	105	"	1565
Hard gray sand	15	"	1580
Slate and shell	55	"	1635
Gray sand	35	"	1670
Coarse gray slate	9	"	1679
Dark brown sand containing amber oil, greatest amount near top of sand.*	16	"	1695
Gray slate	40	"	1735
Gray slate and sand	10	"	1745

Probable representative of Bradford "3d" or oil producing sand.

Gray slate and shell	25 to 1770
Gray slate and sand	6 " 1776
Hard gray sand rock containing a great quantity of gas	4 " 1780
Gray slate	10 " 1790
Fine sand and slate	5 " 1795
Gray sand, upper part containing heavy green oil	20 " 1815
Gray and red micaceous sand and pebbles	20 " 1835
Gray slate	55 " 1890
Gray slate and red sand	5 " 1895
Red sand and pebbles	5 " 1900
White sand containing oil	10 " 1910
White and gray sand containing oil	20 " 1930
Gray slate	74 " 2004

Drilled Dry. Cased	541′
Fresh water course	42½′
Gas and salt water	422′
Gas increases, salt water	538′
Gas vein	1172′
First show of oil	1205′ to 1210′
Sand containing greatest amount of oil, particularly at top of sand. Oil, amber color	1679′ to 1695′
Great gas vein	1776′
Heavy green oil	1800′
White and gray sand containing oil	1990′ to 1930′

Wilcox Well, No. 3, or "John's Well."

Owned by M. M. Schultz & Co., and situated 1782 feet north 73 degrees 30 minutes west of well No. 2.

The well was commenced in the early part of October, 1876, and completed to a depth of 1850 feet about the middle of June, 1877.

After the well had been drilled to a depth of 1720 feet, tubing was inserted to a depth of 1684 feet, and it was reported that the well produced, by pumping, a barrel a day for about six months, when it was decided to drill deeper. The tubing was drawn, and after losing the tools several times, drilling was finally abandoned at a depth of 1850 feet.

The elevation of the top of the well is 1666 feet above Ocean; Wilcox Station being 1527 feet above the same datum.

This well was tubed about the first of the year, and has since been pumped continuously every other day. Its average daily production is reported to be a barrel and a-half.

The Olean Conglomerate is not exposed in the vicinity of the Wilcox Wells, the lower horizon is probably 125 feet above the mouth of Wilcox Well, No. 2.

Drift, as follows:		43′ to	43′
Loam and sand	5′		
Loam and gravel	5′		
Gravel and pebble	10′		
Gravel and sand	5′		
Gravel and pebble	5′		
Gravel and sand rock	5′		
Quicksand and coarse pebble	5′		
Fine sand	3′		
Gray slate		2 to	45
Gray slate		35 "	80
Gray sand		37 "	117
Red slate or shale		18 "	135
Red shale (rock hard)		10 "	145
Gray sand rock		10 "	155
Red shale		5 "	160
Red slate		20 "	180
Gray slate		25 "	205
Red slate		105 "	310
Red shale		15 "	325
Gray slate and sand		15 "	340
Gray slate and shell		15 "	355
Red slate		25 "	380
Gray slate		15 "	395
Gray slate and shell		20 "	415
Gray sand		15 "	430
Gray slate		5 "	435
Gray sand rock		7 "	442
Clover seed rock		8 "	450
Gray shale		15 "	465
Dark gray slate and shell		75 "	540
Gray slate and shell		7 "	547
Gray slate		43 "	590
Hard gray slate		75 "	665
Hard dark gray shale		30 "	695
Gray slate and sand		5 "	700
Hard gray sand		15 "	715
Light sand with shale		5 "	720
White and gray sand		55 "	775
Hard and fine gray sand		25 "	800
Fine dark gray sand		5 "	805
Gray slate		5 "	810
Gray slate and shale		5 "	815
Fine gray sand		23 "	838
Red slate		7 "	845
Gray sand		25 "	870

Red slate	10 to	880
Gray slate	35 "	915
Red slate	5 "	920
Gray slate	15 "	935
Soft gray sand	5 "	940
Soft gray and white sand	15 "	955
Dark gray sand	5 "	960
Hard gray sand	5 "	965
Gray sand and slate	5 "	970
Fine hard dark gray sand	5 "	975
Red slate	5 "	980
Gray slate	35 "	1015
Hard gray sand	20 "	1035
Gray slate	35 "	1070
Dark gray sand	5 "	1075
Gray sand	5 "	1080
Gray shale	15 "	1095
Gray sand and very hard shells	5 "	1100
Soft gray sand	15 "	1115
Gray and white shell	10 "	1125
Close soft white sand	20 "	1145
Hard gray shells	20 "	1165
Gray slate	15 "	1180
White and gray sand and pebbles	10 "	1190
Close white sand	5 "	1195
Gray sandstone and white pebbles	20 "	1215
Coarse white sand	5 "	1220
Silver gray sand	10 "	1230
Fine white sand	5 "	1235
Gray slate and shell	10 "	1245
Gray slate	40 "	1285
Gray slate and shell	25 "	1310
Gray sand	20 "	1330
White sand	10 "	1340
Slate	5 "	1345
Coarse gray sand	10 "	1355
Soft white sand	5 "	1360
Soft gray sand	5 "	1365
Fine white sand	5 "	1370
Slate and hard shell	15 "	1385
Gray hard shell	30 "	1415
Gray slate	20 "	1435
Slate and shell	5 "	1440
Hard gray sandstone	10 "	1450
White sand	5 "	1455
Gray slate	35 "	1490

Hard gray shale	5 to 1495
Gray sand	5 " 1500
Close white sand	5 " 1505
Hard white sand	5 " 1510
Gray slate	20 " 1530
Gray slate and shell	5 " 1535
Hard white sand	10 " 1545
Gray shell	5 " 1550
Glay slate	25 " 1575
Gray sand and shell	15 " 1590
Gray slate	15 " 1605
Gray sand	20 " 1625
Gray slate	10 " 1635
Gray slate and shell	30 " 1665
Gray slate	10 " 1675
Gray slate and shell	10 " 1685
Crevice full of quicksand	2 " 1687
Dark sand containing oil	3 " 1690
Crevice, containing loose stones, and oil	5 " 1695
Dark sand and oil	5 " 1700
Coarse sand and oil	5 " 1705
Loose slate	10 " 1715
Light colored slate	65 " 1780
"Gas crevice" full of stone and sand	5 " 1785
Dark sand	7 " 1792
Light colored slate	16 " 1808
Hard fine sand	15 " 1823
White and red sand mixed, red sand like quicksand	9 " 1832
Fine red and white sand	11 " 1843
Sandy slate [?]	7 " 1850

Drilled dry. Cased	547′
Drive pipe	43′
Heavy water course	52½′
Gas vein	593′
First strong smell of oil	1132′
Gas and strong smell of oil	1182′
Oil in gray shale	1685′
Crevice full of quicksand	1687′±
Oil	1690′
Crevice containing loose stones and oil	1695′
Oil	1700′
Oil	1705′
Pumped	1720′ (?)
Oil	1780′
Gas crevice full of stone and sand	1784′
Gas crevice	1808′

The bottom of the Olean Conglomerate is the same distance above well

No. 3 as well No. 2, allowing for the difference in elevation of the two wells.

Ernhout and Taylor Well, No. 1.

Owned by Capt. John Ernhout and Frank Taylor, Esq., on north side of Wilson Run, near south-east corner of warrant 3218, Jones Township, Elk County, and about 3¾ miles north west of Wilcox and several hundred feet north of the P. & E. R.R. The tract upon which this well is located is owned by D. Scull, Jr., Esq., of Philadelphia. Drilling was commenced Jan. 15, 1878, and abandoned March 13, when the tools were lost at a depth of 1335 feet. It is expected after the tools shall have been recovered, that the well will be drilled deeper.

Record reported by Mr. M. M. Schultz. Elevation of well, determined by Mr. A. W. Sheafer, Aid, McKean District, 1645 feet (Bar).

Loam and sand	40′	to	40′
Blue sand shale	160	"	200
Blue slate	40	"	240
Red rock	95	"	335
Red rock, very hard	15	"	350
Red rock, softer	45	"	395
Red rock	45	"	440
Sand and shells	15	"	455
Slate	15	"	470
Red rock	10	"	480
Red sand	15	"	495
Blue sand shells	35	"	530
Brown sand and white pebble	20	"	550
Slate and shells	95	"	645
Hard blue sand	10	"	655
Slate and shells	20	"	675
Brown sand and white shells	5	"	680
Slate and shells	75	"	755
Blue sand	25	"	780
Slate and shells	210	"	990
Red rock	20	"	1010
Slate	50	"	1060
White sand	35	"	1095
Red sand	20	"	1115
Slate and shells	135	"	1250
Gray sand	25	"	1275
Gray slate and shells	10	"	1285
Gray sand	20	"	1305
Slate and shells	10	"	1315
White sand	5	"	1320
White sand containing gas and strong smell of oil	15	"	1335

Drilled dry. Cased	481½′
Gas and smell of oil	1320′
Lost tools	1335′

The position of the bottom of the Olean Conglomerate above the Ernhout and Taylor Wells has not yet been determined.

A comparison may be made between these sections and the records of the Wilcox Wells by means of the red shale bands.

Ernhout and Taylor Well, No. 2.

Owned by Ernhout and Taylor, and situated in the south eastern corner of warrant 3215, Wetmore Township, McKean County, about one mile north of well No. 1. Tract formerly part of McKean and Elk Land and Improvement Co.'s lands.

Drilling commenced March 12, 1878, mineral water "vein" struck at a depth of 1990 feet May 9. The well was afterwards drilled 10 feet deeper through a dark fine (coffee grounds) sand strongly impregnated with oil. Oil not having been found in this well in paying quantities the casing was drawn, and water from the fresh water "veins" permitted to flow into the hole. The gas threw out of the well water, at regular intervals, to a height of 125 feet, more or less.* Shortly after the casing was drawn, a wooden plug was inserted into the upper part of the well and partially filled the hole. After this was done the well spouted every eleven minutes, the eruption lasting for two minutes. The column of water and gas rises above the top of the derrick (70 feet), and after several pulsations falls and almost ceases to spout, when it suddenly rises again repeating the action, and vanishing entirely at the end of two minutes.

Record reported by Mr. M. M. Schultz. Elevation of well determined by Mr. Sheafer, 1730 feet (Bar).

Loam and sand	40′ to	40′
Gray slate	85 "	125
Shells	10 "	135
Gray slate	65 "	200
Gray slate and shells	105 "	305
Red shale	10 "	315
Sand and shells	40 "	355
Red shale	125 "	480
Shells	30 "	510
Red rock	50 "	560
Gray slate	30 "	590
Red shale	55 "	645
Gray slate	175 "	820
Hard sand shells	80 "	900
Sand shell	100 "	1000
Sand	75 "	1075
Red rock	5 "	1080
Red rock, "pale"	5 "	1085
Gray slate	85 "	1170

* See paper which I read before the Society, Sept. 21, 1877, on the "Wilcox Spouting Water Well." The action in these two wells is similar.

Red rock	5 to 1175
Soft, muddy, gritty, slate	130 " 1305
Gray slate	80 " 1385
Light gray slate	10 " 1395
Sand shells	10 " 1405
Sand, smell of oil	10 " 1415
Sand containing heavy gas "vein."	2 " 1417
Sand	5 " 1422
Gray slate	48 " 1470
Sand and shells	85 " 1555
Dark and light gray slate	210 " 1765
Sandy slate	45 " 1810
Hard gray sand	5 " 1815
Slate	65 " 1880
Dark brown sand	10 " 1890
Soft gray slate	90 " 1980
Dark sand strongly impregnated with oil	10 " 1990
Dark fine sand (coffee grounds) containing oil	10 " 2000

Drilled dry. Cased	364′
Gas	1415′
Oil smell	1405′
Strong smell of oil	1890′
Strong smell of oil	1990′
Heavy "vein" of mineral water, easily corroding the tools	1990′

Bear Creek Well, or "Dry Hole," P. C. L. and P. Co.

Owned by the Producers' Consolidated Land and Petroleum Company, of Bradford. Situated on Bear Creek, east side of County road between Wilcox and Ridgway, in warrant 3257, Jones Township, Elk County. Land leased from Wilcox Tanning Company.

Drilling was commenced about April 1, 1878, and was completed in from 50 to 60 days.

The record was reported by Mr. M. M. Schultz. No show of oil was found.

The elevation of the top of the well is 1595 feet (Bar.) above ocean.

Drift	25′ to 25′
Blue slate rock	25 " 50
Red rock	15 " 65
Blue slate	10 " 75
Red rock	20 " 95
Sandy or "putty" slate rock	25 " 120
Sand rock	25 " 145
Soft slate	12 " 157
Hard shells	5 " 162

Very muddy slate	20	to	182
Hard slate	10	"	192
Hard sand	8	"	200
Hard slate	30	"	230
Very white loose sand	35	"	265
Hard shells and slate	5	"	270
Very hard sand	20	"	290
Tough slate rock	10	"	300
Very hard shells	10	"	310
Hard fine sand	10	"	320
Soft slate	30	"	350
Hard fine sand	69	"	419
Soft slate	10	"	429
Hard fine sand	10	"	439
Shells	30	"	469
Very red rock	5	"	474
Soft slate or "putty" rock	80	"	554
Shells and slate	55	"	609
Blue slate	15	"	624
Red rock	10	"	634
Blue slate	22	"	656
Hard sand	9	"	665
Red rock	26	"	691
Blue slate	12	"	703
Hard shell	4	"	707
Red rock	86	"	793
Blue slate	22	"	815
Red rock	48	"	863
Slate and shells	30	"	893
Red rock	26	"	919
Hard gray sand	10	"	929
Soft slate and shell	167	"	1096
Gray slate	159	"	1255
Sand	10	"	1265
Slate and shells	30	"	1295
Fine red sand	10	"	1305
Slate and shells	203	"	1508
Sandy shells	25	"	1533
Slate and shells	34	"	1567
Close light sand	12	"	1579
Soft slate	25	"	1604
Close white sand	10	"	1614
Slate and shells	52	"	1666
Pebble sand	5	"	1671
Slate and shells	15	"	1686
White sand shells	10	"	1696

Hard slate	10 to 1706
Loose white sand	50 " 1756
Slate and shells	65 " 1821
Muddy slate	15 " 1836
Slate and shells	12 " 1848
Muddy slate	20 " 1868
Slate and sand shells	30 " 1898
Sand	22 " 1920
Slate and shells	8 " 1928
Slate	60 " 1988
Slate and shells	10 " 1998

Drilled dry. Cased	380′
Drive pipe	25′
Crevice drained off water	120′
" " "	230′
Salt water	270′

Drillers reported "oil smell" in sand from 1706 to 1756′

The Olean Conglomerate in this locality varies very much in its character. It is found changing from a coarse pebble conglomerate to a rather fine or even shaly sandstone in comparatively short distances. The "blue slate rock" directly under the drift in the Bear Creek well, represents probably a portion of the Olean Conglomerate.

Silver Creek Well or "Dry Hole." Burton and Wallace.

Owned by Messrs. Burton and Wallace, of Rynd Farm, situated on Silver Creek, west side of County road, between Wilcox and Ridgway, in warrant 3261, Ridgway Township, Elk County. Land leased from Wilcox Tanning Company.

Drilling was commenced about the same time as at the Bear Creek Well, and was completed June 26, 1878.

The record was reported by Mr. M. M. Schultz. No show of oil was found.

The elevation of the top of the well is 1615 feet (Bar.) above ocean.

Conductor	15′ to 15′
Slate	15 " 30
Gray sand	25 " 55
Pebble sand	30 " 85
Red slate	5 " 90
Black sand	60 " 150
Fine blue sand	70 " 220
Red slate	10 " 230
Fine pebble rock	30 " 260
Dark fine sand	40 " 300
Slate and hard shells	10 " 310
Fine blue sand	70 " 380

White slate	10 to	390
Hard fine sand	55 "	445
White slate and hard shells	95 "	540
Red rock	5 "	545
Soft white slate	55 "	600
Hard shells and slate	10 "	610
Soft white rock	40 "	650
Red rock	100 "	750
White slate	15 "	765
Red rock	85 "	850
White slate	22 "	872
Red rock	25 "	897
White shells and slate	26 "	923
Red rock	40 "	963
White slate	42 "	1005
Hard shells and slate	20 "	1025
White slate with shells	50 "	1075
Hard black sand	25 "	1100
Hard slate	75 "	1175
Black slate and shells	45 "	1220
Hard white sand	15 "	1235
Slate	10 "	1245
Sand and shells	10 "	1255
Hard shelly rock	45 "	1300
Pale red rock and slate	10 "	1310
White slate and shells	10 "	1320
Red sand	12 "	1332
Soft slate	13 "	1345
Hard shells	20 "	1365
Light red sand	10 "	1375
Hard shelly rock	20 "	1395
Fine gray sand	10 "	1405
Hard red rock	10 "	1415
Slate and shells	20 "	1435
Red sand and pebbles	25 "	1460
Hard shells	15 "	1475
Slate and shells	35 "	1510
White slate	10 "	1520
Gray sand	8 "	1528
Red rock	7 "	1535
Slate and hard shells	45 "	1580
Hard fine white sand	25 "	1605
Hard slate and shells	20 "	1625
Fine white sand	8 "	1633
Hard shells	7 "	1640
Fine gray sand	10 "	1650

Hard shells and slate	15 to 1665
Hard shells	5 " 1670
Sand and pebbles	8 " 1678
Slate and shells	82 " 1760

Drilled dry. Cased	450′
Conductor	15′
Salt water in slate	415 to 540′
" " red rock	1528 to 1535′
Smell of oil reported in sand	1670 to 1678′

The Olean Conglomerate is probably represented in the record by the sand from 30 to 85 feet below the top of the well.

The records of the Bear Creek and Silver Creek Wells are invaluable as having a direct bearing upon the probable existence of petroleum to the south and south-east of Wilcox.

It will be noticed that the mass of the red rocks are some 300 feet lower in the the Bear and Silver Creek Wells than in the Wilcox Wells, estimating from the bottom of the Olean Conglomerate.

The question as to whether the mass of red bands in the two localities are the same and whether the strata included between them and the Olean have thickened to the south and south-east, is extremely suggestive.

NOTE.—The records are published just as they have been reported to me. I have not even altered the phraseology, which is quite different in a number of places where the same idea was evidently intended to be conveyed.

I will merely add, for those who are unacquainted with the terms employed by the drillers, that "shell" means any hard stratum encountered in the well, and not, as might be supposed, a fossil.

Nature's Reforesting. By Eli K. Price.

(Read before the American Philosophical Society, September 20, 1878.)

The paper on *Sylviculture* read in November and December, 1877, has produced the following confirmatory letters of views therein expressed. They are from the present Chief Justice of Pennsylvania, who lives in Beaver, and the Professor of Botany in the University of Pennsylvania, formerly a resident of Mifflin County, Pennsylvania.

CONTINENTAL HOTEL, FEBRUARY 11, 1878.

MY DEAR SIR:—I have read the address you sent me on *Sylviculture* with great interest, especially as some of its facts have come under my own observation. The western part of Pennsylvania was once among the best wooded portions of it, yet the destruction of timber has plainly affected springs and streams. Many of the springs have become wet weather water courses, while the floods in the streams rise suddenly and high, and subside as quickly ; the rainfall running rapidly over the denuded surface, and failing to penetrate it, as when shaded by the forest, and covered with leaves and weeds.

There is a curious fact I have never read of, yet which displays the effort of nature in the spread of vegetation. In July, 1837, I returned home from the Constitutional Convention, which sat in Harrisburg. When passing along the canal in the valley of the Juniata, I noticed long reaches of stone covered mountain sides, bare of all vegetation from base to summit, and of most curious structure, the stones being, apparently, comminuted rocks, so small and flat as to have come to a regular inclination at angles, varying probably from twenty-five to forty degrees. After I began to come to that city to the sessions of our Court, passing upon the Pennsylvania Railroad, I occasionally looked for some of these naked stone mountain sides without seeing them. At first I supposed this to be accidental, my attention happening not to be drawn to them at the proper time. In the course of time I began to think I was mistaken, and that these bald spots had disappeared. I was led to look more closely and continuously, and saw a few left, but greatly diminished in extent, and some mere dots between growing trees. At last I discovered mountain sides covered with a very small growth of trees, mere shrubs in size. The last time my attention was given, I saw one large space of mountain side covered with the small flat stones before described, and in it here and there a single sapling or shrub or two standing alone, proving that from leaves or other vegetable matter deposited by the winds, soil had begun to be formed, and vegetation to grow. From what I have noticed of other stony mountain sides covered with large timber, along the same valley, I conclude that there was a time when all these mountains were similar rocky, and stony surfaces, bare of all vegetation, and left by the convulsions of nature just as she cast them up.

I am very truly yours,

DANIEL AGNEW.

HON. ELI K. PRICE.

BEAVER, AUGUST 26, 1878.

MY DEAR SIR :—On my return by the Pennsylvania Railroad last week I discovered at several places the evidence of the fact I stated to you last winter in regard to the growth of timber on the bald stony surface of the Allegheny Mountains. I am now perfectly satisfied of the truth of my suggestions. I saw distinctly the remaining uncovered surface as of comminuted stone in patches small and great, the young growths of shrubs and sapling interspersed, with here and there one shrub in a bare patch, indicating the beginning of covering and the different stages of progress.

The first point I noticed was about seven or eight miles west of Mifflin —the second at 161st mile *to* Pittsburgh —the third at 152d mile *to* Pittsburgh—the fourth 110th mile *to* Pittsburgh, and the fifth just east of the Spruce Creek Tunnel.

An examination of these places I have no doubt will show them to be constantly arising.

Yours Truly, &c.,

DANIEL AGNEW.

HON. ELI K. PRICE, Philadelphia, Pa.

WEST CHESTER CO., Penna., August 29, 1878.

MY DEAR MR. PRICE:—Your letter was received yesterday. Owing to the work constantly pressing me I have been unable to get away more than four days this summer. During that time I passed (in train) along the line of the Pennsylvania Central Railroad and in the narrows of the Juniata between Mifflin and Lewistown, and my attention was called to the fact that on a number of rocky places all the timber was small and of recent growth. This is at or near the places mentioned by Chief Justice Agnew, and in so far may be regarded as confirming his views, when taken in connection with the fact that extensive and destructive conflagrations appear to be less frequent there than formerly. Being raised in that region, I can remember when for miles the mountain sides each year were a line of fire. Though I have not been there of late years much of my time, I still feel justified in the statement that such events are now of rare occurrence. Fires doubtless do originate each year along the line of the Railroad, but they do not appear to spread far and wide as before.

Touching the motion of the rocks as preventing growth; I can only give as an instance the old mountain road between McVeytown and Kishacoquillas Valley. This ran through some of the most rocky places in the region, and where the slope was very steep, and indeed almost undermined them on the upper side. For years this road was practically abandoned, at least no work was done upon it. I do not remember the place where the rocks had slidden enough to close the road. Indeed these very places were favorite places of growth for the Purple Flowering Raspberry (*Rubus odoratus*) and the *Hydrangea arborescens*. Motion here must have been very slight.

It is a source of great regret to me that I have not been able to take the time to go into a full investigation of this matter. As it is one of interest, and closely associated with my line of work. I believe that the large rocks allowing the snow and rain to find its way readily to a considerable depth have also favored carrying the soil in the same direction (and then away). Professor Hayden alluding to similar places in our western domain, offers this as an explanation of the scarcity of large trees there.

Very sincerely Yours,

J. T. ROTHROCK.

I believe Major Powell in his report, published or about to be published by Government, goes into the question of destruction of forests by fire very fully, and presents the case in a very strong light.

WEST CHESTER, CHESTER CO., PENNA., September 3, 1878.

DEAR MR. PRICE:—Since writing to you I find the following statement in a lecture by Prof. Gray of Cambridge, on "Forest Geography and Archæology" quoting from Professor Shaler of Kentucky—"Professor Shaler from his observations in the border land of Kentucky thinks that there are indications there of comparatively recent conversion of oak openings into prairie, and now since the burnings are over, of the re-conversion of prairie into woodland." The passage in the first part of the quotation refers to Shaler's opinion that fires have destroyed the forests there. This you know is in entire accordance with what is said on pages 276 and 277 of Michaux Travels, published in 1805 (Lambert's translation), of exactly the same region.

Sincerely yours,

J. T. ROTHROCK.

Professor Leo Lesquereaux has formed the opinion that the prairies have failed to produce trees because of a soil inimical to their growth. This theory appears to be successfully combatted by O. P. Hay in the American Naturalist for May 1878, p. 299. It is also contrary to many facts stated in "Sylviculture." The last page of that paper contains the conclusion of O. W. Wight, in his Geology of Wisconsin, who said, "Fire has killed the timber over wide areas, on which grass was growing, exhibiting before our eyes nature's simple method of reconverting woodland into prairie. The reverse process is just as simple. When prairies are no longer swept over by fire, timber springs up, reconverting prairie into woodland. Grass, with fire as an ally, can beat timber. *Timber can beat grass, when it has no fire to fight.*" We may also add that without fire to fight it can conquer stones and root itself beneath the rocks, and be anchored all the stronger. It is ever man that is the great destroyer, and he is competent to repair his own devastation.

Contributions from the University of Pa., No. XV. Preliminary notice on Chromometry, a new branch of quantitative analysis with the blowpipe.

BY PROFESSOR GEORGE AUG. KÖNIG, PH. D. WITH A PLATE.

(*Read before the American Philosophical Society, Oct. 4, 1878.*)

In a former paper presented to the Society (Proceedings Vol. XVI., January, 1877), I described a colorimetric estimation of titanium. Mention is made in that paper of the interference with accurate results by the presence of metals producing green glases in the reducing flame, such as vanadium or chromium, the green being complementary with the red of titanium and thus destroying the latter. That method is purely colorimetric, as the determination depends on a comparison of color *intensity* with glass beads containing known quantities of titanium. But the mutual extinction of complementary colors led me, already at that date, to seek a way for the utilization of this principle, as expressed in the same paper: "I am now experimenting upon the feasibility of extinguishing the color of titanium by a graduated scale of green, etc." Finding, however, some serious practical obstacles, I allowed the subject to rest until the present summer, when perfect leisure favored a more successful pursuit.—I now place before the Society the result in a preliminary form, reserving for a future paper the details and the special determinations, as well as tables, for a number of the most important minerals and ores.—The new method of analysis I propose to name "chromometry," for I measure the *quality* as well as the quantity of certain colors, both isolated and when combined with other colors not their complementaries, these latter being the determinants. Thus, iron imparts to borax in the oxydizing flame a dark red-brown color while the bead is hot, which passes into pure yellow at the ordinary temperature of the air. Under the same conditions manganese produces a purplish-red glass, both together a brown glass in all shades from pure yellow to pure red, according to the relative quantities of the two metals. If this glass be looked at through a certain thickness of a transparent green medium, such as green glass—the red will have disappeared and a pure yellow will be seen; increasing the thickness of green medium ever so little, will cause a greenish yellow color to appear, whilst an equal reduction in the medium will cause a brownish-yellow tint. The human eye is much quicker to appreciate a change of shade, than a small change of intensity of color, as those well know, who are accustomed to the polarization of sugar. In this instance I designate the pure *yellow* as the *point of extinction*, while colorlessness or any other simple color may represent extinction in other cases.—Thus it will be understood that the new method *analyses* the colors, what colorimetry of liquids as heretofore applied does *not*, it involves another principle and should therefor be called by another name.—Chromometry seems to express the essentials of the method very well "a measuring of color" besides being a purely Greek compound noun, not Latin Greek, as Colorimetry. The new principle of analysis by complementary colors is applicable to both liquid and solid transparent colored bodies, but I shall confine myself for the present to the solids exclusively.

In regard to their behavior towards borax and microcosmic salt—the metals are *chromatic* (imparting characteristic colors to these fluxes) or *achromatic* (imparting no color, or no characteristic color).—The chromatic series comprises: copper, nickel, cobalt, iron, uranium, chromium, vanadium, tungsten, titanium, manganese, molybdenum, niobium, ilmenium, neptunium. All of these metalls fall within the capacity of chromometric determination. Some of them are eminently chromatic as: Manganese cobalt, vanadium, titanium, and they are capable of very accurate determination. 0. mgr. 01 of Mn_2O_3, dissolved in 100 mgrs. of borax glass yields a distinct color, 0. mgr. 1 a deep color, 0. mgr. 2 nearly opaqueness. The range of greatest sensitiveness is between 0. mgr. 05 and 0. mgr. 10; the limit of uncertainty for my eye is 0. mgr. 002 Mn_2O_3.

Execution of the method.

1. *Preparation of the bead.* Before starting upon an analysis, I melt a number of borax beads weighing each about 90 mgrs. Some of these I crush in a steel mortar and keep the coarse powder on a watch glass for use. A number of platinum wires, weighing 100 mgrs. each, or a few tenths less, are likewise kept in readiness. They have at one end a circular loop (*l*) 0.1 inch in diameter. One of these wires (*w*), Fig. 1, I place on the pan of a delicate balance, which should indicate one twentieth of a milligram with precision, and at the same time rapidly. (Such balances are known as "Small size Assay balances and are manufactured in great perfection by the firm of Trömner & Sons of Philadelphia.) The wire is readily tared by the milligram rider, as its weight is close to 100 mgrs.—A quantity (*s*) of 5 mgr. of the finely ground ore, or in many cases of determinative mineralogy a splinter of a mineral, is now weighed with the greatest care (the hand must rest exactly at zero) since an error here of ± 0. mgr. 05 will produce either 99 percentum or 101 instead of 100. With some practice the error will not exceed ± 0.5 p. c. I remove now the 5 mgr. weight and replace it by one decigram. In the other pan I place one of the ready borax beads (*b*) and with the addition of pulverized borax glass (*p*) equilibrium is restored. The scale pans are made of platinumfoil. The one holding the flux and substance is placed on a holder (Plattner's cupel holder is very good) and brought beneath the blowpipe flame, so that the current of gases will not affect it, whilst the wire is inserted into its handle. The flame is a strong clean oxydizing one, produced best with lard oil and a mechanical blast (I find a small Catalan blast, made from a Wolf's bottle, very convenient and steady). Bringing the red hot loop of the wire down upon the borax bead causes this to adhere firmly, and after being melted picks up at once and without loss the smaller particles of the flux. In adding now the substance every precaution against mechanical loss must be taken. Should the substance contain volatile matter, care is particularly required, because if the mass of red hot flux be dipped into the midst of the fine powder the gases or vapors will generate so suddenly that a scattering must take place. But if the bead be approached to the margin of the small heap of powder and only a small quantity of it be taken up at a time, no loss will be sustained, as many experiments prove. From the smooth platinum surface of the pan every particle of substance can be collected. This operation consumes from 5 to 10 minutes according to the solubility of the metallic oxides. The bead is now allowed to cool and, still on the wire, replaced on the balance. Some

of the borax has been volatilized; this with the volatilized constituents of the test substance, has now to be made up to 100 by addition of pulverized borax glass. After remelting in the oxidizing flame and cooling it will be found that the weight is still 100 mgr. Now I examine the bead. If too deeply colored or even opaque, I remelt it, throw it from the wire into a porcelain capsule, and crush it in the steel mortar. Of the powder I weigh off 5–10–20 etc. mgrs. according to the depth of coloration, and complement 100 mgrs. by a bead and pulverized glass, as before described. If after melting and cooling the color should be still too deep (in exceptional cases which will hereafter be described), a second dilution is effected in the same way. Of a substance containing 1.5 p. c. Mn_2O_3—and no other coloring oxides—5 mgrs. will just give the convenient depth of color to the first bead and no dilution is here necessary. Again melted and thrown from the wire, the bead is ready for the next treatment. The quantity of colored glass adhering to the wire matters not, if it does not exceed 10 mgrs.

2. *Optical preparation of the bead.*—In developing this method it was soon found that with the spheroidal shape of the bead no constant results were obtainable. Acting as a lens it would concentrate the color if the radius of curvature were smaller, and dilute it if larger, besides it did not seem feasible to attach the bead in the chromometer so that the line of greatest thickness should exactly fall into the line of vision. After trying a number of contrivances unsuccessfully, I finally hit upon the simplest of all and one that proved entirely satisfactory. I take a platinum cylinder 0.09 inch high, 0.145 inch inner, and 0.167 inch outer diameter, hold it with a platinum tipped forceps into the flame until it is red hot, then press its circumference upon the bead, so that the latter adheres firmly. If now held again into the clear flame horizontally, bead downwards, until the glass becomes liquid and the cylinder red hot, capillary attraction will cause the glass to flow up into the cylinder, without any overflow on the outside of the platinum ring, and if turned properly while cooling, the glass will equally protrude with convex surface on either end of the ring, about 0.03 inch (fig. 3). After cooling, the bead, thus mounted, must appear entirely free of air bubbles. By the next step the protruding convexities are cut away, leaving two plane parallel faces and at the same time bringing about the standard thickness in the glass. Fig. 4 represents in natural size the serviceable contrivance which renders this operation both rapid and accurate.

A is a brass plate $\frac{3}{16}$ inch thick and 2 inches in diameter. A central perforation admits with easy friction the tube *B*, into one end of which the platinum cylinder fits. By slitting the tube has spring and holds the cylinder sufficiently tight. A shoulder in the tube prevents the cylinder from sliding in deeper when pressure is put on. The apparatus is placed upon a plane glass plate with some fine corundum (or emery) and water, the forefinger presses upon the knob of the tube, while thumb and middle finger grasp the neck of the plate and move the bead over the glass plate.

FIG. 6.
1/4 NAT. SIZE.

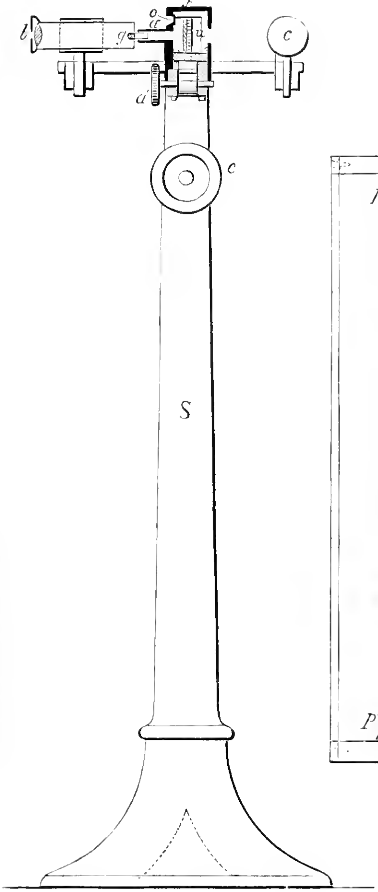


FIG. 7.
NAT. SIZE.

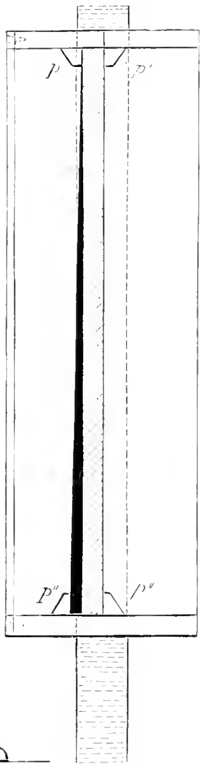


FIG. 1.
NAT. SIZE

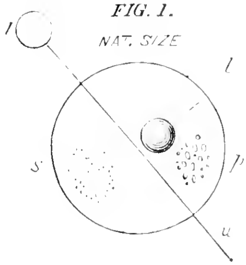
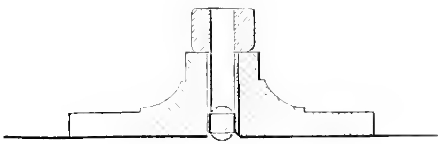


FIG. 3.

FIG. 5.
NAT. SIZE

FIG 4.
NAT. SIZE.



After grinding one side, the bead is pushed out, reversed and the other side cut similarly. A rectangular slot in a brass plate (fig. 5) exactly 0.12 inch wide serves as a gauge into which the bead must pass with friction. One obtains soon such a practice that the fit will be obtained without requiring a second setting. The operation only consumes 3 minutes. The roughness of the faces causes now the bead to be only translucent, but by applying a thin film of Canada balsam a beautiful transparency is obtained. I place the bead into a small air bath heated to 150 C° for a few minutes then apply by means of a pointed tube the liquid balsam, replace in the air-bath 5 minutes, after which the bead is ready for the chromometer, as soon as it has resumed equal temperature with the air in the room.

3. *The Chromometer.*—The construction of this simple instrument is represented in transverse sectional view in the fig. 5. A box *f*, 8 x 1 x 1 inches, is mounted on a stand *s*, 18 inches high. A wedge (*w*) having the complementary color to that of the metal which is to be determined, cemented for support upon a colorless glass plate, moves by rack motion in the box *f*. The motion is imparted by turning the knob *d*. In its centre the box is perforated so that pure sky light or light reflected from the porcelain plate *c* may pass through the colored glass into the tube *a*, through the bead *g*, into the eye of the observer at the lens *b*. The latter has only a small magnifying power and serves mainly to give a straight line of vision parallel to the tube *a*. The lens is readily removable, so as not to obstruct the insertion of the bead into *a*. The joint *e* serves to incline the line of vision, if that should become necessary. The sliding plate which carries the wedge is furnished with a permanent millimeter scale, which is read by the observer through the opening *o* in the box, simultaneously with the observation of the bead. Fig. 7 gives a natural size horizontal view of the sliding plate with a section through the wedge. The latter is held by the projections p, $p_{,}$, $p_{,,}$, $p_{,,,}$, and can be readily exchanged.

Mode of working with the Chromometer.

In the first place the wedge must be calibrated. A single determination will suffice for this purpose, since the law pertains that "the *intensity of color is directly proportional to the thickness of the wedge, and hence to the percentage of metal under determination.* If, therefore, the wedge is accurately cut, so that its section is a perfect triangle, its length and thickness at both ends being known, it is only necessary to dissolve a proper quantity of the chemically pure metal or one of its compounds in the manner described, to cut the bead and to determine the point of extinction on the scale, and the quantities corresponding to each millimeter can be calculated by simple proportion. Having found, for example, that a certain wedge, 3 inches long, tapering to a perfect edge on one extremity and being 0.1 inch thick at the other extremity, placed so that the apex is exactly at zero on the scale, will extinguish the color of a normal bead containing 0.^{mgr} 08 Mn_2O_3, exactly at the division 15 on the scale, it is evident that each division will be equal to $\frac{0.08}{15}$ mgr. $= 0.0053$. This fraction is, therefore, the titre of this scale. Dissolving 5 mgr. of a mineral containing manganese and nothing that could interfere, we find the point of extinction at 17, then we have percentage p of Mn_2O_3

$$p = \frac{(0.0053 \times 17) \times 100}{5} = 1.802.$$

In a subsequent paper I shall give tables and determinations for a number of important minerals and ores. As the determinations will have to be made, for the most of them, in the humid way, the labor will be extensive and time consuming. I should esteem it a great favor if my co-laborers in mineral chemistry would furnish me with such small samples of minerals and ores analyzed by them and coming within the limits of this method. In so much as each worker multiplies himself, so to speak, by lessening the time consumed in determinations, I cannot but consider this chromometric method as of the greatest importance, and again ask for active co-operation in its further development. Thus far I have proved the method thoroughly only for manganese, iron and chromium. The former offers no difficulty and gives equally accurate results with the most approved gravimetric methods. I shall next extend it to copper ores.

Crucial Harmonics. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, October 4th,* 1878.)

No surer test of any hypothesis has ever been suggested than its furnishing a successful anticipation, or prediction, of facts or phenomena that were previously unknown.

The harmonic progression, which starts from Jupiter's centre of linear oscillation as a fundamental unit and which has 4 for its denominator-difference, was taken as the ground for such a prediction, in the communication which I read to the American Philosophical Society on the 2d of May, 1873.* Kirkwood had, a short time before, computed a probable orbit for "Vulcan," which satisfactorily represented the second interior term of the series, and this accordance was one of the principal sources of the confidence with which I ventured upon a publication of the prediction.

Forty-one days afterwards, on the 19th of June, De la Rue, Stewart and Loewy communicated to the Royal Society certain conclusions, based upon three sets of sun-spot observations, taken in three different years, and extending over periods, respectively, of 145, 123 and 139 days. Those observations indicated some source of solar disturbance at .267 of Earth's mean radius-vector, which represented the first interior term of my series and gave the first conclusive verification of my prediction. In announcing

* Proc. Soc. Phil. Amer., xiii, 238.

this fact to the Society, I presented three nearly identical series, the first being determined solely by Jupiter, the second by Earth, and the third by relations of planetary and solar masses.* I gave precedence to the first of these series, both because of Jupiter's predominant importance and because of the many planetary harmonies which are determined by Jupiter's mean perihelion.†

At the time of the late total solar eclipse, Watson and Swift each observed two small planets between the orbit of Mercury and the Sun. By comparing the published position of the planet which was first announced by Watson, with some of the most trustworthy of the recorded observations which were thought by Leverrier to indicate intra-Mercurial transits, Gaillot and Mouchez found an orbital period of 24.25 days,‡ which represents the third interior term of my series and the second strict verification of my prediction.

The relatively rapid motion of Phobos, the inner satellite of Mars, and the probably meteoroidal nature of the corona, may reasonably lead us to look for an indefinite number of further verifications in the results of future discovery. No other known medium possesses so great a degree of elasticity as the hypothetical luminiferous æther; none other is, therefore, so well fitted for the production of musical, or rhythmical harmonic vibrations. Numerous evidences of intelligent arrangement and design have been pointed out in the solar system. They all indicate important laws, but none show so close and general accordance with actual planetary positions as those which most accurately record the "music of the spheres."§

I submit the following table, both as evidence of the foregoing statements and as a possible help towards the discovery of new planets or the determination of their orbital periods.

No.	Harmonic Prediction.			Confirmation.	
1	$\frac{2}{3}$ Jupiter =	$\frac{1}{1}$	3 469	Node of Subsidence.	3.469
2		$\frac{1}{5}$	.694	Venus m. p.‖	.698
3		$\frac{1}{9}$	.385	Mercury m.	.387
4		$\frac{1}{13}$	.267	De la Rue, S., and L.	.267
5		$\frac{1}{17}$	.204	Kirkwood.	.209
6		$\frac{1}{21}$	.165	Watson.	.164
7		$\frac{1}{25}$	.139	....	....
8		$\frac{1}{29}$	.120	....	....
1_1		$\frac{1}{33}$	.105	Helios,	.106
2_1		$\frac{1}{177}$	.0196	Themis,	.0196
3_1		$\frac{1}{321}$	.0108	Eunomia.	.0108
4_1		$\frac{1}{465}$	.0075	Phaos,	.0074
5_1		$\frac{1}{609}$	.0057	Lychnis,	.0057
6_1		$\frac{1}{753}$	.004606	Sun's surface.	.004606

* Proc. Soc. Phil. Amer., xiii, 470, 472.

† Ibid. 239.

‡ Comptes Rendus, 5 Août, 1878.

§ Proc. Soc. Phil. Amer. xiii, 474.

‖ m, *mean*. p. *perihelion*.

The harmonic denominators for Nos. 1–8, etc., are of the general form $4n-3$. The denominators for Nos. 1_1–6_1, are of the form $4\,V-3$; V being equal to $9\,(4n-3)$. The first term of the second series, or the 9th term of the first series, gives the orbital distance of a planet which would revolve about the sun synchronously with a solar half-rotation, a period which seems to be determined, as we have already seen, by the action of LIGHT.

The term 2_1, or the 45th term of the first series represents the orbital distance of a planet which would revolve in a sidereal day, or synchronously with Earth's rotation on its axis. The corresponding planet may be fitly named Themis, in honor both of the daughter of Ouranos and Gaia, and of her character as goddess of law and order.

The term 3_1, or the 81st term of the first series, marks the orbital distance of a planet which would have an orbital period synchronous with Jupiter's rotation on its axis. Its designation has also a double fitness; Eunomia having been the mythical daughter of Jupiter and Themis, and her name signifying "good government."

The term 4_1, or the 117th term of the first series, gives the position of a planet which would have an orbital period twice as great as if it were at Sun's surface.

The term 5_1, or the 153d term of the first series, represents a planet which would have an orbital period determined by Herschel's "Subsidence" from opposite extremities of an early solar diameter.

The term 6_1, or the 189th term of the first series, represents the present surface of Sun, provided the depth of the photosphere is one per cent. of Sun's radius.

The denominator of the one hundred and eighty-seventh term of the first series ($1+186 \times 4=745$), which terminates the intra-telluric series, represents the ratio of the aggregate planetary mass to Sun's mass.

Herschel's modified statement of the nebular hypothesis and Gummere's criterion, not only furnish ground for a satisfactory explanation of such remarkable velocities as that of the inner moon of Mars,* but they also seem to require that secondary orbs, when they revolve in less time than is required for the rotation of their primaries, should be denser than the primaries. I find, therefore, good reason for anticipating that Phobos, as well as any yet unknown possible moons of Mars which have an orbital term of less than a day, will be found to be more dense than the planet itself.

That these accordances find a *vera causa* in the harmonic undulations of the luminiferous æther, is made still more evident by the constant solar equation, $\sqrt{gh} = gt$ = *velocity of light*; g, representing Sun's superficial gravity at any stage of nebular condensation, past, present, or future; h, solar modulus of light; t, time of corresponding rotary oscillation, or half-rotation; t, is also time of traversing $\frac{1}{2}$ modulus of light, or $\frac{1}{2}$ mean luminiferous æthereal atmosphere, under the constant acceleration g.

* Proc. Soc. Phil. Amer., xvii, 302, 342, etc.

Stated Meeting, October 18, 1878.

Present, 16 members.

Vice-President, Mr. FRALEY, in the Chair.

Dr. Muhlenberg, a newly elected member, was presented to the presiding officer and took his seat.

Letters accepting membership were received from Dr. Morris Longstreth, dated Philadelphia, 333 S. 12th street, October 7; Mr. J. B. Knight, Hall of the Franklin Institute October 7; and Mr. Samuel H. Scudder, Cambridge, Mass., October 4, 1878.

A letter acknowledging diploma of membership was received from Mr. A. Agassiz, dated Cambridge, Mass., July 9, 1878.

Letters of acknowledgment for publications received were read as follows: from the Holland Society of Sciences, Jan. 7, 1877 (I–VI, i; Proc. I, XIV, XVI); Royal Society, New South Wales, Sydney, September 9 (100; List).

The following receipts for Proceedings No. 101: Essex Institute; Providence Franklin Society and Society for the Encouragement of Industry; New Bedford Library; Amherst College; Yale College; Surgeon-General's Office; U. S. Naval Academy; Smithsonian Institution; Kansas State Historical Society; Messrs. G. L. Vose, Jacob Bigelow, M. D., Dr. Walcott Gibbs, T. P. James, Dr. Asa Gray, E. N. Horsford, Jas. B. Francis, Dr. Pliny Earle, Jas. D. Dana, O. C. Marsh, H. A. Newton, Geo. G. Brush, Wm. P. Blake, J. S. Newberry, Dr. W. A. Hammond, W. H. Green, Wm. Blasius, Pliny E. Chase, T. P. Porter, George Smith, C. F. Himes, J. F. Carll, F. V. Hayden, Simon Newcomb, Dr. Theodore Gill, C. A. Schott, Admiral J. Downes, E. Goodfellow, W. B. Taylor, J. H. C. Coffin, J. M. Hart, J. L. Campbell, Daniel Kirkwook, A. H. Worthen, Dr. Robt. Peter, J. D. Whitney, J. F. Clarke, and Dr. E. Jarvis.

Also receipts for Catalogue, as follows: Boston Public Library (Part III); Amer. Antiquarian Society (Part III); Wisconsin State Historical Society (Part III); Regents of the University of New York (Part I); and the U. S. Naval Observatory (Parts I, II, III).

A letter requesting exchange of catalogues was received from the Public School Librarian at St. Louis.—On motion the exchange was ordered.

Letters of envoy were received from the Royal Society of New South Wales, Sydney, Sept. 11, 1878; Royal Bavarian Academy, Munich, March 30, 1878; and Holland Society of Sciences, Harlem, Jan., 1877.

A letter was received from Mr. Walter White, Assistant Secretary of the Royal Society, dated London, Sept. 23d, 1878, presenting a copy in bronze of the newly instituted Davy Medal; and letters from the U. S. Department of State transmitting the same.

Donations for the Library were received from the R. Bavarian Academy; R. Accademia dei Lincei; R. Academy at Lisbon; Kansas Academy at Topeka; and Academy at San Francisco; the Department of Mines, Melbourne; Royal Danish Society; Revue Politique, and M. M. Delesse and Lapparant, Paris; London Nature; Mr. O. Fisher, F. G. S.; Essex Institute; Boston Society of Natural History; Harvard College; American Antiquarian Society; Yale College; Prof. Geo. J. Brush; Ed. S. Dana; Lyceum of New York, (N. Y. Academy of Natural Science); Prof. J. S. Newberry; Polytechnic Review; Brooklyn Entomological Society; Franklin Institute; American Journal of the Medical Sciences; Medical News and Library; Penn Monthly; Prof. E. D. Cope; Dr. J. B. Cox; Mr. Edwin A. Barber; U. S. Coast Survey; U. S. Engineer Department; Bureau of Education; Weather Bureau; University of Virginia; Georgia Historical Society; Kansas State Horticultural Society; Ministerio de Fomento, and Geological and Statistical Society, Mexico; and Ministerio de Fomento, Madrid.

A bronze medal, a copy of the newly instituted Davy

Medal, was presented to the Cabinet by the Royal Society of London. On the obverse a head of Sir Humphrey Davy. On the reverse the following legend:—"The Royal Society to Robert Wilhelm Bunsen. Gustav Robert Kirchhoff. In accordance with the will of Humphrey Davy, who devoted the testimonial presented to him by the Coalowners of the Tyne and Wear to the encouragement of Chemical research —1877."

The Secretary offered for publication in the Transactions a memoir entitled, "The Upper Carboniferous Flora of West Virginia. With 23 plates. By W. M. Fontaine and I. C. White," and exhibited proof sheets of the quarto plates.—On motion the paper was referred for examination and report to Dr. Leidy, Dr. J. S. Newberry, and Mr. Lesquereux.

The Secretary read by title a communication entitled "On the limiting Constant of Gravitation. By Pliny E. Chase."

Prof. Lesley read a communication entitled "Notes on a series of analyses of the Dolomitic Limestone rocks of Cumberland Co., Pa."—The subject was discussed by Dr. König, Prof. Frazer, and Mr. Walter.

Mr. Briggs read from a MSS. part of his discussion of the economical problem of force and fuel applied to Electric Lighting as compared with Lighting by Coal Gas.

Mr. Briggs invited attention to the remarkable fact that all the exhibitors of Artificial Ice Machines at Paris (six in number, of which Pictet's seems to be best) claimed for their several machines twice or three times the maximum efficiency to be expected, if the accepted theory of the coefficient of heat be true.

Prof. Frazer communicated the fact that in his use of the local telephone circuit during the Summer he had observed a continued resonance of over tones.

In the course of some experiments on a telephone line with a view to decrease the crackling due to atmospheric disturbance, an observation was made by Prof. Frazer which will seem to illustrate to what an infinitesimal motion the sounds heard through the telephone are sometimes due. A telephone was selected in which the diaphragm was held fast at only two or three points instead of on a flat surface, which usually binds the outside of the metal plate. The diaphragm gave to one note a clear resonance, in which the overtones so characteristic of metal plates in vibration were distinctly heard (middle A of piano). On sounding this note into the mouthpiece, while keeping the other telephones covered so as not to be directly affected by the air-waves, it was found that the overtones were audibly traceable in one of the other telephones with which connection was had over a line of about one-third of a mile with a ground return circuit.

It is difficult enough to understand how the minute waves into which a metal plate is thrown by a vigorous note of the voice can reproduce sound through the intermediate agency of maxima and minima of resistance in the medium of current transmission; but that the minute wavelets which are produced upon the backs of these, should at the extremity of a long line produce sufficiently powerful variations of conductivity to cause the mechanical fluttering of the diaphragm of another instrument to a sufficient degree to cause the effect of sound could scarcely have been foreseen.

Pending nominations 864, 867, 868, 869, 870, and new nomination 871 were read.

In the absence of Prof. Houston the consideration of his motion to amend the minutes was postponed to the next regular meeting.

The Secetary read a letter from Prof. Henry Morton, dated Hoboken, Oct. 7., drawing attention to a marked word, "*Foucou's*," in an enclosed original letter, written to him by Prof. Sadtler, dated Dec. 31, 1877; and for the purpose of showing that he (Prof. Morton) did Prof. Sadtler no injustice in quoting this word (instead of Fouqué) in his letter of May 15, 1878, commented upon in Prof. Sadtler's reply as published in the Proceedings A. P. S., Vol. XVII, page 724.

The pending nominations 864, 867 to 870 were balloted for, and, after scrutiny of the ballot boxes by the presiding officer, the following were declared duly elected members of the Society:—

Dr. Albert H. Smith, of Philadelphia.

Rev. Saml. Longfellow, of Germantown.

Rev. Ed. A. Foggo, D. D., of Philadelphia.

M. A. Descloizeaux, of Paris.

Dr. C. Schorlemmer, of Manchester, England.

and the meeting was adjourned.

The Limiting Constant of Gravitation. *By Pliny E. Chase.*

(Read before the American Philosophical Society, October 18, 1878.)

Newton and Lesage both thought that gravitation might be due to some action of an æther or "æthereal spirit." If such supposed action is uniform it should be capable of representation by some uniform or constant value. toward which planetary or gravitating motion should constantly tend.

Faraday sought in vain to find such a value, and his want of success led him to the belief that the "correlation of forces" could not include the force of gravity. It is true that a kind of constancy is observable in bodies at rest, and another kind in circular orbits; but if the distance from the principal center is changed, the former varies inversely as the square of the distance, the latter inversely as the square root of the distance. Inasmuch as there is no known limit of possible density, there is no obvious limit to the possible velocity of gravitating motion.

My various investigations have shown that heat, actinism, kinetic laws, spectral lines, the arrangement and masses of planets, interstellar nodes, barometric fluctuations, centers of inertia, terrestrial magnetism, chemical combinations, and the aggregation or dissociation of stellar systems, all point to the velocity of light as a limiting constant. Weber, Kohlrausch and Maxwell having found a like pointing, in the relations which exist between electro-static and electro-dynamic phenomena, it seems probable that the goal of Faraday's search may also have been the velocity of light, and that such velocity is the fundamental basis of universal correlation.

I have already pointed out three methods of approximation to the limit: 1, by the tendency towards equality in planetary revolution and in the mean moment of solar inertia of rotation; 2, by the tendency to equality between mean radial oscillatory velocity and the velocity which marks the limit between complete solar dissociation and incipient nucleal aggregation; 3, by the tendency to uniformity in dissociative velocity at each of the three principal centres of nebular condensation in the solar system.

Against the first of these methods the objection has been urged that it supposes the sun to be homogeneous. The validity of this criticism cannot be determined until the problem has been subjected to a rigid mathematical analysis. If such analysis should hereafter show that the objection is well taken, it may be found that the sun is more homogeneous than the dense planets, and sufficiently so to satisfy all the requirements of the method. Draper's recent photograph of the corona indicates a diameter twice as great as that of the sun. This is in exact accordance with the supposed gaseous nature of the sun, and, consequently, with its homogeneity, as well as with the relations which I have pointed out between Jupiter's mass and position.

Some have thought the second method faulty, because it involves a consideration of hypothetical conditions of nebular condensation, such as are inconsistent with the common notions of the nature of matter. But those conditions were introduced merely to indicate joint tendencies, without any regard to the variety of possible or impossible forms which the tendencies may be supposed to assume or to indicate. In all mathematical physics an ideal completeness is assumed, such as is never found in nature. The method in question is analogous to the one which has been satisfactorily adopted in investigating the laws of elastic undulation.

It seems to have been generally admitted that the third method may be accepted as lending probability to the indications of the other two, but it involves the same question of dissociative velocity, and is, therefore, open to the same criticism as the second method. For this reason it seems desirable to see whether the problem can be successfully treated in some other way.

If gravitating movements have any common limit, either of originating efficiency or of ultimate tendency, which is uniform in all stellar systems, that limit should evidently be sought in the direction of phenomenal maxima, and with special reference to the principal center of the system. If the æthereal hypotheses are correct, we may reasonably presume that the gravitating constant is dependent upon some æthereal constant.

La Place established the general principle that the state of a system of bodies becomes periodic when the effort of the primitive conditions of movement has disappeared by the action of resistances. This principle, which is a necessary consequence of the third law of motion, is well illustrated in elliptical planetary orbits, in which the cyclical movement may be resolved into alternate oscillations, of approach to perihelion and retreat to aphelion. The duration of all such oscillations, whether circular, slightly elliptical, or as nearly radial and rectilinear as the central nucleus will allow, is determined by the length of the major axis, varying as the $\frac{3}{2}$ power of the length. If the major axes are equal, the oscillations are synchronous.

If orbital collisions of particles, in the neighborhood of the focus, shorten the major axes, cosmical rotation may be substituted for free planetary revolution. But the limiting value, which is to be alternately overcome and renewed, will not be changed thereby; the period for destroying or acquiring that limiting value should still be one-half of the cyclical period, or the period of a half rotation.

The equation of constant velocity, in an elastic atmosphere or in an æthereal medium, is

$$v = \sqrt{gh} = gt,$$

v denoting the wave-velocity; g, the acceleration of gravity at the point of observation; h, the modulus of elasticity, or the height of a homogeneous atmosphere; t, the time of rise or fall, through $\frac{1}{2}\,h$, under the constant retardation or acceleration g; t is also, as has just been shown, the time of a half-rotation which is supposed to be due to æthereal impulses. Challis has found* that if all the ordinary central forces are due to transformed æthereal vibrations, "the actions of such forces on atoms are in every instance attributable to *æthereal currents*, whether the atoms be *immediately* acted upon by steady motions of the æther or by æthereal vibration."

* Phil. Mag., Sept., 1872; Sept., 1876; June, 187 .

The constancy of wave-velocity requires that h and t should vary inversely as g. The law of conservation of areas demands the same ratios of variability in the rotation of any contracting or expanding nebular nucleus; for, the velocity of rotation varying inversely as radius, and the distance traversed varying as radius, the time of rotation (or t, the time of semi-rotation) varies as the square of radius; but g varies inversely as the square of radius, $\therefore gt \propto \frac{1}{r^2} \times r^2$, and is constant for all possible stages of nebular condensation. The record of rotation is, therefore, invariable, representing the undulatory velocity of the æthereal medium, as well as the constant limiting velocity of gravitating tendency for which Faraday sought.

The value of g being a maximum, in our system, at Sun's surface, there is where the limiting value of gt is to be found. If we estimate Sun's semi diameter* at 16′ 2″, Earth's mean radius vector is 214.41 solar radii. Laugier's mean estimate of t (the time of Sun's semi-rotation) is 12.67 days, or 1093872 seconds; $\sqrt{gr} = (214.41^{\frac{3}{2}} \times 2\pi r) \div (365.256 \times 86400)$. $\therefore g = r \div 2559500$. and $gt = r \div 2.340$. But the velocity of light, according to Struve's constant of aberration, is $214.41\, r \div 497.825 = r \div 2.322$.† This investigation, therefore, leads to the same result as those which I have before undertaken, and gives *the velocity of light* as the limiting constant of gravitation.

Stated Meeting, November 1, 1878.

Present, 20 members.

Vice-President, Mr. Fraley, in the Chair.

Mr. J. B. Knight, Prof. L. Haupt, and Dr. Morris Longstreth, newly elected members, were introduced to the presiding officer and took their seats.

Letters accepting membership were received from Dr. Albert H. Smith, dated 1419 Walnut St., Phila., Oct. 20, 1878; Rev. Edward A. Foggo, D. D., 717 Locust St., Phila., Oct. 28, 1878; Rev. Samuel Longfellow, Germantown, Oct. 24; and Dr. A. S. Packard, Jr., Brown University, Providence, R. I., Oct. 18, 1878.

Letters of acknowledgment were received from the Observatory at Prag, Nov. 6, 1877 (99,100, List); the Royal Danish Academy, Sept. 30, 1878 (100, List); the Royal

* Amer. Nautical Almanac.

† This is equivalent to Faye's value of gt for lat. 16° 59′, or Carrington's for lat. 11° 16′.

Institution, London, Oct. 15, (101, Cat. III); the Royal Astronomical Society, Oct. 18, (101, Cat. III); the Society of Antiquaries, London, Oct. 14, (101, Cat. III); and the Boston Public Library, Oct. 17, (Cat. I, II, III).

Letters of envoy were received from Sir Lewis Mallet, India Office, Oct. 11, 1878; Physical Society of Bordeaux, Oct. 15 (acknowledging also the receipt of Proc. 95, 96, 98, 99); Meteorological Office, London, Oct., 1878; and Mr. E. Steiger, 25 Park Place, New York, Oct. 23, 1878.

Donations for the Library were received from the Academies at St. Petersburg, Copenhagen, and Brussels; the Société Vaudoise; Geographical Society, School of Mines, and Revue Politique, Paris; Commercial Geographical Society at Bordeaux; Observatory at San Fernando; Harvard College Library, and Museum of Comparative Zoology, Cambridge; E. Steiger; Entomological Society of Brooklyn; Engineers Club, and Historical Society, Phila.; Museum of Wesleyan University, Middletown, Conn.; Public School Library, St. Louis; and the Argentine Society of Sciences at Buenos Ayres.

Prof. Chase read a "Note on the density of the Kinetic Ether."

Prof. Sadtler read a paper "On the Electrolytic Estimation of Cadmium, by Edgar F. Smith, Ph.D." as a contribution from the Laboratory of the University of Pennsylvania.

Prof. Sadtler presented to the Society a chemical preparation obtained by a new and interesting reaction from Pennsylvania petroleum.

The presence of *Olefines* or unsaturated hydrocarbons in Petroleum has been proved by Prof. Schorlemmer, who obtained bromides of these hydrocarbons by the action of bromine upon the several fractions of petroleum. This reaction has only proved the presence of the lower boiling members of the series however. I had given to me by Dr. C. M. Cresson a thick viscid liquid said to be mainly made up of higher olefines. Now the following reactions have been carried out with Ethene C_2H_4—

$$C_2H_4 + ClOH \quad C_2H_4\begin{cases} OH. \\ Cl. \end{cases}$$

$$C_2H_4\begin{cases} OH \\ Cl \end{cases} + O_2 = \begin{matrix} CH_2Cl \\ CO.OH \end{matrix} + H_2O$$

I endeavored to apply these reactions to the mixture of higher olefines and succeeded perfectly. In oxydising I used the "chromic acid" mixture, and after obtaining the chlorine-substitution acids I saponified them with caustic soda. The preparation shown is, therefore, a mixture of soda salts of these chlorine-substitution compounds of the higher fatty acids As these compounds cannot be made by such reaction from the higher "paraffins," their formation proves conclusively the presence of the higher "olefines."

Prof. Houston read a joint paper entitled "On the circumstances influencing the efficiency of Dynamo-electric machines, by Prof. Houston and Prof. Thompson.

Prof. Haupt read a paper entitled "On the scales of Maps" with tables.

Pending nomination No. 871 was read.

Prof. Houston's resolutions, offered October 4, were called up for consideration, and after a discussion of the subject by Prof. Barker, Prof. Houston, Prof. Thompson, Dr. König, and other members present, it was

Resolved, That the fourth and fifth paragraphs of page 728 of No. 101 of the Proceedings, being portions of the minutes of the meeting of June 21st, 1878, be corrected to read as follows:

"Prof. Houston exhibited a microphone relay invented and made by himself and Prof. Thompson of the Philadelphia High School, to be applied to the articulating telephone."

"Prof. Barker exhibited a suite of Mr. Edison's instruments invented and made by him during the last year or two, and stated that, in his opinion, in their inventions so far as they involve similarity of principle, Mr. Edison had priority over Mr. Hughes."

It was then, on motion of Dr. LeConte, resolved that the Index on page 730 be corrected accordingly.

Prof. Sadtler referred to the reading of a letter from Prof. Morton to the Secretaries, at the last meeting, and said that he had already himself made due acknowledgment to Prof. Morton before the Society at the meeting of August 16th, 1878, as the minutes show.

And the meeting was adjourned.

Contributions from the Laboratory of the University of Pennsylvania, No. XVI.—On the Electrolytic Estimation of Cadmium.

By Edgar F. Smith, Ph. D.

(*Read at the meeting of the American Philosophical Society, Nov. 1, 1878.*)

In a recent article published in the *American Journal of Science and Arts* (Vol. XVI., Sept., 1878), Prof. F. W. Clarke calls attention to the estimation of cadmium by electrolysis, which, however, proved unsuccessful—the cadmium being indeed thrown out of the solution but in such a form as to enclose impurities; yielding consequently unsatisfactory results.

Out of curiosity, to see what might be effected by substituting some other salt for the chloride, I employed an acetate solution and met with success, as the following experiments will show :

I. .1450 grms. cadmium oxide were dissolved in acetic acid, the excess of the latter expelled upon a water bath and the platinum crucible then about half filled with water, and placed upon a copper ring connected with the negative pole of a two-cell Bunsen battery, while joined to the wire leading from the positive pole was a strip of platinum foil extending into the acetate solution. The deposition of the cadmium upon the sides of the platinum crucible was regular and in a perfectly crystalline grayish white layer. In about three hours the separation was complete. The cadmium was first washed with distilled water, then with alcohol and finally with ether. It was dried over sulphuric acid. The metallic cadmium weighed .1270 grms. corresponding to 87.58 % Cd. The calculated percentage of metal in the oxide is 87.50.

II. .2046 grms. cadmium oxide placed in a small broad platinum crucible were dissolved in acetic acid and after evaporating the excess of the latter water was added—the solution, however, remaining rather concentrated. The platinum vessel was connected with the negative pole of a bichromate battery. To the copper wire of the positive pole was attached a platinum wire from which was suspended a small platinum crucible, which dipped into the solution in the larger vessel. The space between the walls of the two crucibles was not more than the eighth of an inch. Only two cells of the battery were employed. The deposit of cadmium here as in the first experiment was perfectly crystalline and metallic in appearance. Not the slightest trace of spongy metal was visible. The separation of the metal was finished in about the same time as in (I), and it was then washed and dried as above. Found .1790 grms. metal—corresponding to 87.48 % Cd.

From the various experiments made I have discovered that to obtain good results the following should be observed : 1st. Work with rather concentrated solutions of the acetate. 2d. Employ a sufficient number of cells of either battery to produce a rapid and rather energetic current.

October 31, 1878.

On the Scales of Maps. By *L. M. Haupt, Prof. of Civil Engineering Towne Scientific School.*

(*Read before the American Philosophical Society, Nov.* 1, 1878.)

The object of this paper is to attempt if possible the removal of the ambiguities existing in regard to the use of ratios as expressing the scales of maps and degrees of slopes.

Mathematical authorities are by no means agreed concerning the definition of the term ratio. They all maintain that it is an expression for the relation existing between two quantities, but differ in the manner of determining the value of this relation ; some, as Peck, Davies, Robinson and others, divide the second quantity or consequent by the first or antecedent ; some, as Hutton, Alsop, Ray and others, divide the first by the second quantity, and still a third class, as Chauvenet and others, define it as being the quotient obtained by dividing one quantity by another. It may therefore be either $\frac{a}{b}$ or $\frac{b}{a}$, 2,000,000, or $\frac{1}{2000000}$.

The same confusion is found to exist in designating the scales of maps and drawings. Some publishers and engineers giving it as so many miles, or other denomination, to the inch ; others, as so many inches to the mile. Again in expressing slopes many authorities use the tang. of the angle made with the horizon, that is the height divided by the base ($\frac{a}{b}$) while others use the co-tang. or $\frac{b}{a}$.

Now if we consider the manner of obtaining the value of the ratio in a Geometrical Series or progression where *no* ambiguity exists, we find that as each subsequent term is obtained from its predecessor by multiplying by a constant factor called the ratio, so to obtain this factor or ratio we must necessarily divide any term by the *preceding* one, and as this is the only way in which its value can be determined, it establishes a rule which should be made to apply to all other cases.

We should then define a *ratio as being the expression for the value of the relation existing between two quantities*, and as *obtained by dividing the* SECOND *by the* FIRST.

The query then arises as to which quantity should be considered the first and which the second, and we answer that the *given material object* to be represented by the map or drawing is the *Unit or measure* with which the other is to be compared. The map or drawing may be made of any convenient size, but the object to be represented is already fixed or constant in its dimensions, and hence, as the unit or standard of comparison, should be made the *divisor*, or denominator of the quantity expressing the ratio : it is consequently the antecedent or first quantity. To illustrate, let it be required to determine the ratio between a map and its original in nature.

The tract to be delineated in miniature is the fixed object, invariable in size, which is to be compared with the plot representing it, and which may be made larger or smaller according to circumstances, hence it become the unit of comparison, and is the antecedent or first quantity, and as such the denominator of the fraction expressing the ratio. The formula will then be:

Field : Plot $= \frac{F}{P}$. P and F being always reduced to the same denomination.

Thus a scale of $\frac{1}{5280}$ is 5280 ft. of field to 1′ of map or one mile to 1 ft. $= \frac{1}{12}$ of a mile to 1″, and not 12″ to 1 mile

It is evidently *incorrect* therefore to indicate the scales of maps as so many inches to a mile as is frequently done. Take the case of the recent Geological maps of one of our sister states said to be plotted on a scale of 3″ to 1 m. or 3″ to 63,360″ $= \frac{63360}{3} =$ 21,120 that is to say the map is 21,120 times larger than the state itself, a manifest absurdity resulting from considering the *map* as the first quantity or standard rather than the field itself.

In such cases errors of interpretation can scarcely arise as the intention is so evident, but there are numerous others that may lead to misconstruction, as where the drawings of small objects are nearly of the same size as the things represented—thus a scale of $\frac{1}{2}$″ to 1″ would confuse a mechanic unless he happened to know which was the larger, the object or the drawing.

So the expression $\frac{1}{4}$″ to 1′ is likewise incorrect as it is the reciprocal of the ratio intended—the inches evidently referring to the drawing and the foot to the object. As it stands, applying the definition of ratio as deduced, it will be equal to $12 : \frac{1}{4} = 48$, making the drawing 48 times the size of the model—it should be 1′ to $\frac{1}{4}$″.

If it be remembered that *the antecedent always refers to the given object* and *the consequent to the drawing*, no difficulty can arise. It will always happen then that if the drawing is on a smaller scale than the thing delineated, the ratio will be a *proper* fraction ; if larger, an improper fraction, and if equal the value will be unity, or $\frac{1}{1}$.

It is hardly necessary to call attention to the fact that the number of scales in use is practically infinite, and that serious inconvenience results therefrom to Engineers and Surveyors whose work extends over several counties or states, making it frequently necessary to re-draw large sections of country. In compiling atlases it is the practice of publishers to vary the scales according to the amount of territory to be represented that the sheet may be filled up, but nothing is gained thereby since the scale used for the greatest area to be represented will show with equal clearness all the features of any other area. Moreover the eye becomes accustomed to estimating distances on the maps, with sufficient accuracy for a reconnaissance, when the scale is uniform, but when variable it leads to great confusion, and especially when the publisher has neglected to indicate the scale, as sometimes happens.

It is very desirable to establish, if possible either by recommendations of scientific societies or by general laws, some conventional scales for maps of various sizes. Taking a state of medium area as N. Y. or Penna. for the unit, and reducing it to a convenient size sheet of paper, say 4 × 3 ft., would require a scale of $\frac{1}{400000}$, the same as is used by the U. S. Coast Survey for general charts and reconnaisance, but too small for most other purposes. Larger states could be plotted on the same scale by dissecting them. Foreign countries conducting Geodetic Surveys have adopted such a system. In Prussia, Austria and Switzerland the plane table sheet are plotted on a scale of $\frac{1}{25000}$. In Italy the field work is plotted on a scale of $\frac{1}{50000}$, and in Sweden $\frac{1}{100000}$. The older British charts and maps were made on a scale of 1 m. to 1″ or $\frac{1}{63360}$, and the later maps of 1 m. to 6″ or $\frac{1}{10560}$, but these latter, while not being large enough to show parish boundaries with sufficient accuracy, require about six times the amount of labor in their preparation and are inconvenient. The scale used by Prussia and Switzerland for general maps is $\frac{1}{100000}$, or one fourth that of the detail sheets obtained from the plane table surveys.

Populous, cultivated and mineral districts in Great Britain are plotted on a scale of $\frac{1}{2500}$ = 1 m. to 25.344″, partially cultivated and thinly settled districts, on a scale of 1 m. to 6″ = $\frac{1}{10560}$. For the plans of cities of over 4000 inhabitants a scale of $\frac{1}{500}$ or 1 m. to 10.56 feet is used, and for towns and villages $\frac{1}{1056}$ or 1 m. to 5 ft. is general.

Numerous other instances might be cited showing the great variety of scales in use, but these will suffice. It is evident that in Government or State Surveys some systematic connection may readily be established between the several scales used, and it is very desirable that this uniformity of scale be made more general. The scale adopted should be just large enough to show clearly all necessary detail. Anything more than this is a wasteful expenditure of time and money.

For general maps of States showing intercommunications, a scale of $\frac{1}{100000}$ will be found sufficiently large.

For maps of counties, *in toto*, a scale of $\frac{1}{50000}$ will enable all necessary features to be clearly represented; this scale applied to Lycoming Co., the largest in Penna., would require a map $6\frac{1}{2} \times 4\frac{1}{6}$ ft. For townships the scale of $\frac{1}{25000}$ is quite large enough, and furnishes an admirable size for the projection of Geological data.

For cities, towns and villages some decimal, sub-multiples of the above scales should be used.

Cadastral maps of farms, parks or estates may be plotted on scales of $\frac{1}{250}$, $\frac{1}{500}$, $\frac{1}{1000}$, etc.

In indicating the degrees of slopes or the bater of retaining walls, the natural tangent of the angle which the slope makes with the horizon should invariably be used.

To save time in determining the relative values of some of the most important scales in use, and to aid in introducing the metric system of lengths. I have with the assistance of Messrs. Wm. M. Potts and J. W. Van Osten, Jr., prepared the accompanying tables of equivalents. The first, gives the number of Miles, Kilometers, Poles, Chains, Yards, Meters and Feet of territory which are equivalent to one inch of map for any given scale. The second, is the reciprocal of the first, and states the amount of map surface which would be covered by any one or more of the above units, for any scale.

Table of Map Equivalents giving for each

No.	Scale.	Miles.	Kilometers.	Chains.	Poles.
1	$\frac{1}{7,349,760}$	116.	186.6821	9280.0000	37120.0000
2	$\frac{1}{2,090,880}$	33.	53.1078	2640.000	10560.00
3	$\frac{1}{1,267,200}$	20.	32.18663	1600.000	6400 00
4	$\frac{1}{1,200,000}$	18.9393	30.4791	1515.15	6060.60
5	$\frac{1}{1,013,760}$	16.	25.7492	1280.00	5120.00
6	$\frac{1}{1,000,000}$	15.7828	25.3992	1261.62	5046.50
7	$\frac{1}{811,008}$	12.8000	20.5994	1024.00	4096.00
8	$\frac{1}{760,320}$	12.	19.3129	960.00	3840.00
9	$\frac{1}{635,000}$	10.0221	16.1286	801.768	3207.07
10	$\frac{1}{633,600}$	10.	16.09329	800.00	3200.00
11	$\frac{1}{600,000}$	9.4696	15.2398	757.575	3030.30
12	$\frac{1}{506,880}$	8.	12.87456	640.00	2560.00
13	$\frac{1}{500,000}$	7.8914	12.6996	631.313	2525.25
14	$\frac{1}{400,000}$	6.3131	10.1597	505.050	2020.20
15	$\frac{1}{380,160}$	6.	9.65587	480.00	1920.00
16	$\frac{1}{375,000}$	5.9185	9.5239	473.48	1893.92
17	$\frac{1}{316,800}$	5.	8.04664	400.00	1600.00
18	$\frac{1}{300,000}$	4.7348	7.61992	378.78	1515.15
19	$\frac{1}{240,000}$	3.7878	6.09570	303.03	1212.12
20	$\frac{1}{200,000}$	3.15656	5.07985	252.525	1010.10
21	$\frac{1}{190,080}$	3.	4.827935	240.00	960.00
22	$\frac{1}{160,000}$	2.5252	4.0638	202.02	808.08
23	$\frac{1}{150,000}$	2.36742	3.80496	189.39	757.57
24	$\frac{1}{126,728}$	2.	3.21866	160.00	640.0
25	$\frac{1}{120,000}$	1.89393	3.05784	151.515	606.06
26	$\frac{1}{100,000}$	1.57828	2.53995	126.26	505.05
27	$\frac{1}{80,000}$	1.2626	2.0319	101.01	404.04
28	$\frac{1}{79,200}$	1.2500	2.01166	100.00	400.00
29	$\frac{1}{76,800}$	1.21212	1.9604	96.967	387.87
30	$\frac{1}{63,360}$	1.	1.6093	80.00	320.00
31	$\frac{1}{60,000}$	0.94696	1.52392	75.75	303.03
32	$\frac{1}{59,400}$	0.9375	1.508737	75.00	300.0
33	$\frac{1}{50,000}$	0.78914	1.26996	63.131	252.52
34	$\frac{1}{40,000}$	0.63131	1.0159	50.50	202.02
35	$\frac{1}{39,600}$	0.6250	1.0058	50.0	200.0
36	$\frac{1}{39,370}$	0.62138	1.	49.7104	198.88
37	$\frac{1}{38,400}$	0.6060	0.9752	48.484	193.93
38	$\frac{1}{38,016}$	0.6000	0.9656	47.925	191.70
39	$\frac{1}{33,792}$	0.5353	0.86146	42.666	170.66
40	$\frac{1}{30,000}$	0.47348	0.7619	37.8787	151.48
41	$\frac{1}{25,344}$	0.4000	0.64373	32.000	128.000
42	$\frac{1}{25,000}$	0.39457	0.63967	31.5656	126.262
43	$\frac{1}{23,760}$	0.37500	0.60349	30.	120.000
44	$\frac{1}{21,120}$	0.33333	0.53589	26.666	106.666
45	$\frac{1}{20,000}$	0.31565	0.50798	25.2525	101.0101
46	$\frac{1}{19,800}$	0.31250	0.50290	25.	100.
47	$\frac{1}{19,200}$	0.30303	0.48762	24.242	96.969

lineal inch of Map, the following number of

No.	Metres,	Yards and Feet	of Actual Distance.	Where Used.
1	186682.18	204160.00	612480.00	Map of U. S. in atlas.
2	53107.86	58080.00	174240.00	Map of Pa.
3	32186.635	35200.00	105600.00	U. S. C. S.
4	30479.7	33333.33	100000.0	U. S. C. S.
5	25749.27	28160.0	84480.0	△ India.
6	25399.2	27755.77	83333.3	U. S. C. S.
7	20599.416	22528.00	67584.00	
8	19312.95	21120.00	63360.00	R. R. Va.
9	16128.6	17638.89	52916.66	U. S. C. S.
10	16093.29	17600.00	52800.00	U. S. Eng.
11	15239.8	16666.6	50000.0	U. S. C. S.
12	12874.65	14080.0	42240.0	Eng. Ord. Sur.
13	12699.6	13888.8	41666.6	U. S. C. S.
14	10159.7	11111.1	33333.3	U. S. C. S.
15	9655.87	10560.0	31680.0	Ludlow's Rep.
16	9523.9	10416.5	31250.0	U. S. C. S.
17	8046.64	8800.00	26400.0	Barnes' Pa. Maps, 1851.
18	7619.9	8344.3	25000.0	U. S. C. S.
19	6095.7	6666.6	20000.0	U. S. C. S.
20	5079.8	5555.5	16666.6	U. S. C. S.
21	4827.935	5280.0	15840.0	Ludlow's Rep.
22	4063.8	4444.4	13333.3	U. S. C. S.
23	3804.9	4166.6	12500.0	U. S. C. S.
24	3218.66	3520.0	10560.0	Sherman's March.
25	3057.8	3333.3	10000.0	U. S. C. S.
26	2539.9	2777.7	8333.3	U. S. C. S.
27	2031.9	2222.2	6666.6	U. S. C. S.
28	2011.7	2200.0	6600.0	
29	1960.5	2133.33	6400.0	Geol. Sur.
30	1609.3	1760.0	5280.0	Fremont.
31	1523.9	1666.6	5000.0	U. S. C. S.
32	1508.73	1650.0	4950.0	
33	1269.9	1388.8	4166.6	U. S. C. S.
34	1015.9	1111.1	3333.3	U. S. C. S.
35	1005.83	1100.0	3300.0	U. S. C. S.
36	1000.0	1093.6	3280.8	
37	975.24	1066.66	3200.0	Geol. Surv.
38	965.59	1054.33	3163.0	
39	861.458	938.66	2816.0	
40	761.9	833 3	2500.0	U. S. C. S.
41	643.728	704.000	2112.000	
42	639.673	694.44	2083.333	
43	603.487	660.00	1980.000	
44	535.8969	586.66	1760.000	
45	507.98	555.5	1666.66	
46	502.906	550.00	1650.00	U. S. C. S.
47	487.617	533.333	1600.00	

Table of Map Equivalents giving for each

No.	Scale.	Miles,	Kilometers,	Chains,	Poles,
48	$\frac{1}{18,818}$	0.29700	0.47796	23.760	95.04
49	$\frac{1}{15,840}$	0.25000	0.40232	20.	80.
50	$\frac{1}{15,000}$	0.23674	0.38099	18.9393	75.75
51	$\frac{1}{11,880}$	0.18750	0.30174	15.	60.
52	$\frac{1}{10,000}$	0.1578	0.25417	12.626	50.505
53	$\frac{1}{9,900}$	0.15625	0.25100	12.500	50.000
54	$\frac{1}{9,600}$	0.15151	0.24376	12.121	48.484
55	$\frac{1}{7,920}$	0.12500	0.20112	10.	40.000
56	$\frac{1}{7,200}$	0.1136	0.18378	9.0909	36.363
57	$\frac{1}{6,000}$	0.09471	0.15285	7.5757	30.303
58	$\frac{1}{5,940}$	0.09275	0.15092	7.5000	30.000
59	$\frac{1}{5,000}$	0.078913	0.12695	6.31313	25.252
60	$\frac{1}{4,950}$	0.078123	0.12582	6.250	25.000
61	$\frac{1}{4,800}$	0.07575	0.121881	6.0606	24.242
62	$\frac{1}{3,960}$	0.06250	0.100561	5.	20.000
63	$\frac{1}{3,600}$	0.05681	0.091391	4.5303	18.1212
64	$\frac{1}{3,333}$	0.05261	0.08463	4.2060	16.8242
65	$\frac{1}{3,168}$	0.05	0.080466	4.	16.000
66	$\frac{1}{3,000}$	0.04734	0.07610	3.7787	15.151
67	$\frac{1}{2,970}$	0.04687	0.07541	3.75	15 000
68	$\frac{1}{2,500}$	0.03945	0.06396	3.1565	12.626
69	$\frac{1}{2,400}$	0.03787	0.06098	3.0379	12.1515
70	$\frac{1}{1,980}$	0.03125	0.05029	2.5	10.000
71	$\frac{1}{1,280}$	0.02020	0.032507	1.6016	6.406
72	$\frac{1}{1,250}$	0.019728	0.031697	1.5767	6.307
73	$\frac{1}{1,200}$	0.018939	0.030578	1.5151	6.060
74	$\frac{1}{1,080}$	0.017046	0.027520	1.3636	5.454
75	$\frac{1}{960}$	0.01515	0.024376	1.2121	4.848
76	$\frac{1}{840}$	0.013258	0.021399	1.06057	4.2420
77	$\frac{1}{792}$	0.0125	0.02011	1.	4.
78	$\frac{1}{720}$	0.01136	0.018378	0.9091	3.6363
79	$\frac{1}{600}$	0.009471	0.015285	0.75757	3 0303
80	$\frac{1}{500}$	0.0078913	0.012695	0.63131	2.5252
81	$\frac{1}{480}$	0 007575	0.012188	0.60606	2 4242
82	$\frac{1}{360}$	0.00568	0.009139	0.45303	1.81212
83	$\frac{1}{300}$	0.004734	0.007610	0.37787	1.51515
84	$\frac{1}{240}$	0.003787	0.006098	0.30379	1.21515
85	$\frac{1}{198}$	0.003125	0.005029	0.25	1.
86	$\frac{1}{120}$	0.001894	0.003057	0.15151	0.6060
87	$\frac{1}{60}$	0.000947	0.001528	0.07575	0.3030
88	$\frac{1}{39.37043}$	0.0006213	0.001	0.0497101	0.1988405
89	$\frac{1}{36}$	0.000568	0.0009139	0.045303	0.181212
90	$\frac{1}{12}$	0.0001894	0.0003057	0.015151	0.0606
91	$\frac{1}{1}$	0.00001578	0.00002536	0.0012595	0.00505
92	$\frac{4}{3}$	0.000011835	0.0000190	0.0009467	0.003787
93	$\frac{2}{1}$	0.00000789	0.00001268	0.0006297	0.002525

lineal inch of Map, the following number of

No.	Metres.	Yards and Feet { of Actual Distance.		Where Used.
48	477.96	522.72	1568.1	U. S. C. S.
49	402.325	440.00	1320.00	
50	380.99	416.66	1250.00	U. S. C. S.
51	301.744	330.00	990.00	
52	254.177	277.77	833.33	U. S. C. S.
53	251.004	275.000	825.00	
54	243.763	266.66	800.	
55	201.125	220.00	660.	
56	183.782	200.	600.	
57	152.854	166.66	500.	
58	150.924	165.00	495.	
59	126.950	138.888	416.66	U. S. C. S.
60	125.8238	134.166	412.50	
61	121.88175	133.333	400.	
62	100.5625	110.0	330.	
63	91.391	100.	300.00	
64	84.6334	92.592	277.777	U. S. C. S.
65	80.0466	88.	264.	
66	76.1057	83.333	250.00	
67	75.4138	82.5	247.5	
68	63.9673	69.444	208.33	U. S. C. S.
69	60.9811	66.666	200.	U. S. C. S.
70	50.2906	55.55	166.66	
71	32.5079	35.555	106.66	U. S. C. S.
72	31.6973	34.7222	104.166	U. S. C. S.
73	30.578	33.3333	100.	U. S. C. S.
74	27.520	30.	90.	
75	24.3763	26.666	80.	
76	21.4046	23.3333	70.	
77	20.1125	22.	66.	
78	18.3782	20.	60.	
79	15.2854	16.666	50.	
80	12.695	13.8888	41.666	U. S. C. S.
81	12.18817	13.3333	40.	
82	9.1391	10.	30.	
83	7.61057	8.3333	25.	
84	6.09811	6.6666	20.	
85	5.02906	5.555	16.666	
86	3.0578	3.3333	10.	U. S. C. S.
87	1.52854	1.6666	5.	
88	1.	1.093623	3.280869	
89	0.91391	1.	3.	
90	0.30578	0.3333	1.	
91	0.025368	0.02777	0.083	
92	0.019026	0.020833	0.0625	
93	0.012684	0.013888	0.0415	

A Reciprocal Table of Map Equivalents showing the number of inches of

No.	Scale.	1 Mile.	1 Kilometer.	1 Chain.	1 Pole.
1	$\frac{1}{7,349,760}$	0.0086205	0.005359	0.00010775	0.00002693
2	$\frac{1}{2,090,880}$	.03030	.01882	.000378	.0000945
3	$\frac{1}{1,267,200}$	.05000	.03106	.000625	.00015625
4	$\frac{1}{1,200,000}$	.05280	.03280	.000660	.0001650
5	$\frac{1}{1,013,760}$	.06250	.03883	.000781	.00019525
6	$\frac{1}{1,000,000}$	.06336	.03937	.000792	.00019800
7	$\frac{1}{811,008}$	.078125	.04854	.0009765	.0002441
8	$\frac{1}{760,320}$	.08333+	.05177	.001041	.00026025
9	$\frac{1}{635,000}$	.09979	.06199	.001247	.00031175
10	$\frac{1}{633,600}$	.10000	.06213	.001250	.0003125
11	$\frac{1}{600,000}$	.10560	.06561	.00132	.0003300
12	$\frac{1}{506,880}$	.12500	.07766	.001562	.0003905
13	$\frac{1}{500,000}$	.12672	.07874	.001584	.0003960
14	$\frac{1}{400,000}$	.15840	.09842	.00198	.0004950
15	$\frac{1}{380,160}$	.16666+	.10355	.002083	.00052075
16	$\frac{1}{375,000}$	.16896	.10498	.002112	.00052800
17	$\frac{1}{316,800}$	.20000	.12426	.00250	.0006250
18	$\frac{1}{300,000}$	.21120	.13122	.00264	.0006600
19	$\frac{1}{240,000}$	.26400	.16403	.003300	.008250
20	$\frac{1}{200,000}$	.31680	.19684	.003960	.0009900
21	$\frac{1}{190,080}$	.33333+	.20711	.004166	.0010415
22	$\frac{1}{160,000}$	.39600	.24605	.004950	.0012325
23	$\frac{1}{150,000}$	.42240	.26245	.005280	.0013200
24	$\frac{1}{126,720}$	.50000	.31067	.006250	.0015625
25	$\frac{1}{120,000}$	.52800	.32807	.006600	.0016500
26	$\frac{1}{100,000}$	.63360	.39368	.00792	.0019800
27	$\frac{1}{80,000}$	.79200	.49210	.009900	.0024750
28	$\frac{1}{79,200}$	.8	.497101	.01	.0025
29	$\frac{1}{76,800}$	.82500	.51261	.010312	.0025780
30	$\frac{1}{63,360}$	1.00000	.62130	.012500	.0031250
31	$\frac{1}{60,000}$	1.05600	.65614	.013200	.003300
32	$\frac{1}{59,400}$	1.066666	.662801	.013333	.00333
33	$\frac{1}{50,000}$	1.26720	.78737	.01585	.0039625
34	$\frac{1}{40,000}$	1.58400	.98421	.019800	.004950
35	$\frac{1}{39,600}$	1.6	.994202	.02	.00500
36	$\frac{1}{39,369}$	1.60934	1.00000	.020116	.0050290
37	$\frac{1}{38,400}$	1.65000	1.02522	.020622	.00515550
38	$\frac{1}{38,016}$	1.66666	1.03509	.0208333	.0052083
39	$\frac{1}{33,792}$	1.875000	1.16537	.023437	.005859
40	$\frac{1}{30,000}$	2.11200	1.31228	.026400	.0066000
41	$\frac{1}{25,344}$	2.50000	1.55334	.031250	.0078125
42	$\frac{1}{25,000}$	2.53440	1.57474	.031680	.0079200
43	$\frac{1}{23,760}$	2.66666+	1.65692	.03333+	.008333+
44	$\frac{1}{21,120}$	3.00000	1.86403	.037500	.0093750
45	$\frac{1}{20,000}$	3.16800	1.96842	.03960	.009900
46	$\frac{1}{19,800}$	3.2	1.988404	.04	.010
47	$\frac{1}{19,200}$	3.30000	2.05044	.04125	.0103125

Map and parts thereof, of the various scales now in use, which represent

No.	1 Metre.	1 Yard.	1 Foot.	Where Used.
1	.000005359	.00000489	.00000163	[(Military.)
2	.00001882	.0000172	.00000573+	Sherman's March Map.
3	.00003106	.0000284	.00000946+	" "
4	.00003280	.0000300	.00001000	U. S. C. S.
5	.00003883	.0000355	.00001183+	△ India.
6	.00003937	.00003600	.00001200	U. S. C. S.
7	.00004854	.00004438	.00001446	
8	.00005177	.0000473	.00001576+	R. R. Virginia.
9	.00006199	.0000566	.00001553+	U. S. C. S.
10	.00006213	.0000568	.000015600	U. S. Eng's.
11	.00006561	.0000600	.0000200	U. S. C. S.
12	.00007766	.0000710	.0000236+	Eng. Ord. Sur.
13	.00007874	.0000720	.0000240	U. S. C. S.
14	.00009842	.0000900	.0000300	U. S. C. S.
15	.00010355	.0000946	.00003153+	Ludlow's Rep.
16	.00010498	.0000960	.00003200	U. S. C. S.
17	.00012426	.0001136	.00003753+	Barnes' Pa. Map, 1851.
18	.00013122	.0001200	.0004000	U. S. C. S.
19	.00016403	.0001500	.0000500	U. S. C. S.
20	.00019684	.000180	.0000600	U. S. C. S.
21	.00020711	.0001893	.0006310	Ludlow.
22	.00024605	.0002250	.00007300	U. S. C. S.
23	.00026245	.0002400	.0000800	U. S. C. S.
24	.00031067	.0002840	.0000946+	Sherman's March
25	.00032807	.0003000	.0001000	U. S. C. S.
26	.00039368	.0003600	.0001200	U. S. C. S.
27	.00049210	.0004500	.00015000	U. S. C. S.
28	.0004971	.0004545	.00015151	
29	.00051261	.00046875	.00015625	Geol. Surv.
30	.00062130	.00056800	.00018933+	Fremont.
31	.00065614	.000600	.000200	U. S. C. S.
32	.000662	.00060606	.00020202	
33	.00078737	.000720	.0002400	" "
34	.00098421	.000900	.000300	" "
35	.0009941	.0009090	.0003030	
36	.0010000	.0009144	.0003048	
37	.00102522	.0009375	.0003125	Geol.
38	.001035	.000947	.0003156	
39	.0011653	.0010653	.0003551	
40	.00131228	.0012000	.0004000	U. S. C. S.
41	.00155334	.0014190	.0004730	
42	.00157474	.00144000	.0004800	
43	.00165692	.00151515	.00050505	
44	.00186403	.0017040	.0005680	
45	.00196842	.0018000	.0006060	
46	.001988	.001818	.0006060	
47	.00205044	.00187500	.0062500	

A Reciprocal Table of Map Equivalents showing the number of inches of

No.	Scale.	1 Mile.	1 Kilometer.	1 Chain.	1 Pole.
48	$\frac{1}{18,818}$	3.36698	2.09206	.042087	.0105275
49	$\frac{1}{15,840}$	4.0	2.485507	.05	.0125
50	$\frac{1}{15,000}$	4.22400	2.62456	.052800	.0132000
51	$\frac{1}{11,880}$	5.33333	3.314009	.06666	.016666
52	$\frac{1}{10,000}$	6.33600	3.93685	.079200	.0198000
53	$\frac{1}{9,900}$	6.4	3.976808	.08	.020
54	$\frac{1}{9,600}$	6.60000	4.10088	.082500	.020625
55	$\frac{1}{7,920}$	8.	4.971014	.10	.025
56	$\frac{1}{7,200}$	8.80000	5.46784	.11000	.027500
57	$\frac{1}{6,000}$	10.56000	6.561423	.132000	.033000
58	$\frac{1}{5,940}$	10.6666	6.628018	.133333	.03333
59	$\frac{1}{5,000}$	12.67200	7.8737	.15840	.039600
60	$\frac{1}{4,950}$	12.8	7.953616	.16	.04
61	$\frac{1}{4,800}$	13.20000	8.201770	.165000	.041250
62	$\frac{1}{3,960}$	16.	9.942028	.2	.05
63	$\frac{1}{3,600}$	17.6	10.93568	.22	.055
64	$\frac{1}{3,333}$	19.00990	11.81173	.237623	.05940575
65	$\frac{1}{3,168}$	20.	12.42434	.25	.0625
66	$\frac{1}{3,000}$	21.12	13.122846	.264	.066
67	$\frac{1}{2,970}$	21.33333	13.256036	.26666	.06666
68	$\frac{1}{2,500}$	25.34400	15.74740	.31680	.079200
69	$\frac{1}{2,400}$	26.40000	16.40354	.330000	.082500
70	$\frac{1}{1,980}$	32.	19.88465	.4	.1
71	$\frac{1}{1,280}$	49.50000	22.94414	.618750	.1546875
72	$\frac{1}{1,250}$	50.68800	31.49480	.63360	.158400
73	$\frac{1}{1,200}$	52.80000	32.80708	.660000	.165000
74	$\frac{1}{1,080}$	58.66666+	36.45231	.73333+	.18333+
75	$\frac{1}{960}$	66.00000	41.00885	.825000	.206250
76	$\frac{1}{840}$	75.42857	46.86726	.942857	.23571425
77	$\frac{1}{789}$	80.30418	49.89670	1.003802	.2509505
78	$\frac{1}{720}$	88.00000	54.67847	1.100000	.275000
79	$\frac{1}{600}$	105.60000	65.61416	1.320000	.33000
80	$\frac{1}{500}$	126.72000	78.73700	1.584000	.39600
81	$\frac{1}{480}$	132.00000	82.01770	1.650000	.412500
82	$\frac{1}{360}$	176.00000	109.35694	2.2000	.550000
83	$\frac{1}{300}$	211.20000	131.22833	2.640000	.66000
84	$\frac{1}{240}$	264.00000	164.03541	3.300000	.825000
85	$\frac{1}{198}$	320.	198.8405	4.	1.
86	$\frac{1}{120}$	528.00000	328.07083	6.600000	1.65000
87	$\frac{1}{60}$	1056.00000	656.14166+	13.20000	3.3000
88	$\frac{1}{39.37079}$	1609.330	1000.	20.11663	5.02916
89	$\frac{1}{36}$	1760.	1083.5694	22.	5.5
90	$\frac{1}{12}$	5280.00000	3280.7083	66.00000	16.5000
91	$\frac{1}{1}$	63360.00000	39368.5000	792.0000	198.000
92	$\frac{4}{3}$	84480.00	52491.0333+	1056.000	264.000
93	$\frac{2}{1}$	126720.00	78737.0000	1584.000	396.000

Map and parts thereof, of the various scales now in use, which represent

No.	1 Metre.	1 Yard.	1 Foot	Where Used.
48	.00209206	.0019130	.0006376+	U. S. C. S.
49	.002485	.002272	.0007575	
50	.00262456	.0024000	.0008000	U. S. C. S.
51	.003314	.0030303	.0010101	
52	.00393685	.0036000	.0012000	U. S. C. S.
53	.003976	.003636	.001212	
54	.00410088	.00375	.0012500	
55	.064970	.004544	.0015150	
56	.00546784	.005000	.001666+	
57	.006561423	.006000	.002000	
58	.006628	.0060606	.0020202	
59	.0078737	.007200	.002400	U. S. C. S.
60	.007952	.007272	.002424	
61	.008201770	.0075000	.002500	
62	.00994	.009088	.003030	
63	.0109356	.01	.003999	
64	.01181173	.0108010	.003603+	U. S. C. S.
65	.012424	.0113181	.0037727	
66	.0131228	.012	.004	
67	.013256	.0121212	.0040404	
68	.01574740	.014400	.0048000	U. S. C. S.
69	.01640354	.015000	.005000	U. S. C. S.
70	.0218712	.02	.007999	
71	.02294414	.0281250	.0093750	U. S. C. S.
72	.03149480	.028800	.0096000	" "
73	.03280708	.030000	.010000	" "
74	.03645231	.03333+	.0111111+	
75	.04100885	.037500	.012500	
76	.04686726	.0428547	.0142849	
77	.04989670	.0456273	.0152091	
78	.05467847	.050000	.016666+	
79	.06561416	.060000	.020000	
80	.07873700	.072000	.024000	U. S. C. S.
81	.08201770	.075000	.025000	
82	.10935694	.100000	.033333+	
83	.13122833	.12000	.040000	
84	.16403541	.150000	.050000	
85	.218712	.2	.079999	
86	.32807083	.30000	.100000	U. S. C. S.
87	.6561416+	.600000	.200000	
88	1.	.914392	.304464	
89	1.093569	1.	.333333	
90	3.2807083	3.00000	1.0000	
91	39.36850	36.0000	12.0000	
92	52.49103+	48.00000	16.0000	
93	78.737000	72.0000	24.0000	

Circumstances Influencing the Efficiency of Dynamo-Electric Machines. By Profs. Edwin J. Houston and Elihu Thomson.

(*Read before the American Philosophical Society, November 1st*, 1878.)

During the recent competitive trials made at the Franklin Institute as to the relative efficiency of some different forms of Dynamo-Electric Machines, the authors having been entrusted with the work of determining the relations between the mechanical power consumed and the electric and thermic effects produced, took the opportunity thus afforded to make a careful study of many interesting circumstances which influence the efficiency of these machines.

It is proposed in the present paper to select from the many circumstances thus noticed, a few of the more interesting, reserving the others for a future consideration.

It will readily be understood from the comparatively new field in which we had been working, no reliable data of the electrical work of these machines having before been obtained, that difficulties constantly arose owing to necessary conditions of operation, and new developments as to the behavior of the machines under varied conditions, were constantly met.

A convenient arrangement of the particular circumstances we are about to discuss may be, 1st, Those affecting the internal work of the machine ; 2d, Those affecting the external work, and 3d, The relations between the internal and external work.

The mechanical energy employed to give motion to a Dynamo-Electric Machine is expended in two ways, viz., 1st, In overcoming friction and the resistance of the air ; and, 2d, In moving the armature of the machine through the magnetic field, the latter of course constituting solely the energy available for producing electrical current. The greatest amount of power expended in the first way was noticed to be about 17 per cent. of the total power employed. This expenditure was clearly traceable to the high speed required by the machine. The speed therefore required to properly operate a machine is an important factor in ascertaining its efficiency.

The above percentage of loss may not appear so great, but when it is compared with the total work done in the arc, as heat, constituting as it did in this particular instance over 50 per cent. of the latter, and about 33 per cent. of the total work of the circuit, its influence is not to be disregarded. In another instance the work consumed as friction was equal to about 80 per cent. of that appearing in the arc as heat, while in the Gramme machine experimented with, this percentage fell to 20 per cent. of that which appeared in the arc as heat, and was only about 7 per cent. of the total power consumed in driving the machine.

In regard to the second way in which mechanical energy is consumed, viz.: in overcoming the resistance necessary to move the armature through the magnetic field, or in other words, to produce electrical current, it must not be supposed that all this electrical work appears in the circuit of the machine, since a considerable portion is expended in producing what we term the local action of the machine, that is local circuits in the conducting masses of metal, other than the wire, composing the machine.

The following instances of the relation between the actual work of the circuit, and that expended in local action, will show that this latter is in no wise to be neglected. In one instance an amount of power somewhat more than double the total work of the circuit was thus expended. In this instance also it constituted more than five times the total amount of power utilized in the arc for the production of light. In another instance it constituted less than one-third the total work of the circuit, and somewhat more than one-half the work in the arc.

Of course work expended in local action is simply thrown away, since it adds only to the heating of the machine. And since the latter increases its electrical resistance, it is doubly injurious.

The local action of dynamo-electric machines is analogous to the local action of a battery, and is equally injurious in its effects upon the available current.

Again, in regard to the internal work of a machine, since all this is eventually reduced to heat in the machine, the temperature during running must continually rise until the loss by radiation and convection into the surrounding air, are eventually equal the production, and the machine will at last acquire a constant temperature. This temperature, however, will differ in different machines according to their construction, and to the power expended in producing the internal work, being, of course, higher when the power expended in producing the internal work is proportionally high.

If therefore a machine during running acquires a high temperature when a proper external resistance is employed, its efficiency will be low. But it should not be supposed that because a machine when run without external resistance, that is on short circuit, heats rapidly, that inefficiency is shown thereby. On the contrary, should a machine remain comparatively cool when a proper external resistance is employed, and heat greatly, when put on short circuit, these conditions should be regarded as an index of its efficiency.

As a rule the internal resistance of Dynamo Electric Machines is so low that to replace them by a battery, the latter, to possess an equal internal resistance, would have to be made of very large dimensions, so that the efficiency of Dynamo-Electric Machines, cannot be stated in terms of battery cells as ordinarily constructed.

In regard to the second division, viz., the external work of the machine, this may be applied in the production of light, heat, electrolysis, magnetism, &c.

Where it is desired to produce light, the external resistance is generally that of an arc formed between two carbon electrodes; the resistance of the arc is therefore an important factor in determining the efficiency. To realize the greatest economy, the resistance of the arc should be low, but nevertheless should constitute the greater part of the entire circuit resistance.

In some of our measurements the resistance of the arc was surprisingly low, being in one instance .54 ohm., and in another .79 ohm. It was however in some instances as high as 3.18 ohms.

It may be noted as an interesting fact that where the greatest current was flowing, the resistance of the arc thereby produced was low. This is undoubtedly due to higher temperature and increased vaporization from the carbons. In this latter case also the greatest amount of light was produced.

The amount of work appearing in the arc as measured by the number of foot pounds equivalent thereto, is not necessarily an index of the lighting power. In two instances of measurement, the amount of energy thus appearing in the arc was equal, while the lighting powers were proportionately as three to four. This apparent anomaly is explained by considering the resistance of the arc, it being much less in the case in which the greater light was produced. The heat in this case being evolved in less space, the temperature of the carbons, and therefore their light-giving powers, was considerably increased.

A few remarks on the economical production of light from electrical current may not be out of place. The light emitted by an incandescent solid will increase as its temperature is increased. In the voltaic arc the limit to increase of temperature is in the too rapid vaporization of the carbon. Before this point is reached, however, the temperature is such that the light emitted is exceedingly intense. No reliable method of measuring the temperature of the arc has as yet been found.

A well known method of obtaining light from electrical currents is by constructing a resistance of some material such as platinum having a high fusing point and heated to incandescence by the passage of a current. When platinum is employed the limit to its increase of temperature is the fusing point of the platinum, which is unquestionably but a fraction of the temperature required to vaporize carbon. Were the falling off in the amount of light emitted merely proportional to the decrease in temperature, the method last described might be economical. Unfortunately however for this method, many facts show that the decrease in the light emitted, is far greater than the decrease of the temperature. Most solids may be heated to 1000° F., without practically emitting light. At 2000° F., the light emitted is such that the body is said to be at a bright red. At 4000° F., the amount of light will have increased far more than twice, probably as much as four times that emitted at 2000° F. It is reasonable to suppose that with a further increase of temperature, the same ratio of increase will be observed, the proportionate increase in luminous intensity far exceeding the increase in temperature.

It would therefore appear that the employment of a resistance of platinum or other similar substance, whose temperature of alteration of state as compared with that of carbon is low, must be far less economical than the employment of the arc itself, which as now produced has been estimated as about two or three times less expensive than gas.

Indeed it would seem that future improvements in obtaining light from electrical currents will rather be by the use of a sufficient resistance in the most limited space practicable, thereby obtaining in such space the highest possible temperature.

Perhaps the highest estimate that can be given of the efficiency of Dynamo-Electric-Machines as ordinarily used, is not over 50 per cent. Our measurements have not given more than 38 per cent. Future improvements may increase this proportion. Since the efficiency of an ordinary steam engine and boiler in utilizing the heat of the fuel is probably overestimated at 20 per cent., the apparent maximum percentage of heat that could be recovered from the current developed in a Dynamo-Electric-Machine, would be overestimated at 10 per cent. The economical heating of buildings by means of electricity may therefore be regarded as totally impracticable.

Attention has, long ago, been directed to the use of Dynamo-Electric Machines for the conveyance of power. Their employment for this purpose would indeed seem to be quite promising. Since in this case one machine is employed to produce electrical currents, to be reconverted into mechanical force by another machine, the question of economy rests in the perfection of the machines and in their relative resistances.

In respect to the relations that should exist between the external and internal work of Dynamo-Electric Machines, it will be found that the greatest efficiency will, of course, exist where the external work is much greater than the internal work, and this will be proportionately greater as the external resistance is greater. Our measurements gave in one instance the relaton of .82 ohm. of the arc to .49 ohm of the machine, a condition which indicates economy in working. The other extreme was found in an instance where the resistance of the arc was 1.98 ohms., while that of the machine was 4.60 ohms. a condition indicating wastefulness of power.

Stated Meeting, Nov. 15, 1878.

Present, 23 members.

Vice-President, Mr. E. K. Price, in the Chair.

Letters of acknowledgment were received from Prof. Steenstrup, of Copenhagen, dated Oct. 15, 1878 (101); the R. Zoological Society, Amsterdam, Oct. 15, 1878 (101; Catalogue, part iii); Teyler Foundation, Leyden, Oct. 26 (101); Astronomical Society, Leipzig, Oct. 26 (101); Astronomical Observatory of the Roman College, Oct. 29 (96); Royal Academy of Sciences, Lisbon, April 23 (99); Royal Observatory, Greenwich, Oct. 29 (101); Prof. B. Pierce (101); Buffalo Society of Natural Science, Nov. 12 (101); and the Public School Library, St. Louis, Oct. 28 (Catalogue i, ii, iii).

Donations for the Library were received from the Asiatic Society of Japan; the Minister of Mines, Melbourne; the Government of South Australia; Imperial Academy of Russia; Society of Natural History, Moscow; German Geological Society, Berlin; Zoologische Garten, Frankfurt; Natural History Society in Freiberg im Breisgau; N. L. Magazin, Görlitz; Zoological Society in Amsterdam; Royal Astronomical Society, Meteorological Office, Meteorological Society, and Nature, in London; Philosophical Society of Glasgow; Royal Irish Academy; American Journal, and Yale College, New Haven; Franklin Institute, Medical News, American Journal of Pharmacy, and Robinson's Epitomy of Literature, in Philadelphia; National Museum, and Ministerio de Fomento in Mexico; and Prof. Saenz at Bogota.

Dr. Barker, pursuant to notice, described the location, apparatus, personnel, methods, and results of the Solar Eclipse observations of July 29, last, at Rawlins, and exhibited photographs, and the tazimeter used by Mr. Edison, who was of the party.

Dr. McQuillen described the vivisection and subsequent post mortem dissection of the brain of a pigeon (See minutes, Proc. Vol. XVII, page 314) which lived six months between the operations; and introduced Dr. Carl Seiler, who described the methods of obtaining slices and mounting them and exhibited such slices in a microscope.

A communication was received entitled "On some of the Characters of the Miocene Fauna of Oregon. By E. D. Cope."

The following resolution was offered by Curator Dr. Cresson, seconded in writing by Curator Dr. Brinton, and put to the meeting and passed.

Resolved, That the Curators of the Society be directed to make arrangements through the Numismatic and Antiquarian Society of Philadelphia, for the deposit of the collection of Coins and Medals, belonging to the Society, in the Pennsylvania Museum of Industrial Art, under agreement that the said collection be properly catalogued and displayed and returned on demand.

And the meeting was adjourned.

On some of the Characters of the Miocene Fauna of Oregon.

(Read before the American Philosophical Society, November 15, 1878.)

By E. D. Cope.

We have been for some time in possession of information as to the ungulate forms which inhabited Oregon during the Miocene period. Through the labors of Profs. Leidy, Marsh and Bettany, we have learned of the existence there of *Oreodontidæ* in considerable variety; of *Anchitheriidæ*; of peccary like species; of *Elotherium*, and of *Rhinocerus*. But of the unguiculate types, of *Rodentia*, and of the inferior orders of Mammalia, almost nothing is yet known. Having recently received a number of specimens from the deposits in question, I am in a position to offer a number of new identifications. The following species already known from the Miocene of Colorado, I find contained in the collection, viz.: *Palæolagus haydeni*; *Canis gregarius*; *Canis lippincottianus*; *Hypertragulus calcaratus*; *Leptomeryx evansi*.

Rodentia.

Steneofiber gradatus, sp. nov.

This species is represented in my collection by a cranium which is nearly perfect, the principal deficiency being the absence of the mandibular rami. It is of smaller size than the *S. nebrascensis* and *S. pansus*, and differs from both these species in the relative sizes of the superior molar teeth. The first of these is the largest, and the others diminish regularly in size to the last, whose grinding face does not present more than one-third the extent of that of the first. The triturating surfaces of the second and third have their long axes transverse. In all the crowns, besides the internal and external enamel inflections, there is but one fossette, which is anterior to the external inflection. The latter has become isolated from the superficial enamel on the last three molars, by attrition. The superior incisors are flat anteriorly with the external angle rounded, and its dentine presents the transverse undulations seen in *S. pansus*.

Measurements.		M.
Length of skull from incisive alveolus		.0500
Width between summits of first molars		.0060
" " fourth "		.0095
Length of molar series		.0115
Diameter of the first molar	antero-posterior	.0040
	transverse	.0045
Diameter of third molar	antero-posterior	.0028
	transverse	.0032
Diameter of fourth molar	antero-posterior	.0020
	transverse	.0024

From the above measurements it is apparent that the molar series in this species is equal in length to the anterior three molars of the *S. nebrascensis* and *S. pansus*. The posterior fossettes of the crowns seen in those species are wanting in the *S. gradatus*.

ENTOPTYCHUS CAVIFRONS, gen. et sp. nov.

Char. gen. Probably of the family *Saccomyidæ*.* The cranium is elongate, and presents inflated periotic bones, and slender zygoma. The foramen infraorbitale is small and anterior in position, entering the maxillary bone near its suture with the premaxillary.

Generic characters. Molars $\frac{4}{4}$ $\frac{4}{4}$, rootless, and identical in structure. The crowns are prismatic, and in the young stage present a deep inflection of enamel from one side, the external in the superior teeth, the internal in the inferior. After a little attrition, the connection with the external enamel layer disappears, and there remains a median transverse fossette, entirely enclosed by enamel. The tooth then consists of two dentinal columns in one cylinder of enamel, separated by a transverse enamel-bordered tube. Incisors not sulcate.

The teeth of this genus differ from those of *Perognathus* in being without distinct roots, and in having the enamel loop cut off and enclosed. In *Dipodomys*, the molars are undivided simple prisms.

Specif. Char. This species is represented by some entire crania, and numerous separated jaws. The postorbital part of the skull is subquadrate in outline, and depressed in form. The interorbital region is narrowed, but the superciliary margins do not meet nor converge to form a sagittal crest. They are thickened, forming two subparallel ridges which are separated by a shallow concavity of the frontal bone. The nasal bones are very narrow, and their posterior apices just attain the line of the supero-anterior angle of the orbit. The base of the malar bone is much elevated and very oblique. The molar teeth are directed obliquely backwards, the alveolus of the first issuing below the anterior part of the orbit. The first superior molar is the largest, and the proportions of the others diminish regularly posteriorly. The first inferior molar is a little smaller than the second and third, and is about equal to the fourth. Its anterior column is contracted, while the last molar is like the second and third. The face of the inferior incisor is flat, and its enamel is smooth. The external face of the jaw is bounded below by a strong angle, as far anteriorly as below the first molar.

Measurements.

	M
Length of skull to incisive alveoli	.041
Width of skull at mastoids	.020
" " between orbits	.005
" " at middle of muzzle	.010
Elevation of skull from second molar	.011
Length of molar series	.007
" first molar	.002
Width of " "	.002
Length of crown of last molar	.0015

* See Coues' Report U. S. Geol. Surv. Terrs. XI, p. 191.

Measurements.	M.
Width of crown of last molar	.0015
Length from M. 1 to infraorbital foramen	.007
Depth of mandibular ramus at M. 2	.006
Width of face of inferior incisor	.0016

Entoptychus planifrons, sp. nov.

A larger species than the *E. cavifrons*, represented in my collection by parts of crania, and rami. The former show that besides the superior size, this species differs from the *E. cavifrons* in the absence of the superciliary ridges, and hence perfect flatness of the interorbital region. The latter is also wider, measuring five-sixths the width of the muzzle at its middle, while in the *E. cavifrons* it is only half as wide. The subjoined measurements give the characters in detail.

Measurements.	M.
Width of interorbital space	.007
" muzzle at middle	.0086
Elevation of skull from second molar	.0130
Length of inferior molar series	.0072
Depth of ramus at M. 2	.0072
Width of inferior face at M. 2	.0043
" " incisor	.0018
Distance between infraorbital foramen and M. 1	.0050

Entoptychus crassiramis, sp. nov.

This, the largest species of the genus, appears to have been less abundant than the two already described. I refer to it portions of two crania and three mandibular rami, found separately. The superior size of the parts is obvious, the posterior three superior molars having the same longitudinal extent as the entire series of the *E. cavifrons*. The gradation in the size of these teeth, is as in that species, the grinding surfaces diminishing rapidly in extent posteriorly. The superciliary ridges are not well preserved, but were probably thickened as in *E. cavifrons*, and the interorbital space was relatively as narrow, and not so wide as in *E. planifrons*. The measurements below exhibit the characters more exactly.

Measurements.		M.
Width of skull between orbits		.007
Elevation of skull from second molar		.015
Length of series of superior molars		.0115
Diameter of second molar	antero-posterior	.003
	transverse	.004
Diameter of fourth molar	antero-posterior	.002
	transverse	.002

In the mandibular rami the inferior masseteric ridge extends to below the anterior border of the first molar, and is very prominent and acute. It results that both the exterior and inferior aspects of the ramus are con cave to the anterior extremity of the crest, which slopes upwards. The incisive alveolus, though not prominent as in the *Hystricomorpha*, is on the inner side of the base of the ramus in front, and the enamel-face of the incisor tooth is directed more inwards than downwards. Above the alveolar prominence, the inner face of the ramus is gently concave. The anterior origin of the coronoid process is opposite the posterior border of the second molar.

Measurements.	M.
Length of inferior molar series	.0105
Width of anterior face of inferior incisor	.0028
Depth of ramus at M. 2	.0085
Width of ramus below at M. 2	.0070

PLEUROLICUS SULCIFRONS, gen. et sp. nov.

Char. gen. Fam. Saccomydiæ. Superior molars rooted and short-crowned. The crowns with a lateral fissure bordered with an inflection of the enamel sheath, extending to their bases. In the superior molars this inflection is on the external side, and does not divide the crown. Superior incisors not grooved.

This genus is curiously near to the existing *Heteromys* and *Perognathus*, the two genera of *Saccomyidæ* with rooted molars. The former differs in having the molars divided into two columns, each of which is sheathed in enamel, while *Perognathus* only differs so far as I am aware, in having the superior incisors grooved.

Specif. Char. This species resembles those of the allied genus *Entoptychus* in many respects. The superciliary borders are thickened upwards, forming two ridges, which enclose a groove between them which is more pronounced than in the *Entoptychus cavifrons*. The muzzle is plane above and considerably wider than the interorbital space. The base of the malar is thin and oblique, and the *foramen infraorbitale exterius* is well in advance of the molar teeth and at the anterior part of the maxillary bone. A groove passes backwards from its inferior border, terminating in a small foramen which marks a point nearly half way to the first molar. Within this, another shallow groove bounds the more prominent median line. The palatal surface exhibits two shallow lateral grooves, which commence opposite the posterior border of the first molar.

The grinding surfaces of the molars are transverse ovals, only interrupted by the exterior fissure. The first molar is slightly different in form, being larger, and its section, when not much worn, being nearly round. Its anterior portion extends towards the alveolus, giving an antero-posterior oval, on prolonged wear. Each tooth has three roots, one interior and two exterior; in the first they may be described as two posterior and one anterior. The last molar is the smallest, the series exhibiting a regular gradation in size.

Measurements.	M.
Interorbital width	.0050
Width of muzzle at middle	.0080

Measurements.		M.
Depth of cranium at M. 2		.0138
Length of molar series along base		.0080
Diameter of second molar	antero-posterior	.0016
	transverse	.0020
Width of face of superior incisor		.0020

MENISCOMYS HIPPODUS, gen. et sp. nov.

Gen. Char. The characters of this genus are derived from the dentition of both jaws, and from portions of the cranium which are preserved. The molars are rooted, and number $\frac{4}{4}$. Those of the superior series are without enamel inflections, and the triturating surface exhibits two external and one internal crescentic sections of the investing enamel. On the second superior molar there are three external crescents in the typical species; and the first molar is simply conic. Between the inner and external crescents, there are the curved edges of enamel plates directed obliquely and transversely. The grinding surfaces of the inferior molars display in the unworn condition, two L-shaped transverse crests, connected longitudinally on the median line; on wearing, the lateral emarginations of the enamel become shallower, disappearing from the inner side, but remaining on the outer. Incisor teeth not grooved. *Foramen infraorbitale anterius*, if present, elevated in position and near orbit.

The characters of the dentition of this genus resemble those of the genus *Pteromys*, which is now confined to Asia and the Malaysian Archipelago. The superior molars differ from those of *Pteromys* in wanting all reëntrant enamel inflection. Specimens in my collection indicate two species of *Meniscomys*.

Specif. Char. Superior molars with a vertical ridge from the points of junction of the crescents on the external side; there are thus two on the second molar, and one each on the third and fourth. Within each of the external crescents is another crescentic edge of a pair of vertical enamel plates, and the inner marginal crescent sends off a short transverse branch towards them. With attrition, all these crests unite by their extremities, enclosing four distinct lakes, which, after still further wear, disappear. Attrition produces a similar result in the inferior molars, viz.: two pairs of crescents enclosing four lakes, which ultimately wear out. The inferior incisor has a shallow concavity on its anterior face.

The maxillary bone, anterior to the molar teeth, is shorter than the premaxillary. The incisive foramina are entirely in the latter. The sides and superior aspect of the muzzle are regularly convex in transverse section. The inferior incisive alveolus is enclosed entirely in the plane of the ramus, and extends posteriorly to below the last molar tooth. The masseteric ridge is very oblique, and rises to a median point below the second molar. The coronoid process rises from the front of the last molar.

Measurements.	M.
Length of superior molar series	.008

Measurements.		M.
Diameter of second superior molar	antero-posterior	.004
	transverse	.0035
" third " "	antero-posterior	.0020
	transverse	.0025
Width of superior incisor		.0020
Length from base of first superior molar to base of incisor		.0065
Width between bases of first molars		.0020
Length of first inferior molar		.0033
Depth of ramus at second molar		.0050
Width " below "		.0035

MENISCOMYS MULTIPLICATUS, sp. nov.

This species is considerably larger than the *M. hippodus*, and differs in the greater complication of the enamel plates of the inferior molars. The four crescentic areas are discernible on the worn surfaces of the crown, of which the posterior inner is reduced in size on the middle two molars. The two enclosed lakes have very plicate borders which form many small loops, and sometimes they are fused into a single irregular area. The last molar is extended a little posteriorly, and all present an entrant angle between the inner columns. The coronoid process originates opposite the third molar, and the masseteric ridge ceases below the middle of the jaw below the second molar.

Measurements.		M.
Probable length of inferior molar series		.0120
Length of posterior three molars		.0095
Diameter of second molar	antero-posterior	.0030
	transverse	.0025
Length of fourth molar		.0040
Depth of ramus below second molar		.0070
Width " " "		.0050

CARNIVORA.

TEMNOCYON ALTIGENIS, gen. et sp. nov.

Gen. Char. This genus is only known from a mandibular ramus which supports all the teeth excepting the incisors and probably the last molar. There are four premolars and probably three true molars, all having the general character of those of *Canis*. The only character by which I distinguished the new genus *Temnocyon* is seen in the form of the heel of the sectorial tooth. Instead of presenting a concave surface bounded by ridges or tubercles, it presents a more or less median cutting edge as in the posterior premolars of *Oxyæna*. In the typical species, there is but one row of cusps on the first tubercular molar, but they are not elevated, and stand on one side of the crown. In comparing this genus with types other than *Canidæ*, one can recognize in its characteristic peculiarity of the sectorial tooth, one well-known in the typical genera of *Viverridæ* and *Mustelidæ*. *Temnocyon* is, however, truly canine in other details, and appears to approach the genus *Palæocyon* of Lund. According to this author, the posterior inner tubercle of the anterior part of the crown of the sectorial tooth is wanting in that genus, so that it is distinct from the North American form.

Specif. Char. The mandibular ramus is rather deep and compressed, much more so than in the *Canis latrans*, with which it agrees in the length of the dental series. As compared with the existing species of *Canis* and *Vulpes* of North America, the sectorial tooth is relatively smaller and the premolars larger. In this respect it agrees with most other dogs of the Lower Miocene, and differs from those of the Upper Miocene (Loup Fork).* The posterior tubercle is wanting from the premolars, excepting the last, where it is large and obtuse, differing in this respect also from most recent dogs, and from the cotemporary *Canis gregarius*. In the sectorial tooth the principal cusp is much elevated above the anterior, while the inner median is small, with its apex in line with the anterior. The cutting edge of the heel is not acute, and is a little external to the median line; there is a weak cingulum-like angle at its inner base. The first tubercular tooth is large, nearly equaling in antero-posterior diameter the base of the third premolar. It is parallelogrammic in transverse section, and supports two principal cusps and an anterior ledge. The cusps are pronounced and stand exterior to the middle line; their inner side slopes to the base of the crown where there is no cingulum. The ledge is higher on the inner than the external side. There are no basal cingula on either side of the bases of any of the teeth. The second tubercular molar is lost.

The alveolar margin of the jaw rises behind the sectorial tooth, and the inferior margin begins to ascend below the middle of the same tooth more decidedly than in *C. lupus, latrans* or *cuspigerus*. The two large mental foramina, are situated, the one below the second, the other below the third premolars.

Measurements.	M.
Length of anterior six molars	.073
" " four "	.045
" base of second premolar	.011
Elevation of crown " "	.011
Length of base of fourth "	.015
Elevation of crown " "	.014
Length of base of sectorial tooth	.0185
Elevation of principal cusp of sectorial tooth	.0160
" anterior " " "	.009
Length of heel of sectorial	.007
Elevation " "	.0085
Length of crown of first tubercular	.0115

* See Proceedings Academy Philadelphia, 1875, p. 22, where I have discussed the origin and history of the sectorial tooth.

Measurements.	M.
Width of crown of first tubercular	.0065
Depth of ramus at P. M. 2	.024
" " at sectorial	.028
Thickness " "	.010

CANIS CUSPIGERUS, sp. nov.

This peculiar species is indicated by the greater part of the cranium with dentition, to which are united both rami of the lower jaw with nearly all of the teeth in place. These indicate a dog of small size, about equaling the *Canis gregarius* Cope, but one presenting marked characters.

The third premolar tooth in both jaws differs from the corresponding one in the *C. gregarius* and in most recent species, in lacking the lobe of the posterior cutting edge, agreeing in this (as regards the inferior series) with the *Temnocyon altigenis*. It is present in the fourth inferior premolar, which has besides, a low heel. The inferior sectorial tooth is characterized by its great robustness; the internal median tubercle is much elevated, while the principal cusp is short. The heel is wide and basin-shaped, with the inner border as much elevated as the outer. The first tubercular molar is characterized by its width as compared with its length being nearly as wide transversely as fore and aft. It has two anterior cusps followed by a basin with elevated borders simulating two posterior cusps. There are an anterior and a exterior cingulum. The second tubercular is a miniature of the first, differing in the more robust external posterior cusp, and the absence of external basal cingulum. There are no complete cingula on the external bases of the other inferior teeth. The second superior tubercular is well developed, having two external tubercles. The anterior inner cusp of the superior sectorial is distinct and acute, and there is a cingulum along the inner base of the crown. The exserted portion of the canines is long, slender, and with an oval section narrowed behind. The enamel of all the molars is more or less rugose, a character which is only found among our extinct dogs in the *C. geismarianus*.

The mandibular rami are shallow, and their inferior margin is not stout. A gentle elevation of the latter commences below the first tubercular tooth and the alveolar border rises but little behind. The masseteric fossa is deep and well defined.

Measurements.	M.
Length of inferior molar series	.041
" bases of four premolars	.023
" base of second "	.005
Elevation crown " "	.005
Length of base of fourth "	.0072
Elevation of crown " "	.0055
Length of base of sectorial	.010
Elevation of principal cusp	.006
Width of heel of sectorial	.006

Measurements.

		M.
Diameter of first tubercular	antero-posterior	.006
	transverse	.005
Antero-posterior diameter second tubercular		.0037
Length of base of superior sectorial		.009
" bases of two tuberculars		.012
" base of first tubercular		.0064

CANIS GEISMARIANUS, sp. nov.

This species of dog may be placed with reference to the size of its inferior sectorial tooth between the *C. lippincottianus* and *C. hartshornianus.* In the robust proportions of this tooth it more nearly resembles the *C. cuspigerus.* The mandibular ramus is robust and shallow, and quite distinct from the deep jaw of *C. hartshornianus* The sectorial has perhaps twice the bulk of those of the *C. lippincottianus* and *C. cuspigerus.* From that of the latter it differs further in the small inner tubercle and contracted heel.

The sectorial part of the tooth is relatively small, not exceeding the heel in length, and its cusps are low. The heel is notable for the elevation of the tubercle of the inner side—which exceeds that of the outer; the latter also, is contracted, standing within the external base, which is represented by a short cingulum. A weak cingulum below the sectorial blades. Surface of the enamel rugose where not exposed to friction.

Measurements.

		M.
Diameters of sectorial	vertical, anterior cusps	.006
	" heel	.0038
	antero-posterior	.0115
	transverse, middle	.006
Depth of ramus at sectorial		.012
Thickness of " "		.007

The affinities of this species are evidently with the *C. cuspigerus.* It is named in honor of Jacob Geismar, a skillful naturalist of Philadelphia.

MACHÆRODUS STRIGIDENS, sp. nov.

This obviously distinct species is only represented by the crown of a superior canine tooth, from which the apex has been broken. Its characters are so peculiar that I record it under the above name, not knowing whether I shall have better specimens.

The tooth is long and very much compressed, much more so than in any species of the genus known to me. Its anterior and posterior edges are finely and very perfectly denticulate without lateral flexure near the base. The centre of each side of the tooth is occupied by a wide open gutter, so that the greatest transverse diameter of the crown is not at its middle. These gutters become planes towards the apex, giving an elongated hexagonal section. The size indicates an animal of the proportions of the *M. primævus*, and smaller than the *M. brachyops*.

As compared with the superior canine of the *Daptophilus squalidens*, which the present specimen resembles in its compression and fine denticulation, it differs in its greater relative length and in the presence of the lateral open sulci.

Measurements.

			M.
Diameter at base	antero-posterior		.0120
	transverse	greatest	.0036
		median	.0032
Length of a denticle on base			.000143

MACHÆRODUS BRACHYOPS, sp. nov.

This species, which ranged in size from that of the puma to that of the jaguar, is represented in my collection by parts of two crania; by an entire cranium; by a left mandibular ramus with parts of the skeleton, and by several isolated teeth. The characteristics of the molars in both jaws are those of the other species of this genus. The first superior premolar is two-rooted and small, occupying the middle of the short space between the canine and the second premolar. The latter is large, and has no anterior basal tubercles. Sectorial without anterior basal tubercle. Tubercular tooth small, transverse.

The crania of the three individuals mentioned agree in many particulars; and especially in the very short face and muzzle. This may be more exactly expressed by comparing the interspace separating the second and third premolar from the canine with the length of the base of the latter. From this it is seen that the two dimensions are equal, while in the *M. primævus* the first mentioned is much the longer of the two. In the mandible referred to this species another character is seen in the relatively large size of the premolars, which much exceeds that of the corresponding teeth in *M. primævus*. The first is stated by Leidy to have an anterior basal cusp, which is wanting in the *M. brachyops*.

In the first cranium the sagittal crest is well developed. The canine tooth has an oval section at the base of the crown, whose long diameter somewhat exceeds the distance between it and the anterior base of the second premolar. The infraorbital foramen is large. The second specimen, the left maxillary and part of malar bones with teeth, shows that the length of the base of the sectorial tooth equals the space between it and the middle of the first premolar. The superior aspect of the proximal portion of the malar bone is horizontal, constituting a surface not seen in the species of *Felis*. The canine is robust, with an oval section at the base. The posterior denticulate cutting edge extends higher up than the anterior, and ceases at the base of the enamel. The anterior cutting edge is on the inner side of the anterior face of the tooth.

Measurements

No. 1.		M.
Length of muzzle in front of canine		.017
Diameter of canine at base	antero posterior	.018
	transverse	.011
Distance from canine to p. M. 2		.017

Measurements.

No. 2.	M.
Length of base of series to canine	.062
" " second premolar	.018
" " sectorial	.025
Elevation to summit of infraorbital foramen	.033

The characters displayed by the second cranium lead me to suspect that it is that of a female. A striking feature of the superior dental series is the small size of the canine, which is also not much compressed at the base. As regards the cranium, the sagittal crest is only distinct over the posterior part of the brain case; the zygomata are not very widely expanded, and the muzzle is narrowed. The external infraorbital foramen is large.

The mental border of the mandibular ramus is not flared downwards but is continuous, but the external is separated from the anterior and inferior faces by strong angles. The diastema is long. Three molars, all large; the first without anterior basal tubercle, the second with a large one. Sectorial tooth the longest, with well developed simple cutting heel.

Measurements.		M.
Total length of cranium		.192
Greatest width "		.123
Length of dental series with canine		.077
Diameter of canine at base	antero-posterior	.012
	transverse	.008
Distance between canine and second premolar		.019
Length base second premolar		.019
Length base sectorial		.023
Length inferior dental series, with canine		.094
" diastema		.025
Length base of first premolar		.015
" " sectorial		.027
Depth of ramus below second premolar		.032
" " superior canine		.027

This sabre-toothed tiger is larger than the *Machærodus primævus*, and is more like the animal indicated by a fragment of the lower jaw named by Leidy, *M. occidentalis*. But the latter agrees with the *M. primævus* in the relatively small size of teeth, especially of the first premolar, and in their oblique position, characters not seen in *M. brachyops*.

PERISSODACTYLA.

ANCHITHERIUM EQUICEPS, sp. nov.

This animal is represented by a portion of the skeleton including a complete cranium of one individual with mandibular rami of several others. The characters of the species are well marked, and do not approach very nearly to those of any other known to me.

The skull is considerably larger than that of *A. bairdi*, and the length is greater as compared to the transverse and vertical diameters. The preorbital region is but little concave, and the anterior border of the orbit is above the posterior half of the first true molar. The molar teeth present a tubercle between the anterior lobes, and a weak cingulum extends round the inner base of the anterior one, and in the second premolar, round the base of both inner lobes. Thence it passes round the anterior base of the crown and ceases in a tubercle which rises in contact with the anterior median crest. On the posterior side of the crown the cingulum in like manner terminates in the large three-sided posterior marginal tubercle. The anterior median tubercle-crest is well distinguished from the anterior inner tubercle and is directed very obliquely. The posterior median crest is continuous with the inner, and is well separated from the external crests. The external basal cingulum is robust, the columns are prominent, and the outer faces of the external crescents deeply impressed but with a well marked median ridge. The external cingulum and its margins is rugose; other parts of the enamel smooth. The first premolar has two roots; the second premolar is as long as the fourth, and longer than the last true molar.

Measurements.

		M
Total length of cranium		.280
Length of dental series to first incisor		.147
" " " canine		.130
" molar "		.100
" premolars		.053
" second premolar		.015
Width of " "		.015
Diameter first true molar	antero-posterior	.0135
	transverse	.0165
Diameter of last true molar	antero-posterior	.0135
	transverse	.0170

From *A. condoni* Leidy, this species differs materially in the composition of the superior molars. In that species there are no inner tubercle and cingulum; the anterior median crest is more completely separated; the anterior cingulum does not cease with the anterior marginal tubercle, and the posterior marginal tubercle is linear, not trihedral.

Anchitherium brachylophum, sp. nov.

Portions of the maxillary bones supporting molar teeth, indicate a species of the size of the *A. equiceps*, but differing in various respects.

The median and inner tubercles are not deeply separated, and the former are cut off from the external crescents by a deep fissure. There is no tubercle between the bases of the inner cones, nor is there any internal cingulum. The anterior cingulum does not develop a distinct tubercle, and does not extend to the anterior extremity of the anterior outer crescent. The posterior cingulum develops a large trihedral tubercle, and then extends nearly to the external crescent. The external cingulum is robust, and the external columns are prominent; the intervening spaces are impressed, and have a distinct median ridge. Enamel smooth or slightly rugose at base of crown.

Measurements.		M.
Length of two superior molars		.030
Diameter of first superior molar	antero-posterior	.015
	transverse	.017

These dimensions are those of the *A. equiceps*.

ANCHITHERIUM LONGICRISTIS, sp. nov.

This is a smaller species than the two above described, having the dimensions of the *A. bairdi*. The best specimen representing it consists of a right maxillary bone, which supports all the molars excepting the last. The infraorbital foramen issues above the third premolar. The first premolar is two-rooted; the second is not elongate, and is equal to the other premolars, or the penultimate true molar, in antero-posterior diameter. There are no interior basal tubercles or cingula, but the anterior cingulum has a tubercle which is appressed closely to the anterior median. The posterior cingulum expands into a large trihedral posterior marginal tubercle. The anterior median tubercle-crest, appears in the worn state to be moderately distinct from the internal; both it and the posterior middle are characterized by their production outwards; the latter passing between the exterior crescents and forming a junction with their common connection. The external cingula are not strongly marked, nor the external faces of the crescents impressed; the latter are convex, and with the median ridge little distinct. Enamel smooth.

Measurements.		M.
Length of anterior six molars		.062
" premolar series		.044
Diameter of second premolar	antero-posterior	.013
	transverse	.014
Diameter of second true molar	antero-posterior	.0125
	transverse	.0165

In the Annual Report of the U. S. Geol. Surv. Terrs. for 1873,* I gave the comparative characters of the three species of this genus then known to me, viz.: *A. bairdi* Leidy; *A. cuneatum* Cope, and *A. exoletum* Cope. I now give a table in which the three species above described are introduced, with the *A. condoni* Leidy.

A A tubercle between the internal lobes of the superior molars.

Larger; median tubercles well separated; large anterior and posterior marginal tubercles. . . . . *A. equiceps*.

Smaller; median tubercles not separated; no anterior marginal and a small posterior marginal tubercle . . . . . *A. bairdi*.

AA No tubercle between inner lobes.

* Page 496.

i. External cingulum robust.

β Anterior median crest little or not distinct.

Larger; median crests cut off externally; no anterior marginal tubercle; external faces impressed.......................... *A. brachylophum.*

Small; posterior median crest confluent with external crests; an anterior marginal tubercle; external face little impressed....... *A. longicristis.*

ββ Anterior median crest isolated.

Larger; a large anterior marginal tubercle; posterior marginal linear wrinkled.. *A. condoni.*

Small; anterior marginal tubercle minute, posterior triangular; median crests short; smooth................................ *A. cuneatum.*

ii. External cingulum narrow.

External faces without median rib; median crests short, the anterior cut off; marginal tubercles small.......................... *A. exoletum.*

STYLONUS SEVERSUS, gen. et sp. nov.

Gen. Char. These are derived from superior molar teeth *Stylonus* is allied to *Hippotherium* in details, including the isolation of the anterior internal enamel covered column, which thus forms an island of dentine, and in the prismatic character of the tooth. It differs from it in the fact that the posterior internal column is isolated in the same manner as the anterior, thus forming a second island on the triturating surface of the crown.

This interesting new genus adds one to the already numerous forms of extinct equine animals. It carries to its limit the line of development which retains the inner tubercles of the molar crown distinct from the median. The preceding station on this line which we know is the genus *Anchippus*, where the median crests have not assumed the antero-posterior direction belonging to the higher equine genera, and where the molars have short crowns and long roots. We may then believe that the line which includes *Anchippus*, *Hippotherium*, and *Stylonus*, is a side branch from that which terminated in *Equus*. The line of *Equus* must be traced from *Anchitherium* through *Protohippus* and *Hippidium*.

Specif. Char. Two superior molar teeth were accompanied by a number of inferior molars as having been all found together, but whether they belong to one individual is uncertain. The dentinal lakes of the superior molar are confluent by the median transverse valley, and increased wear would probably join the posterior pair by their posterior angles. The borders of the cementum lakes are simple, except one or two plications on their opposed adjacent borders, and one at the posterior inner part of the posterior. The internal columns are small, and their sections form two equal ovals with their long axes antero-posterior. The anterior dentinal lake sends off a narrow loop towards the posterior part of the anterior column. The shaft of the tooth is incurved, and the external face is unequally divided by the usual ridge. The wide gutters on each side of the latter are uniformly concave, and contain a rather shallow deposit of cementum.

In the inferior molars the two median interior tubercles are stout, and the loops which they bound, are nearly enclosed. There is a tubercle between the bases of the external columns.

Measurements.		M.
Length of crown of superior molar.		.028
Diameter superior molar	antero-posterior	.018
	transverse	.016
Long diameter internal column-lake		.005

From the Pliocene formation of Cottonwood, Grant co., Oregon.

DÆODON SHOSHONENSIS, gen. et sp. nov.

Gen. Char. These are indicated by the terminal portion of the lower jaw of a huge mammal, which does not resemble that of any known genus of this order. It supports on the side, three incisors, one canine, and two premolars, which form an uninterrupted series. The first premolar has two roots; and the canine is of huge proportions. The mandibular symphysis is coössified, and there are no osseous tuberosities on it nor on the adjacent parts of the rami.

The characters of the piece on which this genus is established indicate that the latter probably pertains to the *Chalicotheriidæ* along with *Menodus* and *Symborodon*. From these its six inferior incisors distinguish it, while the absence of a diastema separates it from *Chalicotherium*. From *Palæosyops* and *Limnohyus* it may be known by the large two-rooted first premolar, or more correctly, in all probability, by the absence of the first premolar of the inferior series. In the relatively powerful canines it resembles the last named rather than the first named genera.

Specif. Char. The canine teeth are very robust, as in the species of *Elotherium*. The inferior face of the symphysis is not steeply inclined, and is quite elongate. It is narrowed near the bifurcation and expands to a rounded incisive border. The first incisor is narrower than the second and third, which are robust. There are two small mental foramina, the larger below the anterior root of the anterior premolar; the second below the anterior root of the second premolar.

Measurements.		M.
Length of symphysis above		.155
Width between bases of canines		.100
Antero-posterior diameter of base of canine		.055
Transverse " "	second incisor	.022
Diameter of base of first premolar	antero-posterior	.040
	transverse	.025

This species is the largest of the North American *Perissodactyla*, with the possible exception of the *Menodus proutii*.

ARTIODACTYLA.

HYOPOTAMUS GUYOTIANUS, sp. nov.

This species of a genus little known in North America, is represented by a portion of the left mandibular ramus, in which only the last molar is sufficiently well preserved for identification. The latter is, however, perfect, and furnishes clear evidence of the former existence on the west side of the Rocky Mountains of a species distinct from the *H. americanus* Leidy, from the more eastern regions. The cones are in pairs and are directly opposed; their section is sub-trihedral, the two external sides of the external cones, forming a regular convexity. The cusps are acutely produced and slightly divergent. The posterior side of each outer cusp is excavated; the exterior side of the same presents a median rib with a concavity on each side, which is terminated below by an imperfect cingulum. The latter terminates on each side of the base of the cusp in a rudimental cusp, of which there are thus four on the external side of the tooth. The boundaries of the inner face of the external cusps are angular; the posterior one joins a corresponding ridge from the inner cusps, but there is no descending ridge on the anterior inner side of the internal cusp, which therefore forms no junction with the opposite part of the external cusp. The fifth cusp is well developed, and sends a crest inwards to the interior base of the interior cusp of the adjacent pair.

Measurements.		M.
Diameter of last inferior molar	antero-posterior......	.022
	transverse...........	.010

This species is smaller than the *H. americanus*, and differs much in details. It is dedicated to Prof. Arnold Guyot, of Princeton, New Jersey.

Descriptive list of medals struck to commemorate the Battle of Waterloo. By Henry Phillips, Jr., A.M.

(Read before the American Philosophical Society, Dec. 6, 1878.)

1. Medal by Pistrucci (never struck but reproduced by galvanism). *Obverse.* The Dioscuri in heaven. Zeus in a quadriga smites the Titans with a thunderbolt. *Reverse.* In profile are the heads of the emperors of Austria and Russia, and of the Kings of Prussia and Great Britain, surrounded by allegorical emblems representing peace.
2. *Obv.* Laureated profile facing right with inscription NAPOLEON EMPEREUR.
   Rev. Victory holding a palm branch and hovering in the air over a mass of broken arms and trees. In the exergue, BATAILLE DU MONT ST. JEAN XVIII JUIN MDCCCXV.
3. *Obv.* Laureated profile facing right NAPOLEON BONAPARTE.
   Rev. An eagle vanquished by vultures; WATERLOO. In the exergue, 18 JUIN 1815.
4. *Obv.* Three-quarter bust. WILH: FR: G: L: ARAUS. REGNI BELGICI PRINC: HEREDITAR.
   Rev. Victory between two trophies of arms and the French flag. VIS

VIRTUTE REPRESSA. In the exergue, AD QUATRES BRAS D. XVI JUNII MDCCCXV.

5. *Obv.* Bust facing right. ARTHUR DUKE OF WELLINGTON.
Rev. Two joined hands surrounded by a laurel wreath tied with ribbands, bearing the names of Wellington's victories. WATERLOO, JUNE XVIII MDCCCXV.

6. *Obv.* Bust facing left. DUKE OF WELLINGTON. Exterior legend. *England : Portl: Spain: Swed[n]. Russ[a]. Pruss[a]. Aust[a]. Holl[d]. et France. United* 30*th May* 1814.
Rev. Victory seated on a stand, holding in her right hand a palm branch and in the left a laurel. WELLINGTON. Upon the stand WATERLOO. Exergue, June 18, 1815. Exterior legend, *The hero of freedom, the pride of his country and the ornament of human nature.*

7. *Obv.* Two busts facing—HERZOG VON WELLINGTON. FÜRST VON BLÜCHER. Below the busts, IETTON.
Rev. A battle. SCHLACHT BEI LA BELLE ALLIANCE. Exergue, *v:* 15 : *Bis* 18, *Iun.* 1815.

8. *Obv.* Bust facing right. HENRY WILLIAM MARQUIS OF ANGLESEY.
Rev. Mounted officer leading a squadron. CHARGE OF THE BRITISH AT WATERLOO. Exergue, JUNE XVIII MDCCCXV.

9. *Obv.* Profile facing right. WILHELM IV KOENIG V. HANNOVER. A : KOENIG D : V : R GROSS BRIT : U. IRL :
Rev. Victory on a column of triumph. DEN SIEGERN VON WATERLOO DAS DANKBARE VATERLAND *errichtet Hanover D. XVIII. Jun.* MDCCCXXXII. Exergue, *XVIII Jun. MDCCCXV.*

10. *Obv.* Two heads facing each other under a laurel crown in a frame placed on standards : *La Belle alliance.* HERZOG VON WELLINGTON. FÜRST VON BLUCHER. On the ground a sword, a buckler and a broken eagle, with these words, *S. Joan. Waterloo.*
Rev. A winged figure borne on clouds bearing a shield surrounded by inscription *M. S. Joan, Waterloo.* Inscription on shield in ten lines :

DEN
ANDENKEN
DER FÜR DIE
VERBUNDETEN HEERE
SO SIEGREICHEN
FÜR EUROPA'S WOHL
SO ENTSCHEIDENDEN
TAGE
DES 16 : 17 : 18 JUNI
1815.

11. *Obv.* Two heads facing: BLÜCHER WELLINGTON on a laurel crown.
Rev. DER SIEGGEWOHNTEN HELDEN HERRLICHSTER SIEG VON GOTT GEGEBEN ZUM UNVERWELKLICHEN LORBEERKRANZ. VERNICH-

TUNG DES MEINEIDIGEN FEINDES NACH VIER-TAEGIGER SCHLACHT BEI LA BELLE ALLIANCE D. 18 JUNI 1815.

12. *Obv.* Two superposed heads in profile facing left. ALEXANDER I FRIED WILHELM III.

Rev. Gothic pyramid. DANKBAR GEGEN GOTT EINGEDENK SEINER TREUEN VERBUNDETEN UND EHREND DIE TAPFERKEIT SEINES VOLKES LEGTE IN GEMEINSCHAFT MIT ALEKANDER I KEIZER VON RUSSLAND FRIEDERICH WILHELM III, DEN 19 SEPTEMBER, 1818, DEN GRUNDSTEIN DES DENKMALS FUR DIE RUHMVOLLEN EREIGNISSE IN DEN JAHREN 1813 : 1814 : 1815 :

13. *Obv.* Same pyramid. As a circular legend a list of the victories won by the Prussians over the French, finishing with LA BELLE ALLIANCE* LAON* BAR SUR AUBE* PARIS.*

Rev. An archaic German inscription. Around the German inscription, "Monument at Berlin, made at the royal iron foundery at Berlin, erected in 1820, inaugurated March 30, 1821."

14. *Obv.* Head of Blücher facing left, bust draped in a lion's skin. DEM FÜRSTEN BLÜCHER VON WAHLSTATT DIE BÜRGER BERLINS IM JAHR 1816.

Rev. St. Michael destroying the dragon ; below 1813 : 1814 : 1815.

15. *Obv.* Profile head facing right. BLÜCHER VON WAHLSTADT in a laurel wreath.

Rev. The arms of Blücher below a ducal robe.

16. *Obv.* Profile facing right in a laurel wreath ; GNEISENAU.

Rev. Arms of Count Gneisenau.

17. *Obv.* Profile facing right. FRIEDE. WILHELM VON BRAUNSCHWEIG.

Rev. An armorial escutcheon, surrounded by a collar of an order and charged with six bearings.

18. *Obv.* Right profile bust in a laurel wreath. WELLINGTON.

Rev. The arms of the duke.

19. *Obv.* Left profile, GUILLELMO HEROI DILECTO.

Rev. Four arms forming a cross. *Le* 16 *Juni* 1815.

20. *Obv.* Horseman galloping right. CROWN PRINCE OF ORANGE. HOLLAND'S GLORY.

Rev. Within a crown of palm and laurel. WATERLOO. JUNE 18, 1815.

21. *Obv.* Profile bust facing left. F. MAR. G. L. VON BLÜCHER. THE LIBERTIES OF EUROPE REST[D] BY THE UNITED EFFORTS OF ENGLAND AND HER AUGUST ALLIES THE PRELIMINARIES OF PEACE SIGNED MAY 30, 1814. Profile bust facing right. ALEXANDER EMP. OF ALL THE RUSSIAS.

Rev. Within a crown of palm and olive. IN ARMS INVINCIBLE IN COUNCIL TRUE.

22. *Obv.* Profile facing left. THE DUKE OF WELLINGTON.

Rev. Same as No. 21.

23. *Obv.* Profile facing right. THE DUKE OF WELLINGTON.

Rev. WATERLOO.

24. *Obv.* Bust facing left. ARTHUR DUKE OF WELLINGTON.
Rev. Mausoleum, surrounded by a lion and two figures, with inscription, WELLINGTON, *born May* 1769 *died Sepr.* 14, 1852. Legend. BRITANNIA MOURNS HER HERO NOW AT REST. In the exergue, WATERLOO *June* 18, 1815.

25. *Obv.* Victory holding a sword in right hand and in her left a crown *Gott segnete die vereinigten heere.*
Rev. Bei la belle alliance durch Blücher und Wellington d. 18 *June* 1815.

26. *Obv.* Same as 25.
Rev. DURCH DEN SIEGREICHEN EINZUG BLÜCHER UND WELLINGTON'S IN PARIS D. 7 JUNI 1815.

27. *Obv.* Trophy, formed of a helm, a sword, an olive branch and an owl.
Rev. SIEG BEI LA BELLE ALLIANCE DURCH HERZOG V. WELLINGTON UND FÜRSTEN V. BLÜCHER AM 18 JUNI 1815.

28. *Obv.* Laureated profile head facing left. GEORGIUS W. P. VICEM. REGIS BRITANNIARUM GERENS.
Rev. The Royal standard of England. Above WELLINGTON, below WATERLOO DIE JUN 18, 1815. On the edge, *Ponte Waterlooensi dedicato Jun* 18, 1817.

29. *Obv.* Profile facing right. GULIELMUS I BELGARUM REX.
Rev. The lion of Waterloo on the mound. MONUMENTUM WATERLOOEUM *erectum* M. D. CCCXXIV.

29½. *Obv.* Profile facing right. WILHEM I. KONING DER NEDERLANDEN.
Rev. The lion on a pedestal. In the exergue, WATERLOO.

30. *Obv.* Beneath the All-seeing-eye and within a wreath of palms, a lion armed with a sword and bearing a buckler charged with a bundle of arrows, protects a crown and sceptre under an orange branch. DEO. REGI. PATRIÆ. Exergue XVIII JUNI MDCCCXV.
Rev. Within an oak crown: SOCIETAS WATERLOANA MARTIO MILITUM ANIMO PROBATÆ FIDEI AUSPICE FREDERICO AUG. BELGARUM PR.

31. *Obv.* Laureated head, Prince Regent, facing left. GEORGE P. REGENT.
Rev. Victory seated with extended wings; above WELLINGTON, below WATERLOO JUNE 18, 1815.

32. *Obv.* Laureated head, facing right. GEORG PRINZ REGENT 1815.
Rev. Within two laurel branches WATERLOO, above is a cuirass placed on two swords and two flags. HANNOVERSCHER TAPFERKEIT.

33. *Obv.* Same, except head faces left.
Rev. Same.

34. *Obv.* Profile facing right. FRIEDERICH HERZOG ZU NASSAU.
Rev. Victory holding a palm and crowning a Roman warrior. DEN NASSAUISCHEN STREITERN BEY WATERLOO. Exergue, DEN 18 JUNI 1815.

35. *Obv.* Same head as 34, but larger. FRIEDERICH I. HERZOG ZU NASSAU.

Rev. Within a laurel crown placed on a trophy of flags, DER TAPFERKEIT.

36. *Obv.* Profile bust facing left. FRIEDERICH WILHELM HERZOG.
Rev. 1815 within a crown of oak and laurel. BRAUNSCHWEIG SEINEN KRIEGERN *Quatre Bras* UND WATERLOO.

37. *Obv.* F. W. surmounting a regal crown. Below, PREUSSENS TAPFERN KRIEGERN. Circular legend, GOTT WAR MITT UNS, IHM SEI DIE EHRE.
Rev. A cross between rays. 1815 in the centre of a laurel and oak crown. Below, AUS EROBERTEM GESCHÜTZE.

The same medal also exists with the date 1813 and with the date 1813/1814.

38. An oval medal bearing same emblems as the last. The inscription differs, and is FÜR PFLICHTTREUE IM KRIEGE.

39. *Obv.* A ducal coronet. FUR DAS RECHT : IM KAMPFE.
Rev. A rose with five leaves surrounded by a circle and ten arches. Below, HERZOGTH : GOTHA UND ALTENBURG MDCCCXIV. MDCCCXV.

40. *Obv.* The letter "P" above a closed crown.
Rev. 1815 in a laurel wreath.

41. *Obv.* A battered head of an old person ; above, MEDAILLE DE WATERLOO ; below, AU DERNIER DES CHAUVINS VOILA TOUT CE QUI RESTE.
Rev. REVERS DE LA MEDAILLE. 15 *Juin* 1815. Legend, *A ses compagnons de raclée sa derniere parole....signè cambronne.*

42. *Obv.* Monument of Waterloo ; at the base, XVIII JUNI MDCCCXV.
Rev. *Souvenir du champ de bataille de Waterloo.*

43. *Obv.* Same monument ; *Champ de bataille de Waterloo.*
Rev. In an oak crown, SOUVENIR DE BELGIQUE.

44. *Obv.* Same as 43.
Rev. In a circle, DE HAZE ; MONT ST. JEAN.
Circular legend, HOTEL DES COLONNES.

45. *Obv.* Peace in a cultivated field ; HEIL DEM FRIEDEN ! ER SEGNET REICH DIE ERDE.
Rev. An arch of triumph bearing the words, GLORIA ! EURE THATEN BEWUNDEREN MILLIONEN. Exergue, 1815.

46. A *button ; obverse, Waterloo Juin* 1815.
Rev. A landscape with the Church of Waterloo in the distance.

47. *Obv.* Liberty and Victory, holding in their hands a crown ; above a lion which has broken its chains, and a mass of arms. In the background the lion of Waterloo on its mound. EENDRAGT MAAKT MAGT. Exergue 1815, 1865.
Rev. An oak crown bound with bands charged with seven shields of armorial bearing. PR. V. ORANJE *Saxen Weymar perponcher Brunswyk-oels. Uxbridge* WELLINGTON. *Picton. Bülow. Ziethen.* BLÜCHER.

48. *Obv.* Same as 47, without any inscription.
Rev. The lion of Waterloo. Below, 1815. *Herinnering aan het halve eeuwfeest* 18 *Junij* 1865. *Waterloo.*

49. *Obv.* Laureated profile and bust of Prince of Orange (Wm. III) facing left. DE HELD VAN WATERLOO.
Rev. An antique warrior descended from a horse is crushing with an enormous stone a conquered foe. *Neerlands Roem* 18 *Junij* 1815 *plegteg herdacht.* 18 *Junij* 1865 Exergue, *De tiranny verslagen.*

50. *Obv.* A lion on a pedestal encircled by a trophy of arms and flags. On the pedestal, XVIII JUNIJ MDCCCXV. Legende, WATERLOO 1815-1865.
Rev. The crowned escutcheon of the Netherlands supported by those of England and Prussia. Below, on a ribband, *Je maintiendrai.* TER HERINNEG *aan de roemrijke dagen van* 1815.

51. *Obv.* A helmet, sword and palm beneath the word WATERLOO, on which the sun is shedding its rays. Below, 16—18 Junij 1815. Exergue, MDCCCLXV.
Rev. In a laurel crown *De strik is gebroken, en wij zyn ontkomen.* Ps. CXXIV vs 7.

52. *Medallion.* The lion on its pedestal with the date *XVIII Juny MDCCCXV* surrounded by oak and laurel branches; below, DEUS NOSTER REFUGIUM ET VIRTUS. On the edge 1815–1865. WELLINGTON, BLUECHER, ORANJÉ.

53. *Obv.* Bust facing left. *Georg v. v. g. g. Kœnig v. Hannover.*
Rev. In a laurel crown, *Den Siegern bei Waterloo gewidmet am* 18 *Juni* 1865. On the edge *Nec aspera terrent.*

54. *Obv.* The arms of the City of Hanover. STADT HANNOVER DEN SIEGERN V. WATERLOO 18 JUNI 1815.
Rev. In a laurel crown, *Zur* 50 *Jahrigen jubelfeier am* 18 *Juni* 1865.

Stated Meeting, December 6, 1878.

Present, 13 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from C. Schorlemmer, F.R.S., Professor of Organic Chemistry, Owens College, Manchester, Nov. 4, 1878, and from M. A. Des Cloizeaux, Paris, Nov. 10, 1878.

Letters of acknowledgment were received from the R. Library, Berlin (100; List); Natural History Society, Freiberg in Baden (99; 100; List); Oberhessische Gesellschaft, Giessen (100; want 99); Royal Society, Luxembourg (101); Statistical Society, London (100; Cat. part iii); Smithsonian Institution (101).

Letters of envoy were received from the Royal Irish Academy, Oct. 1878, and the Consul General of the Netherlands, New York, Nov. 22, 1878; and Prof. Jacob Ennis, Shippensburg, Dec. 3, 1878.

Donations for the Library were received from the Academies at St. Petersburg, Buda-Pesth, Berlin, Lisbon and Philadelphia; the Societies at Halle, Bamberg, Breslau, and Bordeaux; Flora Batava; London Nature; Nova Scotian Institute, Halifax; Prof. Ennis; Essex Institute; Mass. Historical Society; Museum of Comparative Zoölogy, Cambridge; American Journal of Science, and Prof. Marsh, of New Hampshire; New Jersey Historical Society; Mr. Robinson, of Philadelphia; the War Department, and Prof. Cleveland Abbé; Editor of the American Antiquarian, Cleveland, Ohio; the Botanical Gazette; Dr. J. W. Mallet, of Mexico, and Mr. Lane S. Hart, State Printer, Harrisburg.

A donation for the collection of portraits was received from Mr. Sol. W. Roberts, a portrait of the late Joseph Henry, in oils, framed and endorsed, "Prof. Joseph Henry, Sec'y of the Smithsonian Institution, &c. Born at Albany, New York, Dec. 17, 1797; Died at Washington, D. C., May 13, 1878, in his eighty-first year. This small portrait of Prof. Henry is presented to the American Philosophical Society by Solomon W. Roberts, Civil Engineer, Philad'a, Dec. 1878."

A paper, entitled "Descriptive List of Medals Struck to Commemorate the Battle of Waterloo. By Henry Phillips, Jr." was read by the Secretary.

Mr. Blasius exhibited and described an ingenious musical invention of Mr. Matthews, of Boston, on the principle of the Jacquard Loom, by which tunes are played, and the instruction of children in time and modulation is made easy.

Prof. Prime described the moraines and surface drift deposits of Northampton County, Pa., and exhibited their positions on a large map.

Prof. Prime described the glacial drift of Northampton County, Pennsylvania, as determined by him during the past Summer.

A glacial moraine may be traced from the Wind Gap in the Kittatinny Mountain through Ackermannville, Bangor and Williamsburg to Portland on the Delaware River. Crossing the river at this point it extends across New Jersey on to Long Island. This Moraine exhibits the hummock surface so common to glacial moraines everywhere; sometimes it contains peat beds; is often forty to sixty feet high, and is the cause of the marshy deposits so frequent in that portion of the country. Being easily cultivated and the soil quite productive it is usually cleared and cultivated.

West of the Wind Gap no glacial moraine can be seen as far as the Lehigh River. That it has existed, however, there is but little doubt and was probably washed away again by aqueous action to be re-deposited as modified drift over most of the limestone portion of the country north of the Lehigh, covering the limestone and rendering its structure difficult to determine. This modified drift is quite prominent at two points; one being on top of the hill where lies West Bethlehem, the other at Easton, in what is called West Ward, both at a height of about 320 feet above tide-level. At West Bethlehem the drift is distinctly stratified, consisting of alternated layers of sand and pebbles or small boulders. At Easton, however, such a bedding is not so distinct.

The fact that both of these deposits occur almost at the same level, would seem to indicate that they had been deposited cotemporaneously by the same action, either fluviatile or due to a subsidence.

Another glacial moraine also exists in the Saucon Valley south of the Lehigh, it extends from Friedensville almost to Bingen station on the North Pennsylvania Railroad.

No trace of glacial action has been as yet noted in the Laurentain rocks forming the South Mountain in Northampton county, and the glaciers either passed around them or going over left no trace of their course. The former being probably the case.

In the discussion which followed Mr. Lesley added the following facts which touched upon the now so widely mooted questions relating to the Drift phenomena of the United States:

He remarked that there were similar isolated patches of gravel, each several hundreds of acres in extent, lying on the level upland of Delaware and Chester counties, south west of Philadelphia, and that these patches have about the same elevation above tide, say 350 feet.

The uppermost or gravel terrace along the north-west side of the valley of the Delaware River, the remains of which have been traced by Mr. Lewis, of Germantown, all the way from Wilmington, in Delaware, northward through Chester county and the Fairmount Park, half way to Trenton, is made by recent levels taken by Mr. Lewis and Mr. C. W. Ames to occupy about the same geological position. Mr. Lewis asserts that he has identified this high level terrace at points in New Jersey on the south-eastern wall of the Delaware River Valley.

At the date of this terrace, whether in tertiary or post-tertiary times, tide water must have covered not only Chester and Delaware counties, but broad belts of inland, including the limestone plain of Northampton and Lehigh counties, and the sites of Easton and Bethlehem.

Professor Frazer has discovered two patches of drift gravel at points in Lancaster county, some miles back from the Susquehanna River, and distant from each other.

It is therefore probable that at the time of the deposit of these gravels a large part of south-eastern Pennsylvania, and in fact of the whole seaboard of the United States, was at least 400 feet under water.

Whether or not a greater depth of water can be assigned, may perhaps be settled by the lines of levels now being run by the Geological Survey to determine accurately the heights of the isolated gravel beds, in connection with the study of other parts of the State.

Mr. Lesley then referred to his discussion of the 1300 foot subsidence of Western Pennsylvania, published in his preface to Professor White's Report of Progress on Beaver county, but considered all present generalizations premature for want of sufficiently accurate data in a sufficient number of places.

It is possible that the remarkable terminal moraine described by the New Jersey geologists, and by Professor Prime, may have had its *geographical* position determined by the border of standing water (ocean) at the time when tide level stood at least 400 feet above its present datum.

The Annual report of the Treasurer was read.

Pending nomination No. 871 and new nomination 872 were read.

The Curators reported that the Cabinet of Antiquities had been removed to the Academy of Natural Sciences, on deposit, subject to demand, in accordance with the resolution of November 16, 1877, and receipted for by W. S. W. Ruschenberger, President of the Academy of Natural Sciences of Philadelphia.

The Curators reported that the Cabinet of Coins had been removed to the Pennsylvania Museum of Industrial Art in Fairmount Park, on deposit in the custody of the Numismatic and Antiquarian Society of Philadelphia, subject to demand, in accordance with the resolution of November 15, 1878, and receipted for by Henry Phillips, Jr., for that Society.

Both the above named collections are, by agreement with the respective societies, to be properly guarded, cared for, exhibited, and restored to the custody of this Society on demand.

On motion, the Curators were authorized to lend, for the use of the Curators of the Academy and Numismatic Society in constructing their respective catalogues of the articles thus deposited in their care, the catalogues in the Library of the American Philosophical Society.

And the meeting was adjourned.

Stated Meeting, December 20, 1878.

Present, 17 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Royal Society, London, Nov. 27 (101); Victoria Institute, Dec. 3 (101); Royal Observatory, Brusselles, Nov. 23 (101; Cat. part iii).

A letter of envoy was received from the United States Department of the Interior, Dec. 11, 1878.

A letter of envoy was received from M. Lubawsky, dated Nov. 24, 1878, Viarma, Russia.

A letter requesting exchanges was received from Mr. Jerome B. Gray, Corresponding Secretary of the Philosophical Society, West Chester, Pa., Dec. 12, 1878. On motion, the name of that Society was ordered to be placed on the list to receive the Proceedings from the beginning.

Also from Rev. Stephen D. Peet, Editor of the American Antiquarian, Cleveland, Ohio, and Corresponding Secretary of the American Anthropological Society and State Archæological Association of Ohio. On motion, Mr. Peet's name was ordered to be placed on the list to receive the Proceedings from the beginning.

A catalogue of and receipt for the coins and medals deposited with the Numismatic and Antiquarian Society was received from Mr. Davis, Curator.

Donations for the Library were received from the Melbourne Mining Survey Office; Russian Geographical Society; Paris Geographical Society and Revue Politique; Bordeaux Commercial Geographical Society; London Nature; Boston Society of Natural History; Rhode Island Historical Society; Brooklyn Entomological Society; Franklin Institute; Medical News; Journal of Pharmacy, and E. D. Cope, Philadelphia; United States Department of the Interior, and Engineer Bureau, Washington; Mexican Agricultural Bureau, and M. C. Brogniart.

Gen. Russell Thayer read, pursuant to notice, a paper on the "Movement of Troops in Cities in cases of Riot and Insurrection." On motion of Mr. Price, seconded by Mr. Roberts, 1000 extra copies were ordered to be printed for general distribution.

Prof. Frazer exhibited and described a magnified colored picture of the crystals in a transparent slice of trap from Lancaster county.

Mr. Briggs explained away the difficulties about the amount of heat developed in the working of ice machines, which he had brought before the notice of the Society at a former meeting, by reference to a pamphlet transmitted to him from Paris by M. Pictet.

The Annual Report of the Committee on Finance was read and approved, and the resolutions recommended therein were moved and adopted.

Pending nominations 871, 872 and nomination 873 were read.

And the meeting was adjourned.

Movements of Troops in Cities in cases of Riot or Insurrection. By Russell Thayer.

(Read before the American Philosophical Society, Dec. 20th, 1878.)

It is indeed fortunate that the cases are few which demand the intervention of armed troops for the suppression of lawless mobs intent upon acts of violence. It is nevertheless true that at rare intervals the employment of the military force becomes necessary for the preservation of public order and security. Such occasions have arisen in the recent past, and may occur in the future.

It will be understood in the treatment of this subject that the troops referred to are militia, although in general the rules to be observed are, of course, the same whether regulars or militia are employed. The general reader will also understand that, the subject being treated from a military point of view, the serious questions of law and fact which precede the calling out of troops for the suppression of violence are not considered. The case supposed is simply as follows, viz.: an armed and turbulent mob exists in a large city, the civil authorities are powerless to suppress violence. As a last resort the military force has been duly and properly called upon, and lawfully empowered to act.

Now, two cases may occur. The mob may exist in the city in which the troops already are; or the troops may be called upon to go to a remote point to enforce the laws and restore order. These cases will be considered separately.

Case I. A large city is in a state of tumult. An armed mob exists. The civil authorities have endeavored to suppress the disturbance, and are powerless to do so. The military are called upon. What are the proper precautions to be taken, and the proper movements to be made?

It will be presumed that there is in the city one brigade, consisting of three regiments of infantry, a troop of cavalry, and a battery of artillery.

The commands are promptly assembled at their respective armories fully armed and equipped. A proper supply of ammunition is issued to each command. At the several armories the following dispositions will be made. A strong, armed guard should immediately be placed at the doors and in front of the building. If a mob collects outside, and threatens to force its way in, the doors and windows should be barricaded with anything that may be at hand (chairs, tables, benches, etc., will serve for this purpose), and a proper force is to be placed at each opening to repel any attack that may be made. It will, however, in most cases be unnecessary to make such dispositions as these, as in circumstances of this kind the mob is generally occupied at some remote point. It should also be here remarked that it adds much to the *esprit de corps* of the soldiers, and also materially impresses a mob of undisciplined men, if the troops are in full uniform, provided that uniform is a serviceable one, as it should be. Everything should be adjusted with the same precision as if the troops were going upon parade. White gloves should be worn, the drum corps should be present, and the proper officers should be mounted; this last is very important, as a commanding officer on foot has not that control of his command which he has when mounted, he cannot see his men, nor can they observe him or understand his orders. The cavalry should also be mounted and horses should be provided for the battery of artillery. In other words the commands should be equipped for the field. They will then be in proper condition to fight, if it is necessary

The commands will be concentrated at some central point, which should be selected somewhat remote from the scene of disturbance. In moving from the respective armories to the place of "rendezvous" the several commands should avoid any unnecessary noise or excitement. If possible they should reach the point at which the brigade is ordered to assemble without coming into collision with any portion of the mob. If, however, the passage of any command is obstructed and meets with armed resistance the command so attacked should immediately halt and prepare to force its way to its destination. If a regiment of infantry, it should be formed in column of companies or divisions. A line of skirmishers should then be sent forward from the leading company for the purpose of driving the mob from its position. The skirmishers should approach as near as possible to the enemy's line or defenses, taking advantage of any cover that may be available, and should reply rapidly to his fire. If necessary the skirmish line can be reinforced by successive lines of skirmishers. The firing should continue until the enemy's fire is entirely silenced, when a charge may be made upon his position with the object of driving him from the streets.

Unless protected by barricades it is not probable that the mob will long withstand the fire from the skirmish line, and as soon as it is dispersed the regiment should proceed to its destination.

The cavalry and artillery should pursue somewhat similar tactics: that is to say, they should endeavor to reach the point of concentration quietly and without disturbance; but if the mob should block their way and dispute their passage by force, decisive measures should be resorted to. In other words, it is expected that the several commands of the brigade will be at the "rendezvous" at the appointed hour, and they will go there, peacefully if they can, forcibly if they must.

It is necessary to state that in all cases the General in command should detail a particular battalion of infantry to proceed to the armory of the battery of artillery and escort it to the place of formation of the brigade. This force of infantry will prevent the artillery, should it be suddenly attacked, from falling into the hands of the mob, by holding the mob in check until the pieces can be unlimbered and brought into action. As soon as this is done and fire is opened from three or four pieces with canister, it is probable the artillery will be able to protect itself. The infantry can then be moved to the rear and act as a reserve.

The several commands of the brigade having arrived at the place of formation as ordered by the General, should be formed into three columns,* as follows: the centre consisting of the battery of artillery and a regiment of infantry, and the right and left columns consisting of the remaining regiments of infantry; the cavalry being assigned to the weaker command.

The infantry of the centre column should be formed in "close column by divisions." This formation is known as "the order preparatory for battle;" it prepares the troops for rapid deployment, and enables them to be speedily deployed in line of battle.

The infantry of the right and left columns should be formed in column of companies or divisions at full distance. This formation will enable them to form line of battle by a simple wheel of the subdivisions to the right or left, as the case may be, if attacked in flank. The centre column is free from this danger, being protected by the columns on its flanks.

The centre column should be preceded by an advance-guard composed of a company of well-disciplined troops selected from the regiment of infantry assigned to that column. The artillery should follow at a distance of about three hundred yards in column of sections, the pieces leading, and each caisson with ammunition following immediately behind its piece. The regiment of infantry should bring up the rear. By placing the company of infantry as an advance-guard in front of the main column, it will prevent any danger from a surprise; and should the mob be encountered sooner than contemplated, the infantry of the advance-guard will be able to hold it in check for a few moments until the leading pieces of artillery can be unlimbered and loaded.

In moving towards the district occupied by the mob, the three columns should proceed simultaneously by parallel streets, within easy supporting distance of each other; the heads of column should be kept as nearly as possible abreast. They will thus arrive at the scene of disturbance together, and striking the mob at different points, produce a more decided effect. Communication between the three columns should be constantly maintained, and should one of the columns be resisted in its march, the others should halt and reinforce it if necessary. Troops from the column not attacked would thus take the mob in flank and demoralize it. At the head of each column should be a number of workmen equipped with picks, axes, crowbars, and similar tools to enable them speedily to remove any obstructions that may have been placed in the road to impede the march of the troops.

The march of the three columns from the place of formation to the place occupied by the mob is known in war as a "manœuvre-march," and, "it is so called for the reason that it has not for its object a simple gain of ground,

*The advisability of forming the brigade into three columns of attack is, of course, somewhat dependent upon circumstances. In the case of a brigade organized as the one in question is supposed to be, and in a city which has a system of parallel streets leading towards the district occupied by the mob, this formation would be considered preferable. The brigade may not be of sufficient strength to admit of its being divided, in which case one or two columns should be formed.

as is the case with an ordinary march, but to reach a suitable position on the field when a battle may follow. It is executed in the immediate neighborhood of the enemy, and really under his observation. It should therefore be characterized by perfect order and great celerity." *

Upon arriving near the scene of action a strong line of skirmishers† should be deployed a few hundred yards in front of each column, and a portion of the infantry of the two flank columns should be deployed in line of battle if the ground admits of such deployment. The skirmishers should move forward and endeavor to clear the ground in front of the lines. If the mob yields, the line of battle and the main body of the troops can follow. If the mob holds the ground and resists by force of arms, the skirmishers should fire upon the mob, and availing themselves of any shelter that may present itself, such as trees, telegraph poles, doorsteps, etc., endeavor to silence the enemy's fire. If considered desirable the skirmishers and advance-guard in front of the centre column can be withdrawn, and fire may be opened upon the mob with the artillery. The skirmish line can be reinforced if necessary by successive lines of skirmishers sent forward from the line of battle.

In active street fighting the mounted officers should be careful not to expose themselves unnecessarily to the enemy's fire. The various movements of the skirmish line, "the advance," "the retreat," etc., should be indicated by the trumpet. The trumpeter should remain constantly by the side of the officer commanding the skirmish line and should sound the various calls under his immediate direction.

If the mob is not behind barricades the artillery should use canister (canister being less destructive to property than grape, solid shot, or shell, and probably more effective for this purpose at close range). If the enemy is protected by defenses, it may be necessary to use shell and solid shot to dislodge him,

The firing of the skirmish line and the artillery, if used, should be continued until the enemy's fire is silenced, when a charge should be made by a portion of the infantry from the three columns, and the mob should be driven by the troops until it is entirely dispersed.

If it should be necessary, a portion of the reserves from the rear of each column can be brought into action and the line of battle be extended.

The cavalry in charging should follow the remnants of the mob for a considerable distance, with the view of preventing it from again concentrating.

Upon the dispersion of the mob the troops should be so disposed as to hold the ground. The dispositions that should be made would, of course, depend on circumstances. If necessary, barricades should be thrown up across the principal streets. The commanding ground in the vicinity should be occupied, but under no circumstances should the troops be sta-

* Dufour.

† The best method of deploying skirmishers in a street is to form the company, or battalion in line, and then deploy by the numbers as explained in Par 358 Upton's Tactics.

tioned in a building where they can be surrounded, or in such a position as would place them in a state of siege by the mob.

Case II. When the troops are required to go to a distant place, a remote city, controlled by a mob, the movements would be somewhat similar upon arriving on the ground. The following points should, however, be carefully considered :

The troops would, in all probability, be transported by rail. They should be thoroughly armed and equipped as in the previous case. The men should have their overcoats and blankets, and be supplied with rations and ammunition. Transportation should be furnished for the horses of the cavalry, artillery, and mounted officers, and in general it may be said that the command should be prepared for a campaign, and be able to rely upon its own resources. This would make the men independent, comfortable, and capable of enduring privation. The experience of all wars demonstrates this fact, that the efficiency of troops is very greatly increased by their being properly clothed and fed.

In moving troops by rail through a country likely to be hostile, great care and extraordinary precautions should be taken. The possibility of accident to the trains containing the main body of the troops and the horses and baggage should be carefully guarded against.

A special train consisting of a locomotive and one or two cars should be sent in advance. A company of infantry under the command of an experienced officer, and a strong gang of workmen, provided with tools, should be sent with this train. The bridges should be carefully examined, and when one is crossed the advanced guard should halt and wait until the trains containing the main body of the troops come up. This plan of action will prevent the possibility of the bridge being burnt or destroyed by enemies lying in ambush, and who may allow the advance-guard to pass by in order to slip in between it and the main columns.

The several trains containing the main body of the troops and the horses and baggage, etc., should keep as close to each other as safety from accident will permit. In passing through towns where danger is apprehended, a strong advance-guard should be sent in front of the trains. It might also be desirable to have a line of troops march on either side of the cars, and to make dispositions to force a passage or repel an attack. The trains should close up to each other as they pass through the towns on the route, and the men should not be permitted to have any communication with the inhabitants. It is hardly necessary to state that there should be a strong guard with the horses and baggage. A rear-guard is also required.

In passing through tunnels and defiles the utmost precaution is necessary. A body of troops, if taken unawares, in such a position, is in great danger of being destroyed. Before passing through a cut or defile, the General should assure himself that the surrounding heights are not occupied ; if they are, the enemy must be driven from them before the trains are permitted to enter the pass.

A tunnel should not be entered until it is found to be entirely clear, and after the passage of the advance-guard, one train only should pass through at a time.

If, in passing through the country, it should be found that the entire population is alarmed and opposed to the passage of the troops, one brigade should not attempt to penetrate any farther, lest a general uprising of the population might occur, and the "line of communication" of the troops from their "base of supplies" being cut, the entire command might be surrounded and captured.

Such precautions as these every capable General will observe. Their neglect has at times caused disaster and ruin.

Under no circumstances should the trains be run directly into the city which is under control of the mob; such action would be in the highest degree imprudent, as the mob would, in all probability, be waiting for the troops at the depots, and by attacking them while in the cars, and unprepared for an assult, great confusion and loss would result, if indeed the entire command should be fortunate enough to escape rout.

Upon nearing the city, the trains should close upon each other and proceed with the utmost caution. Upon arriving within a short march of the city, near the suburbs, and if possible where convenient roads lead into the town, the trains should be halted, the troops including the artillery and cavalry, should be disembarked from the cars, and the several commands be formed.

If three parallel roads or streets lead into the city, a formation similar to that pursued in Case I. can be followed with advantage. That is to say, the Brigade can be formed in three columns and enter the city by three parallel streets, the columns being within easy supporting distance of each other. If this plan is not practicable (and the General can always decide this point, as he will have with him a plan of the city, showing the location of the several streets, etc.), he will be obliged to move in one or two columns. In either case his command must be preceded by an advance-guard, and strong gangs of workmen, capable of leveling any obstructions that may be met with. If possible "flankers," consisting of small bodies of men, should be thrown out upon both flanks, their commanding officer being instructed to notify the General as soon as the position of the mob in the city is found. He will thus be enabled to make his dispositions intelligently, and prepare for the attack.

In entering into the thickly built up portion of the city, it may be found that the houses on either side of the streets through which the troops must pass are occupied by the mob, who begin firing on the troops. If such a state of affairs should be found, the General must immediately halt his command, and detail a certain portion of it to clear the houses on either side of his way. Infantry only is serviceable for this purpose, and if the mob is determined in its resistance, severe fighting will have to be done. If the houses are detached and standing alone, they should be captured by surrounding them; if contiguous, and vigorously defended, a passage may be made from one to the other by breaking through the separating walls, meeting the enemy hand to hand, and compelling his submission.

In no case should the General move his command forward while he is exposed to a flank fire from the houses on either side of the street. In this case the same rule is applicable as is prescribed for the passage of defiles, viz. : first, clear the enemy from the surrounding heights before entering the pass. A violation of this rule may lead to serious results.

The houses on either side of the streets being cleared, the General can make the same dispositions as were applicable in Case I. If the mob should resist his progress in front, the skirmishers that were deployed in front of the line of battle should immediately open fire upon the enemy's position, and protecting themselves by cover as much as possible, endeavor to silence his fire. If this is successful, a charge may be made upon him in force. A strong reserve should also be kept in the rear, which can be moved to any point that may be threatened.

After the mob has been dispersed the troops should boldly take possession of a commanding position in the town and await further developments. Under no circumstances should the troops be shut up in a building where they can be besieged and their "base of supplies" be cut off. Experience has shown the folly of such action. Troops without water and food are quickly overcome, and they should not be placed in a position where such a misfortune can occur.

If it is possible that the mob may reassemble in great numbers and return to attack the troops in their position, with the intention of driving them from the place, the position should be at once fortified by throwing up earthworks and barricades. In the construction of these defenses the workmen before referred to will be found of great service. Barricades can be constructed of anything that may be at hand. Paving-stones, wagons, carts, furniture, bedding, etc., can be used. The artillery should be placed where it will sweep the ground in front of the defenses. The troops should then calmly await the approach of the mob, and upon its arrival within about one hundred yards, simultaneously pour upon it a fire that will destroy it and prevent the possibility of another attack.

This fact should be remembered, that as a general rule in these cases a display of weakness or hesitation on the part of the troops or their commanding officers will proportionately augment the courage and numbers of the mob and incite it to acts of violence. Bold and resolute action, when action is necessary, will in the end save much bloodshed and prevent great destruction of property.

It should be observed that in the consideration of this subject, one brigade of troops only has been considered. Should it be found necessary to employ more than one brigade, a division may be used advantageously. The general movements of the troops, and the plan of action to be followed, will be substantially the same whether a brigade or a division be employed, although in the latter case the movements will be on a more extended scale. A strong display of a well-disciplined and skillfully-handled force will in most instances be sufficient in itself to suppress the mob.

Philadelphia, Dec., 1878.

Contribution to the Lithology of Pennsylvania.

On the Physical and Chemical Characteristics of a Trap occurring at Williamson's Point. By Persifor Frazer, Jr. (1 colored plate.)

(*Read before the American Philosophical Society, Dec. 20th,* 1878.)

A thin vein of trap intersects the chloritic rocks at Williamson's Point, on the Susquehanna River in Lancaster Co. Pennsylvania, and near the Maryland line.

This trap dyke which cuts through the hard quartzose and chloritic rock at Williamson's Point is peculiar in its isolation from known rocks of igneous origin; in the manner in which it is foliated transversely to its contact planes; and in its disappearing on its under side in a feather edge. Its upper continuation is now obscure from the denudation of the rocks which it intersects, but as far as it can be followed it widens in an upward direction, and the uneven facade of rock against which it appears gives it the semblance of being dislocated in places, but this is a deception of the judgment.

The rocks are here twisted in a most extraordinary manner, and this twisting is more remarkable just south of the position of the dyke. A very fine specimen of a portion of this vein, with both walls distinct and attached on one side to the rock which it intersected, is No. 1760 in the collection of the Geological Survey.

An examination of this specimen will reveal the fact that the fissure has not been exactly along planes of lamination, but truncates the tops of several small waves into which the strata have been forced.

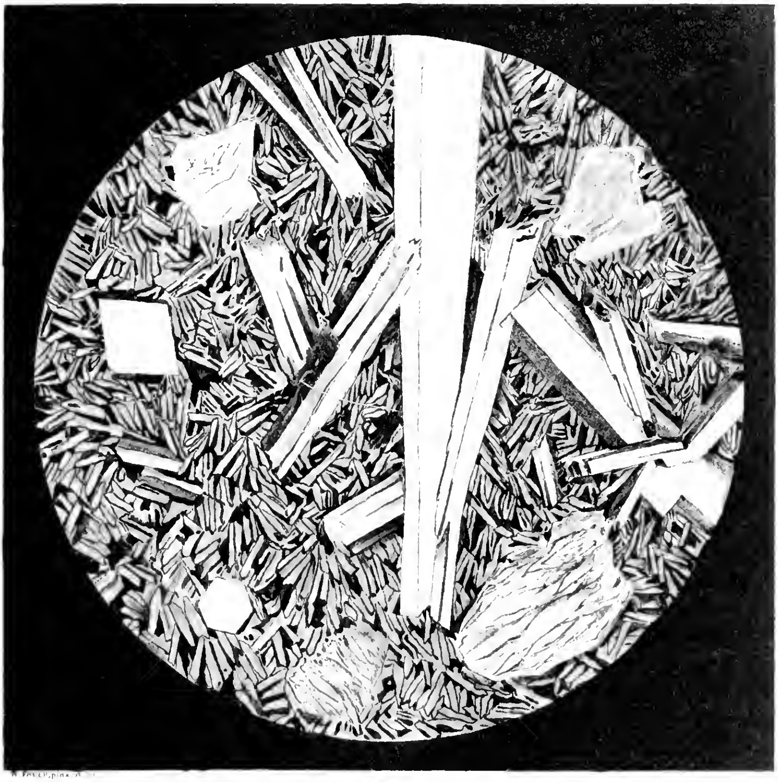
A specimen of this trap was obtained and reduced to a thin section, of which a representation as seen under a power of 400 diameters and in polarized light has been very faithfully made by Mr. Faber.

It was not found expedient in this drawing to imitate exactly all the details in any one field of view, but the more characteristic exponents of the minute crystals were brought together from all parts of the slide and substituted for those less perfectly formed; due regard being had always to the proportions in which the several constituents of the mass manifested themselves.

In the centre of the field is a large double, or multiple, columnar crystal of labradorite to the bottom, and to the middle of which other smaller crystals are attached—whether accidentally in contact or an off shoot in the former case is not certain.

In the upper left hand portion of the field a curious instance of the splitting of labradorite may be observed. It was at first thought that the apparent divergent curvature of the two branches of this crystal might be an optical delusion, and that in reality two independent individuals were thus accidentally in contact at one extremity. Under higher powers than that here given, however, it proved to be an actual ramification of the mass from one common stock like the growth of twigs from the same branch.

The other labradorite crystals will be easily distinguished by the eye,



HUNDREDTHS OF ONE MILLIMETER.

Thin section of Trap from Williamson's Point,
Lancaster Co. Pa.
Magnified 400 Diameters.

and as usual are characterized by their tendency to separate into two or more parts, colored respectively light brown and pale blue.

The four masses of pyroxene are equally distinguishable by the peculiar net work of clefts which cover surfaces, which in polarized light present usually one of the tints here distributed among them. It is often the case when a thin slide has been carefully and evenly made, that at a certain position of the analyzer all the labradorite divides itself into its two characteristic colors depending upon the positions of the optical axes of a pair or a series of the twins. With pyroxene it is different. The fragments, in these traps at least, rarely show definite crystalline form, and in any given position of the analyzer there may be found specimens exhibiting any of the indefinitely large number of gradations in color between bright green and dark violet which accompany the rotation of the analyzer through the angle which separates the projection of their optical axes.

Only a single hexagonal section is given in the picture, but these figures are distributed, though not profusely, throughout the mass. This is probably a minute column of Apatite, and the low percentage of Phosphoric Oxide in the accompanying analysis sufficiently explains why these forms are comparatively rare.

A number of these hexagonal forms having been examined, it was found that when most symmetrical they exercised no influence on polarized light and were, therefore, sections perpendicular to the optical axis of an hexagonal crystal since the basal plane assumed this form.

But where the hexagons were distorted, or in the frequent cases where they were covered by a film of vitreous pyroxene or labradorite, the extinctions were more or less irregular.

One of the quasi-hexagons measured 0.048 mm. between the parallel edges.

The comparatively large rhombic figure is in all probability a section of calcite parallel to one of the planes of the rhombohedron. Several of these figures were measured and examined. One of them was 0.11 millimeter in the longer axis. The angles as measured were 81° 03′ and 98° 36′ respectively. This crystal showed four positions of maximum transparency, and four positions of extinction alternating with each other at distances of 45°* Another and the largest similar section which was measured showed a longer axis equaled to 0.25 mm.

An examination under the improved Füss's microscope with a magnifying power of 275 diameters gave :

Acute angle..............................	80° 30′	180°
Obtuse angle..............................	99° 30′	

In this case there was no general extinction of light during one revolution with or without the quartz prism.

*The microgoniometer having been set at zero when the Nicols were crossed, the succeeding positions of extinction were very nearly 0°, 90′ 180″, and 270°

The modifications of light at a few points seemed to be caused by impurities.

A small rhomb examined in the Füss instrument, under a magnifying power of 275 diameters gave :

Acute angle (imperfect).....................	73° 30′	172°
Obtuse angle "	98° 30′	

A profusion of small black specks distinguished the face of this crystal which was apparently therefore not homogeneous. It showed four extinctions.

A third rhombus at 275 diameters showed :

Acute angle..................................	72°	173°
Obtuse angle..................................	101°	

Neither of the above angles was perfect.

This crystal also showed four extinctions.

The ground mass is composed of minute objects, often stellate in structure, among which are probably small columnar masses of Rutile, as the titanic oxide in the analysis suggests. They are exceedingly small and, except here and there, do not indicate any definite order or arrangement.

This ground mass is not certainly determined. The tufts are sometimes flat and *frayed* at the ends like a piece of worn cloth. They polarize feebly within different shades of brown.

The following is an analysis of this trap by Dr. Genth.

Silica (SiO_2)..	50.79
Titanic Oxide (TiO_2)................................	0.70
Phosphoric Oxide (P_2O_5)............................	0.15
Alumina (Al_2O_3)....................................	14.19
Iron Sesqui-oxide (Fe_2O_3)..........................	3.84
Ferrous Oxide (FeO)..................................	7.44
Manganous Oxide (MnO)................................	0.48
Lime (CaO)...	9.75
Magnesia (MgO).......................................	7.88
Potash (K_2O)..	0.95
Soda (Na_2O)...	1.89
Ignition...	1.95
Total..	100.01

Herewith are presented, side by side, average analyses of Labradorite and of Pyroxene both calculated from the data given in the last edition of Dana's System of Mineralogy (Fifth Edition, 1877). The former is based upon forty analyses of Labradorite and the latter on eighteen analyses of Pyroxene from eruptive rocks.

	Labradorite average of 40 analyses	Pyroxene average of 18 analyses.
Silica (SiO_2)	53.00	49.35
Alumina (Al_2O_3)	27.96	5.79
Iron Sesqui-oxide (Fe_2O_3)	1.33	—
Ferrous Oxide (Fe_2O)	—	8.30
Magnesia (Mg_2O)	0.93	13.88
Lime (CaO)	10.88	20.86
Soda (Na_2O)	4.09	—
Potash (K_2O)	1.08	—
Manganous (MnO)	—	0.27
Water	0.84	0.19
	100.11	98.64

In the following table the percentage of each constituent in Dr. Genth's analysis of this trap is doubled, and the result compared with a column showing the sums of the percentages of the average Labradorite, and the average Pyroxene :

	Sum of Labradorite & Pyroxene.	Double Percentage of Dr. Genth's analysis.
Silica (SiO_2)	102.35	*102.43
Alumina (Al_2O_3)	33.75	28.38
Iron Sesqui-oxide (Fe_2O_3)	1.33	7.60
Ferrous Oxide (FeO)	8.30	14.88
Manganous Oxide (MnO)	0.27	0.90
Magnesia Oxide (MgO)	14.81	15.76
Lime (CaO)	31.74	19.50
Soda (Na_2O)	4.09	3.70
Potash (K_2O)	1.08	1.90
Water (H_2O)	1.03	†3.90
	198.75	199.17

It will be seen that the two columns agree remarkably well in most particulars, which is the same as saying that the composition of the rock is very nearly what the chemical analysis of a mixture of one molecule of Labradorite and one molecule of Pyroxene would show.

In Report of Progress C, 1876,‡ a number of similar traps were discussed and analyses given; amongst others of one from "West Rock," Connecticut, and one from Beeler's farm, York County.

The composition of the former, like the one here considered, agreed more nearly with a distribution of Labradorite and Pyroxene molecules in the proportion of one to one, while the "Beeler" trap corresponded more nearly with the mixture of two molecules of Labradorite with one of Pyroxene.

* 0.70 TiO_2 and 0.15 p. c. P_2O_5 included in SiO_2.

† Ignition.

‡ Second Geol. Survey of Penna.

In the present case tables of comparison were made on the basis of 2 L+P, and 3L+P,* but none agreed so closely as the two first made and presented above.

It should be mentioned that a slight error is due to the counting of all the titanic oxide and phosphoric oxide as part of the silicic oxide, neglecting at the same time to make the necessary allowance for the quantivalential and atom-weight differences, but the amount of these substances was so small that the error will be entirely inappreciable. And besides, even this small error will be avoided in the considerations presented below.

The same is true of the method here followed, which is simply to compare the ascertained percentages of the compounds instead of reducing the analysis to percentage weight of the elements and striking a balance between the electro-negative and the electro-positive elements. This latter method is much more exact but is too delicate and no better for the purpose than the rough and ready system here followed. A comparison of the same bodies given above in their percentage values would be as follows:

	P. c. composition. 1 L. + 1 P.	Analysis of trap.
Silica (SiO_2)	51.50	†51.64
Alumina (Al_2O_3)	16.95	14.19
Iron Sesqui-oxide (Fe_2O_3)	0.67	3.84
Ferrous Oxide (FeO)	4.17	7.44
Manganous Oxide (MnO)	0.13	0.48
Magnesia (MgO)	7.45	7.88
Lime (CaO)	16.00	9.75
Soda (Na_2O)	2.55	1.89
Potash (K_2O)	0.55	0.95
Water (H_2O)	0.52	‡1.95

It will be observed that the theoretical composition requires more Alumina and Lime than are given in the analysis. The alkalies are about the same in both, for there is a little less soda and a little more potash in the rock, which contains also more iron as both sesqui-oxide and protoxide.

Manganese is too small to consider, as is also the slight difference in the per cent. of Magnesia.

The analysis thus considered tells us that the actual composition of the rock, though near 1 : 1 of labradorite and pyroxene, is not quite that, being slightly deficient in alumina and lime (Labradorite), while the excess of the two oxides of iron remind us that we are not to forget one of the most generally distributed constituents of these traps—*e. g.* magnetite; though really under the microscope this mineral is not at all prominent.

The study of the microscopic section having led to the suspicion of cal-

* L stands for one molecule of Labradorite. P stands for one molecule of Pyroxene.

† Including TiO_2 and P_2O_5.

‡ Ignition.

cite in the rock, a great number of specimens were tested for effervescence, and all showed it in a prominent degree. As the above analysis of Dr. Genth gave no carbonic oxide, on inquiry, he writes: "The rock is full of cracks and these are lined with a minute quantity of calcite. The portion of which I sent you the analysis was as nearly as possible selected from that which did not show this coating. * * * Still some of the 'Ignition' may be Co_2," &c., &c.

It is clear from the position of these calcite crystals that they cannot all be due to infiltrated solutions of calcium carbonate through cracks in the rock, because the individual crystals are isolated from each other.

Their occurrence is peculiar and will be the subject of future study.

Three separate determinations of ignition were 3.65, 3.40, and 3.88 (average 3.64).

Average determination of CO_2 = 1,49 p. c.

Annexed is the analysis, resolved into the ultimate constituents of the rock (including 1 p. c. out of the ignition for CO_2).

ANALYSIS OF WILLIAMSON'S POINT TRAP.

Acid

	p. c.			Oxygen p. c.	
Si	23.71	24.48	Oxygen	27.08	28.16
C	0.27		"	0.73	
Ti	0.43		"	0.27	
P	0.07		"	0.08	

Basic.

	p. c.			Oxygen p. c.	
Al	7.55	10.24	Oxygen	6.64	7.79
Fe^{iv}	2.69		"	1.15	
Fe^{ii}	5.79	20.00	Oxygen	1.65	8.39
Mn	0.37		"	0.11	
Mg	4.68		"	3.20	
Ca	6.97		"	2.78	
Na	1.40		"	0.49	
K	0.79		"	0.16	
		54.72			44.34

Considering this collection of atoms as united into molecules in which the oxygen performs partly a linking and partly a saturating function, we may discover something as to the probable kinds of silicates contained.*

The chemical units into which this analysis is resolved below represent the amount of *bond satisfying* work which each atom performs, so that the total amount might with propriety be considered the quantity of *molecule constructing* work performed. It is calculated by considering the number of atoms of each element present, multiplied by the quantivalence of

* On this subject see Report C, 1876, pp. 115 to 121.

the element. Thus a monad atom having but one bond or affinity, exerts a unit of constructive work in the molecule.*

The percentage weight of each element in the compound divided by its atomic weight and this quotient multiplied by the *valence* of the element will constitute what is here given as the number of its chemical units.

Calling a the atomic weight of the element, w the percentage weight, v the valance, and n the number of atoms; we have

$$\text{Chemical units} = nv = \frac{w}{a}v.$$

Subjoined is the table:

CHEMICAL UNITS.

Acid.

Si	3.387	3.832
C	0.090	
Ti	0.344	
P	0.011	

Basic.

Al	1.106	1.298	2.456
Fe^{iv}	0.192		
Fe^{ii}	0.206	1.158	
Mn	0.134		
Mg	0.390		
Ca	0.348		
Na	0.060		
K	0.020		

Total chemical units of both	6.288
Excess of acid over basic units	1.376
	4.912

As the bonds of oxygen must be equal in number to the bonds of those elements which the oxygen links or saturates, it must be assumed that the sum of the bonds of the acid and basic atoms must equal the number of bonds of the oxygen. This last remainder, therefore, gives the amount of oxygen in the compound employed exclusively in a linking function, while the difference between the number of acid and basic atoms (= 1.376) equals the number chemical units of oxygen which are employed in saturating the acid bonds in excess.

Reduced to percentage of the rock in question—

Of the rock there are p. c. of oxygen	44.34
Of which the saturating oxygen is	5.92
Leaving p. c. of linking oxygen	38.42

* [It must be distinctly understood here that these expressions do not give the total (chemical) *energy* of the compound, which, however, could be obtained by adding together the product of these units of molecule building multiplied each by the force necessary to disrupt its union.]

These represent in the rock—

p. c. of (SiO_4) combined in ortho-silicates	22.67
p. c. of (SiO_3) combined in mono-meta-silicates........	28.12
Total....................................	50.79

It is interesting to note in conclusion that the rational formula calculated for labradorite according to the modern chemical system and which regards this mineral as one of the para-silicates is

$$(Ca^{ii}\ Al_2^{vi})^{viii}\ (Si_3^{iv}\ O_{10}^{ii})^{viii}.$$

This might be viewed as a *mixed* ortho- and mono-meta-silicate* in which there are two molecules of the radical (SiO_4) and one of (SiO_3). In the latter one of the atoms of O is employed in saturating alone, and the proportion which this bears to the total amount of oxygen in both radicals is evidently 1 : 11.

In Pyroxene all the silica is present as mono-meta silicic acid.

In a mixture containing exactly one molecule each of Labradorite and Pyroxene, there would then be :

	Orthosilicic Acid.	Mono-meta-silicic Acid.
Labradorite..................................	2	1
Pyroxene.....................................		1
	2	2

That is, the number of molecules of Ortho- and Mono-meta-silicic acid would be equal, or if the p. c. by weight of the latter were as above supposed, 22.67 in the rock, that of the latter would be in such a mixture, 27.17 p. c. which is very nearly that actually given.

On the Total Solar Eclipse of July 29th, 1878.

By George F. Barker.

(Read before the American Philosophical Society, Nov. 15th, 1878.)

The purpose of the present paper is to put on record in the Proceedings of the Society some account of the observations made by certain of its members upon the total solar eclipse of the 29th of July, 1878.

The expedition was organized in June, by Professor Henry Draper of New York, out of compliment to whom, his associates named it the Draper Eclipse Expedition. The party consisted of Dr. Draper as Director, with Mrs. Draper as assistant, who were in charge of the photographic and photospectroscopic work, as also of the observations with the slitless spectroscope ; of President Morton, of Hoboken, to whom was confided the general observations, as well as those with the polariscope and pocket spectroscope ; of Dr. Thomas A. Edison, of Menlo Park, who was to use his newly invented tasimeter. in order to determine whether it was

*See "Tables for the determination of minerals," Frazer. 1874.

possible to measure the heat of the corona; and of myself, who was to observe with the analyzing spectroscope with the especial object of ascertaining the presence either of bright or of dark (Fraunhofer) lines in the spectrum of the corona.

Rawlins, Wyoming Territory, had been selected by the Director as the observing station, because while it was near the central line of totality, it was also easily accessible, being on the Union Pacific Railroad, was a place of some size, having eight or nine hundred inhabitants, and was the location of the railroad repair shops of the Laramie division, so that in case of need, assistance in constructing or repairing our instruments could be had. Moreover, it had a bountiful supply of excellent water brought in pipes from the neighboring Cherokee mountain, which being of granite, yielded a pure product of inestimable value for purposes of photography. Previous experience in that region of country too, had assured Dr. Draper that the air there was dry, and hence that the chances of clear weather on the day of the eclipse were very considerable.

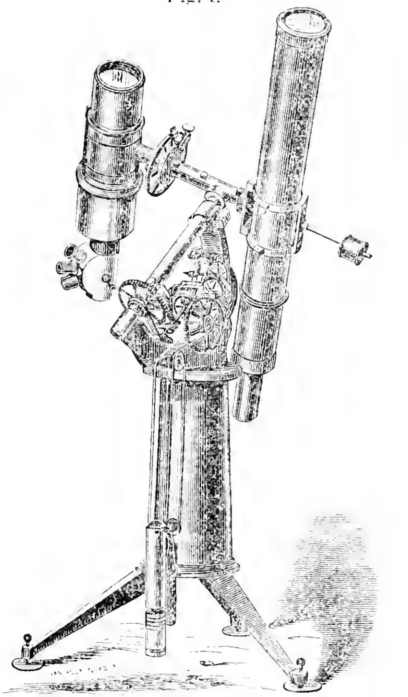
The expedition left New York on the evening of the 13th of July; and, resting by the way at Chicago for a day, reached Rawlins at mid-night of the 18th. The apparatus and material, which had been sent on by express in advance, had already arrived and in apparently good order, though in all it weighed nearly a ton. After a day's reconnoitering, plans were perfected and arrangements made for the construction of a temporary observatory in which to shelter the larger instruments. An excellent site was selected by Dr. Draper, protected in great measure from the strong winds from the west which at times sweep over those mountain plains. In this building the telespectroscopes were erected, a portion of it being converted into a photographic dark room, and supplied with running water from the hydrant. The location of this observatory was determined to be latitude 41° 48′ 50″ N., longitude 2 h. 0 m. 44 s. W. from Washington. Its altitude above the sea level was 6,732 feet. The tasimeter telescope of Dr. Edison was erected in an adjoining building, facing the west and about ten or fifteen feet distant.

The ten days of time which had been allowed for completing the preparations was found to be none too much. During a large portion of every day and most of the night, some or all of the party were engaged in adjustment of the instruments, in practice with them, in determining positions in photographic work, or in the numberless details necessary to success. On the night of the 24th, we were joined by the English astronomer, J. Norman Lockyer, F. R. S., and also by Professor James C. Watson, of the University of Michigan. Mr. Lockyer's work being mostly photographic, he was efficiently aided by Mr. J. B. Silvis, the owner of a photographic car traveling over the Union Pacific Railroad, which chanced at that time to be in Rawlins. Mr. Silvis not only most generously placed himself and his car at Mr. Lockyer's disposal for any experimental purposes entirely free of expense, but on the day of the eclipse, he allowed him to take the car to Separation, about thirteen miles distant, assisted him in observing, and returned with him to Rawlins the same evening.

The day of the eclipse was all that could be desired. The sky was almost without a cloud throughout, and the dew point was found to be at least 34° F. below the temperature of the air. The entire programme of observations was carried out as it had been arranged, and with singularly good fortune. "The results obtained," as summarized by Dr. Draper, "were: 1st, the spectrum of the corona was photographed and shown to be of the same character as that of the sun and not due to a special incandescent gas; 2d, a fine photograph of the corona was obtained, extending in some parts to a height of more than twenty minutes of arc, that is, of more than 500,000 miles; 3d, the Fraunhofer dark lines were observed by both Professors Barker and Morton in the corona; 4th, the polarization was shown by Professor Morton to be such as would answer to reflected solar light; and 5th, Mr. Edison found that the heat of the corona was sufficient to send the index beam of light entirely off the scale of the galvanometer." As these results seem to be of very considerable importance, it appears desirable to give the various methods of observation somewhat more in detail, adopting for the purpose so far as possible the language of the observers themselves, as given in their several reports.

Photographic and Phototelespectroscopic Observations.

Fig. 1.



The instruments which were used by Dr. Draper in his photographic and phototelespectroscopic observations were: "1st. An equatorial mounting, with spring governor driving clock, loaned by Professor Pickering, Director of Harvard Observatory. 2d. A telescope of five and a quarter inches aperture and seventy-eight inches focal length, furnished with a lens specially corrected for photography, by Alvan Clark & Sons. 3d. A quadruple achromatic objective of six inches aperture and twenty-one inches focal length, loaned by Messrs. E. & H. T. Anthony, of New York; to this lens was attached a Rutherford diffraction grating nearly two inches square, ruled on speculum metal. This arrangement (Fig. 1.) with its plate holders, etc., will be designated as a phototelespectroscope. Besides these there was a grating spectroscope, an eye slitless prism spectroscope, with two inch telescope, and finally a full set of chemicals for Anthony's lightning collodion process, which in my experience is fully three times quicker than any other process."

"The arrangement of the phototelespectroscope requires farther description, for success in the work it was intended to do, viz., photographing the diffraction spectrum of the corona, was difficult and in the opinion of many of my friends impossible. In order to have every chance of success it is necessary to procure a lens of large aperture and the shortest attainable focal length, and to have a grating of the largest size adjusted in such a way as to utilize the beam of light to the best advantage. Moreover, the apparatus must be mounted equatorially and driven by clockwork so that the exposure may last the whole time of totality and the photographic work must be done by the most sensitive wet process. After some experiments during the summer of 1877 and the spring of 1878, the following form was adopted.

"The lens being of six inches aperture and twenty-one inches focal length, gave an image of the sun less than one-quarter of an inch in diameter and of extreme brilliancy. Before the beam of light from the lens reached a focus it was intercepted by the Rutherford grating set at an angle of sixty degrees. This threw the beam on one side and produced there three images—a central one of the sun and on either side of it a spectrum; these were received on three separate sensitive plates. One of these spectra was dispersed twice as much as the other, that is, gave a photograph twice as long. This last photograph was actually about two inches long in the actinic region. If, now, the light of the corona was from incandescent gas giving bright lines which lay in the actinic region of the spectrum, I should have procured ring-shaped images, one ring for each bright line. On the other hand, if the light of the corona arose from incandescent solid or liquid bodies, or was reflected light from the sun I was certain to obtain a long band in my photograph answering to the actinic region of the spectrum. If the light was partly from gas and partly from reflected sunlight a result partly of rings and partly a band would have appeared.

"Immediately after the totality was over and on developing the photographs, I found that the spectrum photographs were continuous bands without the least trace of a ring. I was not surprised at this result, because during the totality I had the opportunity of studying the corona through a telescope arranged substantially in the same way as the phototelespectroscope and saw no sign of a ring.

"The plain photograph of the corona taken with my large equatorial on this occasion shows that the corona is not arranged centrally with regard to the sun. The great mass of the matter lies in the plane of the ecliptic but not equally distributed. To the eye it extended about a degree and a half from the sun toward the west, while it was scarcely a degree in length toward the east. The mass of meteors, if such be the construction of the corona, is therefore probably arranged in elliptical form round the sun.

"The general conclusion that follows from these results is that on this occasion we have ascertained the true nature of the corona, viz: it shines by light reflected from the sun by a cloud of meteors surrounding that luminary, and that on former occasions it has been infiltrated with materials thrown up from the chromosphere, notably with the 1474 matter and hydrogen. As the chromosphere is now quiescent this infiltration has taken place to a scarcely perceptible degree recently. This explanation of the nature of the corona reconciles itself so well with many facts that have been difficult to explain, such as the low pressure at the surface of the sun, that it gains thereby additional strength."

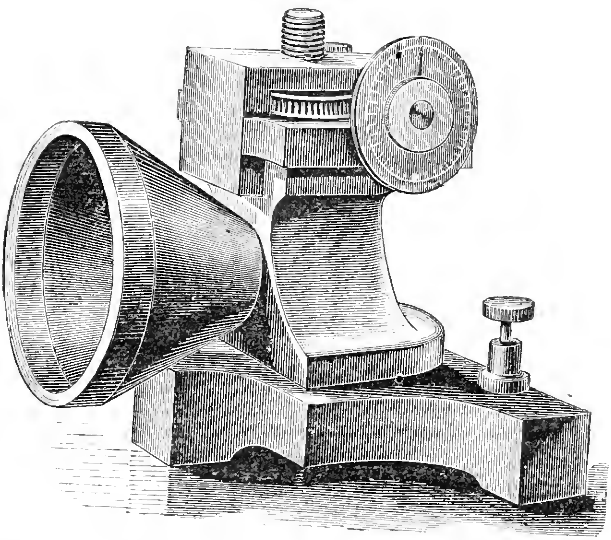
Tasimetric Observations.

As this eclipse is the first in which any attempt has been made to measure the heat of the solar corona, Dr. Edison's report to Dr. Draper on this subject is here quoted in full. He says:

"The instrument which I used at Rawlins, Wyoming, during the solar eclipse of July 29th, 1878, for the purpose of measuring the heat of the sun's corona, was devised by me a short time only before that event, and the time was insufficient to give it as thorough a test as was desirable to ascertain its full capabilities and characteristics.

"This instrument I have named the tasimeter, from the Greek words, *τασις*, extension, and *μετρον*, measure, because primarily the effect is to measure extension of any kind. The form of instrument which I used is shown in the annexed wood cut (Fig. 2.)

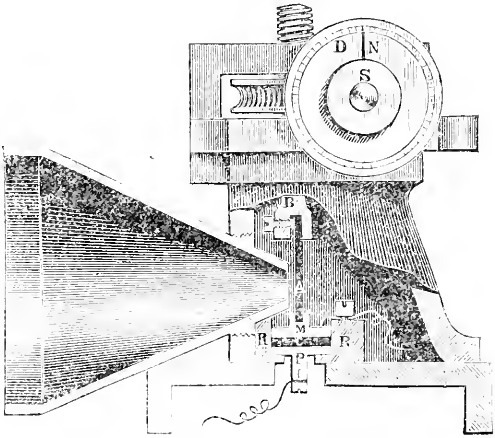
Fig. 2.



"With this instrument was used a Thomson's reflecting galvanometer on a tripod, having a resistance of three-fourths of an ohm. The galvanometer was placed in the bridge wire of a Wheatstone balance, two of the branches of which had constant resistances of ten ohms each, while of the other two one had a constant of three ohms, and the other contained the tasimeter which was adjusted by means of the screw to three ohms. When thus balanced, if the strip of vulcanized rubber A (seen in Fig. 3), placed between the fixed point B and the carbon button C, was exposed to heat from any source, it expanded, placing pressure upon the carbon button, decreasing in this way its resistance and destroying the balance; thus allowing a current to pass through the bridge wire containing the galvanometer, the amount of this current of course being proportional to the expansion of the rubber and to the strength of the battery.

"The form of instrument here described was finished only two days before leaving for the west; hence, I was unable to test it. However, I set it up upon my arrival at Rawlins, but found that it was a very difficult matter to balance so delicate an instrument as a reflecting galvanometer with one cell of battery, through such small resistances. In fact, I did not succeed in balancing it at all in the usual way. Nor could it be balanced in any way until I devised a method which I may designate 'fractional balancing,' when it became very easy to accomplish the result and also to increase the effect by using two cells in place of a single one. This device

Fig. 3.



consisted of a rheostat formed of two rows of pins. The rows were about one-half an inch apart. A wire was connected from a pin on one row to a pin on the other row and so on, so that the current had to pass through the whole length of the wire, which was No. 24 gauge and four feet long. This was used as a shunt around the galvanometer. A copper wire connecting all the pins of one row served to reduce the resistance to zero. When the galvanometer was thus shunted, a very feeble current passed through it. If the spot of light was not at zero it was brought there by either increasing or decreasing the pressure upon the vulcanite of the tasimeter by the adjusting nut. When thus brought to zero the copper wire of the shunt rheostat was taken off of one pin, thus increasing the resistance of the shunt perhaps to one-fiftieth of an ohm. The spot of light was generally deflected nearly off of the scale. The light was again brought to zero by varying the resistance of the tasimeter, and another one-half inch of wire included in the shunt, another deflection and another balance was obtained by the tasimeter. Thus by gradually increasing the delicacy of the galvanometer by increasing the resistance of the shunt and balancing at every increase, the whole of the current was allowed to pass through the galvanometer and the shunt taken off. When this point was reached the damping magnet or director was in close proximity to the case of the galvanometer. To increase its delicacy to the fullest extent it became necessary to raise the director to the top of the rod. This was done by raising it cautiously a quarter of an inch at a time, bringing the spot of light to zero each time by the tasimeter.

"In order to form some idea of the delicacy of the apparatus when thus adjusted, a preliminary experiment was made on the evening of the 27th, with the star Arcturus. The tasimeter being attached to the telescope, the image of the star was brought on the vulcanized rubber. The spot of light from the galvanometer moved to the side of heat. After some minor adjustments, five uniform and successive deflections were obtained with the instrument, as the light of the star was allowed to fall on the vulcanite to produce the deflection, or was screened off to allow of a return to zero.

"It was in this condition when the eclipse occurred. The tasimeter was placed in a double tin case, with water at the temperature of the air between the walls. This case was secured to a Dollond telescope of four inches aperture. No eye piece was used. At the moment of totality the spot of light was slowly passing towards cold. When I withdrew a tin screen and allowed the edge of the luminous corona to fall upon the rubber, the spot of light stopped, went gradually off of the scale towards heat, its velocity accelerating as it approached the end. The time required for the light to leave the scale was from four to five seconds.

"I interposed the screen and endeavored to bring the light back to zero, but I was unsuccessful. Had I known that the heat was so great I should have used a platinum strip in place of the vulcanite, and decreased the delicacy of the galvanometer by the approach of the damping magnet.

"I would then doubtless have succeeded in getting two or more readings, and afterwards by comparison with bodies of known temperature would have obtained a near approach to the temperature of the sun's corona."

Telespectroscopic Observations.

My own results, obtained with an analyzing spectroscope attached to the telescope, seem to be almost unique in this eclipse. This fact must be my apology, if any be needed, for introducing here at such length, the facts of the case as contained in my report.

The instruments and apparatus used in the observations were loaned for the purpose from the physical cabinet of the University of Pennsylvania. They consisted (1) of an equatorially mounted achromatic telescope of four inches aperture made by Jones of London ; (2) a direct vision astronomical spectroscope by Merz of Munich; (3) a second direct vision spectroscope by Hoffmann of Paris; and (4) a pocket spectroscope by Geo. Wale & Co. Beside this spectroscopic outfit, a second four-inch achromatic telescope by Dollond was taken for use with the tasimeter by Dr. Edison, and a Savart, a Senarmont, and an Arago polariscope, for determining the polarization of the corona. The Merz spectroscope above mentioned is described in the "Philosophical Magazine," IV., xli., Feb., 1871. It is provided with two compound direct vision prisms, of which one or both can be used at pleasure, each consisting of five single prisms, two of flint glass with a refracting angle of 84°, and three of crown; one of these having a refracting angle of 84°, the others of 87°. The dispersive power of each of these compound prisms is about equal to that of two equilateral prisms of flint glass. The instrument has a collimating and an observing telescope, each furnished with an object glass two-thirds of an inch in aperture and four inches in focal length. The prism-tube is attached to the collimator by two centres, giving it a lateral motion about a line passing through these centres, which constitutes an axis parallel to the slit. The observing telescope is similarly attached to the tube carrying the prism. These motions serve to alter the incidence of the rays upon the surface of the prism, and also to bring any special part of the spectrum into the middle of the field. The observing telescope is provided with a positive eye-piece of an equivalent focal length of one inch, and also with a needle micrometer, having an eye-piece of one-half inch focus. The graduations upon this micrometer are strongly cut, enabling the positions and the distances of the lines measured with it to be easily read even in a faint light. The spectroscope was firmly attached to the draw tube of the equatorial telescope by means of an open frame made by Zentmayer, so that the position of the image with reference to the slit could be readily observed.

The time from the date of our arrival at Rawlins until the eclipse, was occupied in setting up the instruments, in getting them into adjustment, and in practice with them. It was found that with only one of the compound prisms of the Merz spectroscope, the slit being placed radially, it was easy to observe the lines C and F reversed in the chromosphere, and also the bright line D_3. On the morning of the day of the eclipse, the solar edge was examined for protuberances, in order to locate them in advance of totality. But a single one was noticed, this being on the south-western edge of the sun. As the time of first contact approached, the spectroscope was removed and a paper screen was attached to the draw-tube, an image of the sun being formed on this screen by means of the eye-piece; thus enabling the time of this contact to be approximately determined and the subsequent progress of the eclipse to be conveniently observed. No spots were seen under these circumstances, though this could hardly have been expected since the solar image was so small, scarcely three inches in diameter, unless the spots were of large size. As the time of second contact drew near, the spectroscope was replaced upon the equatorial. Since you deemed it of importance to pay special attention to the oxygen lines in the vicinity of G, the micrometer of this instrument was, at your suggestion, so adjusted that one of its needle-points rested on the hydrogen line near G and the other on the line known as *h*. After the last ray of sunlight had disappeared, I took a few seconds of the precious time to observe the eclipse with the naked eye. The moon appeared intensely black, surrounded by a pinkish halo, extending to about two-fifths of a lunar diameter from the limb, and occupying the entire circumference. At two points this halo was expanded into radial streamers, one of which had parallel sides with a deeply indented or swallow-tailed end, extending westward of the sun and apparently lying in the ecliptic; the other appeared single, was on the eastern edge, and was inclined twenty degrees or more to the north of the ecliptic. The former of these streamers was traced to a distance of about a lunar diameter and a half from the edge, the latter to a somewhat less distance. No structure could be seen in the halo, but in the streamers traces of parallel rays appeared to be present. The amount of light emitted by the corona was a surprise to me. Preparations had been made for using artificial light for reading the circles, but this was found not to be at all necessary. The amount of light seemed to be nearly or quite equal to that given by the moon when ten days old. No protuberances were seen with the naked eye; nor were any streamers observed, other than those already described. A glance at the eclipsed sun was then taken through the finder of the equatorial. The magnifying power being low, the corona presented much the same appearance as to the naked eye; but the streamers showed much more distinct evidences of a radiated structure and a pale rosy protuberance was observed on the south-western edge of the dark disk. This was undoubtedly the same prominence which was observed previous to totality.

Turning my attention now to the spectroscope, upon the slit of which the coronal image had already been brought by means of the finder, the slit being placed radially, the first glance through the instrument showed me a bright, but an absolutely continuous spectrum. The region under examination was of course that portion of the spectrum which had been placed before totality between the needle-points of the micrometer. Totally unprepared for so unexpected a result, I moved the observing telescope so as to bring the green portion of the spectrum into the field, expecting certainly to see 1474 K, and by the appearance of this line to determine whether my instrument was out of adjustment; and if it were, to adjust it again. But no bright line was there; the green region appeared as continuous as the blue. I then gradually closed the slit—which had been previously adjusted on the solar spectrum so that the line D appeared nebulous on its edges—thinking that I might in this way improve the definition, but with no better results; no bright lines could be seen. To my great surprise, however, when the slit was thus narrowed, the region which was then under examination, that extending from *b* to G, appeared filled with dark lines on the brighter background, these dark lines being readily recognized from their general appearance as the solar lines of Fraunhofer. Still intent on getting bright lines, I opened the slit again gradually, moved the observing telescope over the entire length of the spectrum from red to violet, repeating the operation three times and varying the width of the slit from time to time in each region; but not a single bright line could be detected. I then requested you to come and take a glance through my spectroscope, as had been previously agreed; saying that although I could see dark lines and a continuous spectrum, I was unable to detect a single bright line, and knew not what to make of it. You were then looking at the eclipse through your ingenious little telespectroscope of two inches aperture. You came to my instrument, looked at the spectrum, moved the observing telescope over its whole length and remarked that the results in my spectroscope agreed entirely with those in yours, and that in both the spectrum appeared continuous, showing no bright lines whatever.

My mind being thus relieved, I took my place again at the spectroscope, and this time, placing the slit tangential to the moon's limb, I moved the observing telescope from end to end of the spectrum, opening and closing the slit at intervals; but the spectrum appeared as continuous as before. Again the image was adjusted so that the slit was once more radial; and this time on a still different portion of the corona. On examining again the spectrum, no bright lines appeared, except once for an instant, when the slit passed over the small chromospheric prominence already noticed. Warned by Mrs. Draper's clear and distinct counting that the precious 165 seconds had two-thirds gone, I decided to devote the time still remaining to a more careful observation of the dark Fraunhofer lines. Now, for the first time, as I adjusted the width of the slit and its position on the corona with more care, I observed that these lines did not pass clear across the field, but were of a length corresponding to the width of the coronal image on the slit. At the base of the spectrum, which corresponded to the base of the corona, they appeared bright and sharp; certainly quite as much so as in the light of the moon similarly condensed; though the continuous spectrum which formed their background was relatively brighter than in moonlight. There was no difficulty in identifying them as Fraunhofer lines from their general appearance and position; but some of them could be identified beyond question. Such were *b* and F, which were especially distinct, D, E and G, which were considerably less so. They faded gradually out from the base of the spectrum upward, appearing to end where the continuous spectrum of the corona was limited above. While thus employed, a flash of sunlight told us that totality had ended and that the solar eclipse of 1878 was over.

In discussing the results of the spectroscopic observations which have now been detailed, I am, in the first place, quite at a loss to account for the fact that no bright lines were seen by me, notwithstanding the persistent efforts made to get them. The failure to observe them can be accounted for, as it would seem, only on the ground that with the dispersive power employed, the bright lines were too faint to be seen on the much brighter background of the continuous spectrum.

The lessons to be drawn from these spectroscopic observations appear to be few and simple. The absence of bright lines, or at least of any which were at all brilliant, proves clearly the absence in the solar coronal region of any considerable mass of incandescent gas or vapor; which shining by its own light would of course give a bright line spectrum. The presence of Fraunhofer lines in the coronal spectrum shows conclusively the presence of reflected sunlight in the light of the corona and goes to establish the theory long ago suggested, that masses of meteoric matter raining down upon the solar surface from all directions, reflected to us the light of the sun and were therefore the essential cause of the coronal phenomena. And, finally, the fact of the increased brightness of the continuous spectrum, as compared with the intensity of the dark lines of Fraunhofer, goes to strengthen the probability that there is still other light in the corona which comes to us from the incandescent liquid or solid matter of these incandescent meteoric masses. These conclusions, deduced very simply from my own spectroscopic results, agree completely, I am happy to find, with those drawn from your most excellent photographs, as well as from the ingenious heat-measurements of Dr. Edison and the polariscopic determinations of Dr. Morton.

General Conclusion.

The general conclusion then, arrived at by the observations of our party upon this eclipse—a conclusion to which all the results point with singular unanimity—is that the solar corona consists of a mass of meteoric bodies falling in from space upon the solar surface, which meteors being intensely heated by the resistance encountered at their enormous velocity, as well as by radiation from the sun, become highly luminous, and emit a light which gives a continuous spectrum. Moreover, this mass of incandescent meteors is shown not to be equally extended in all directions around the sun, but appears to be ellipsoidal or at least spheroidal in form. That the larger part of the coronal light comes from the incandescence of these meteors, there can apparently, be but little doubt But a considerable portion of it appears to have quite a distinct origin, and to be due to the reflection of solar light by these solid or liquid masses. Hence the appearance of the dark solar or Fraunhofer lines in the spectrum. A third, and in this eclipse an extremely small portion of the light of the corona, would seem to be due to incandescent gaseous matter, either injected into it from below, or produced from the meteoric masses themselves by the intense heat. This portion it is which gives the bright line spectrum, as feeble in this eclipse as it was strong in previous ones. Of the material composing this gas, there is yet, as it would appear, no indication.

From what has now been narrated, it must be conceded that the Draper Eclipse Expedition was singularly and exceptionally fortunate. No small part of this good fortune is due, as we believe, to the courtesy and liberality of the railroad and express companies over whose routes either the party or their instruments traveled. I desire to mention especially, in this connection, Col. Thos. A. Scott and Mr. Frank Thomson, of the Pennsylvania

Railroad; Mr. Henry Keep and Mr. M. L. Sykes, of the Chicago and Northwestern Railroad; Mr. Sidney Dillon and Mr. Jay Gould, of the Union Pacific Railroad; Mr. William H. Fargo, of the American Express Company; Mr. Frederic Lovejoy, of Adams' Express Company, and the Superintendent of the Union Pacific Express Company. The cordial appreciation by these gentlemen of the fact that the work in which we were engaged was one of a purely scientific character, and as such was one to which every reasonable facility should be furnished, was as gratifying to us as it was honorable to them. I should fail to do exact justice were I to omit mention of the service rendered us by Mr. J. J. Dickey, the Superintendent of the Union Pacific Telegraph; Mr. E. Dickenson, Superintendent of the Laramie Division; Mr. R. M. Galbraith, Superintendent of the Repair Shops at Rawlins; Major Thornburgh, Commanding Officer at Fort Fred Steele, with Capt. Bisbee and Surgeon De Witt, his associates in the service; Mr. Lawrence Hayes, of the Railroad Hotel, and to Mr. J. B. Silvis, of the photographic car. "Of the citizens of Rawlins," says Dr. Draper, "it is only necessary to say that we never even put the lock on the door of the observatory, and not a thing was disturbed or misplaced during our ten days of residence, though we had many visitors."

The agreeable party, the pleasant surroundings, the charming weather, the kindness of friends, and above all, the capital success of the observations, make the Draper Eclipse Expedition an exceedingly pleasant memory to us all.

Notes on a series of Analyses of the Dolomitic Limestone Rocks of Cumberland County, Pa., made by Messrs. Hartshorne and Hartranft in the Laboratory of the Second Geological Survey of Pennsylvania. By J. P. Lesley, State Geologist.

(Read before the American Philosophical Society, October 18th, 1878.)

At a meeting of the American Philosophical Society, Dec. 20, 1877, I described the progress of an elaborate investigation which I had instituted for the purpose of determining whether or not any fixed or rational order of deposition could be observed in our Lower Silurian, or Siluro-Cambrian Magnesian Formation (No. II).

I selected a fine exposure made by the rock cut of the Northern Central Railroad, on the west bank of the Susquehanna river, opposite Harrisburg, where a consecutive series of the beds, all conformable and all dipping regularly about 30° to the southward, afforded a good opportunity for collecting two sets of specimens for analysis, one at the bottom and the other at the top of the cut; and great care was taken to survey the cut, mark the beds (from 1 to 115) and range the specimens in two parallel series; so that any lack of homogeneousness in any bed might be detected by analyses of two specimens taken from places in the edge of the bed from 5 to 30 feet apart, according to the depth of the cut, and sometimes by the selection of a third and intermediate specimen, many of the analyses of individual specimens being also repeated.

The investigation was continued throughout the winter by Mr. Henry Hartshorne, and completed during the summer by Mr. Hartranft; and I now find myself able to bring some ot the results to the notice of the Society in the form of tables, (1) of analyses, and (2) of averages. At a future time I will be able to carry the discussion of averages still further, and can then venture to base upon them some hypothetical conclusions of great interest to geologists who occupy themselves with the problem of the genesis of our limestone deposits.

Table I, gives the whole series of analyses made; but includes only the determinations of Carbonate of Lime, Carbonate of Magnesia, and Insoluble Matter; omitting the determinations of oxide of iron, alumina, sulphur, phosphorus and carbon.

This table shows to the eye, without need of a diagram, the remarkable alternations of limestone beds with dolomitoid beds throughout the series.

TABLE I.

Analyses of specimens taken from railroad cuttings opposite Harrisburg; in two series: one at railroad grade; the other near the top of the cut.

NOTE, when the analysis was repeated, with slight difference, the average is given; but the instances of this are few.

Bed.	Lime Carb.		Magnesia Carb.		Insol. Matter.	
	Grade.	Top.	Grade.	Top.	Grade.	Top.
1	58.35	57.10	36.80	38.25	4.60	4.00
2	55.60	56.20	38.50	39.75	5.30	3.80
(*a*) 3*a*	89.90	92.00	3.60	4.00	5.70	4.10
4	93.90	97.05	1.80	1.85	3.80	1.40
(*b*) 5	96.40	97.20	1.40	0.70	1.90	2.10
6	95.50	97.60	1.40	1.30	1.50	1.10
7	87.10	87.40	3.60	3.70	9.70	9.10
(*c*) 8	82.30	87.45	14.50	7.50	3.10	3.90
(*e*) (*d*) 9	68.30	67.60	24.80	27.00	5.50	5.40
10	90.70	90.40	8.05	8.15	1.90	1.70
11	97.60	96.70	1.80	1.30	1.00	2.20
12	66.00	75.80	32.40	19.85	1.60	2.50
13	96.80	97.20	2.30	1.85	1.20	1.40
14	95.85	83.70	2.40	11.85	1.80	3.40
15	92.75	97.30	4.45	1.00	3.40	1.80
(*a*) (3*b*)	(67.20)	(66 50)	(3.20)	(4.10)	(26.60)	(25.30)
(*b*) (flint in 5)	6.50	9.30	0.80	0.30	90.80	89.90
(*c*) Dup. (1)	72.15		21.70		6.30	
(*d*) Intermed. (9)	63.60		30.85		5.10	
(*e*) Calcite (9)	88.70	88.60	0.80	0.90	10.40	9.90

16	97.80	97.10	1.30	2.00	1.10	1.20
(*f*) 17	97.60	[60.20]	1.10	[33.40]	1.10	[5.90]
18	97.00	93.50	1.20	4.30	1.40	2.00
19	65.30	62.30	30.80	34.50	3.50	3.00
20	96.40	98.70	2.90	0.80	0.70	0.50
21	76 30	71.75	18.50	24.30	5.30	4.20
22	93.7	97.4	3.8	1.6	1.9	1.3
(*g*) 23	65.3	64.3	30.8	28.6	3.4	6.5
24	94.8	93.1	1.6	1.9	3.9	4.8
25	68.9	68.9	23.8	23.6	7.4	6.3
(*h*) 26	90.0	[70.85]	6.8	6.3	3.4	[22.95]
(*i*) 27	63.3	75.7	28.60	18.1	6.2	5.6
(*j*) 28	81.25	94.15	6.65	2.15	12.0	4.0
29	65.0	62.4	29.1	31.4	5.4	5.4
30	98.9	97.9	1.1	1.30	0.5	0.9
31	61.0	64.30	27.7	25.20	10.9	10.3
32	96.7	97.6	1.7	1.0	1.7	1.8
33	73.3	71.9	12.4	15.5	12.4	10.4
34	97.6	96.3	1.5	1.2	1.1	1.5
35	75.20	67.25	18.90	25.65	4.7	5.9
36	82.9	79.9	13.5	16.9	2.7	4.2
37	91.0	89.0	5.4	5.8	3.6	3 6
38	79.7	82.9	16.9	12.3	2.9	2.8
39	89.7	98.7	8.2	1.6	1.6	0.3
40	61.5	56.3	33.6	37.2	4.7	6.1
41	96.9	95.8	1.7	2.2	1.4	1.9
42	55.6	57.15	35.0	34.95	6.9	6.5
(*k*) 43	97.8	[91.0]	1.3	[1.3]	1.3	[7.9]
(*l*) 44	73.6	65.5	22.5	28.2	3.4	4.8
(*m*) 45	96.2	[96.2]	2.0	[2.0]	2.4	[2.4]
46	97.2	90.6	1.7	7.6	0.7	1.8
47	63.4	68.2	29.5	27.1	6.4	3.6
48	94.3	95.3	1.9	2.2	3.5	2.2
(*n*) 49	57.8	66.2	33.2	26.9	8.0	5.7
50	60.4	62.0	32.1	31.7	5.3	5.1
51	92.9	95.7	3.2	2.9	3.0	1.7
52	61.4	68.9	31.9	23.7	5.3	7.2
53	81.1	88.7	10.0	7.0	4.7	3.4
54	98.2	97.9	1.3	1.2	1.2	0.7
55	79.8	79.5	10.8	13.4	8.6	6.9

(*f*) Upper specimen evidently abnormal; or bed non-homogenous.

(*g*) Calcite 87.7 1.8 10.4

(*h*) Abnormal (flinty ? in the upper part ?).

(*i*) Abnormal (magnesian in the upper part.)

(*j*) Abnormal (magnesian in the upper part).

(*k*) Abnormal (flinty in the upper part).

(*l*) Upper part more magnesian. This balances 49.

(*m*) It is needful in the averages to *suppose* these brackets. But they are absent from the record.

(*n*) Upper part less magnesian. This balances 44.

56	66.9	66.0	24.2	23.2	7.4	9.7
57	91.6	91.0	2.4	2.3	5.9	6.8
58	64.8	60.1	27.4	29.9	7.2	8.6
59	97.1	99.3	1.8	1.3	1.1	0.2
60	75.1	76.3	20.9	19.9	3.1	2.4
61	89.3	95.1	1.5	1.8	8.9	2.1
(*o*) 62	[49.8]	61.9	31.9	28.4	[16.9]	8.2
63	71.0	72.9	23.8	23.0	6.0	4.9
64	80.7	87.7	14.2	10.0	2.5	2.3
65	67.7	70.0	20.9	21.5	10.2	7.8
66	75.1	79.1	19.2	13.6	5.4	5.8
67	61.0	61.8	33.6	32.1	4.6	5.9
(*p*) 68	85.1	96.0	[10.4]	2.3	3.2	1.9
69	51.7	58.5	32.7	27.4	12.9	11.9
70	98.2	97.4	1.5	1.4	0.8	0.9
71	55.6	53.3	33.7	35.4	10.3	10.0
72	98.1	97.3	1.4	1.6	0.8	1.2
73	93.9	96.6	3.6	1.6	2.7	2.5
74	95.6	96.8	1.5	1.2	2.8	2.1
75	91.3	92.1	2.8	3.2	5.4	5.1
76	64.9	63.0	23.6	26.7	10.6	9.8
(*q*) 77	85.5	97.9	[9.8]	1.8	4.5	1.0
78	56.7	56.0	31.9	31.5	8.5	10.8
79	86.7	85.2	7.1	8.7	5.0	5.5
(*r*) 80	79.8	95.9	(9.9)	2.0	9.4	2.6
(*s*) 81	54.9	56.7	[35.7]	24.0	7.7	18.4
82	84.7	86.9	10.8	8.5	4.1	4.0
83	90.7	91.0	8.0	7.6	1.7	1.9
(*t*) 84	66.8	75.6	[27.2]	16.3	4.4	5.6
85	97.0	93.7	0.9	4.1	8.6	2.1
86	95.4	98.9	1.3	1.1	3.8	0.6
87	52.0	54.1	33.7	28.1	12.5	15.9
88	96.3	98.4	1.9	1.1	2.2	0.7
89	59.4	61.6	33.7	31.8	6.1	5.9
90	97.6	97.6	1.8	1.5	0.9	0.3
91	68.2	74.1	27.9	23.1	3.9	3.0
92	98 2	97.7	1.3	1.9	1.2	0.6
93	58.6	59.2	34.1	35.1	5.6	5.0
(*u*) 94	96.7	85.5	1.4	1.4	1.8	12.6
95	54.8	55.2	31.1	30.6	13.0	12.9
96	95.8	95.4	2.7	2.2	1.3	1.8
97	75.2	77.6	17.3	16.4	6.7	4.8
98	62.0	60.0	29.4	32.8	7.8	6.7
99	96.3	96.0	1.9	3.2	1.1	0.9
100	62.2	62.5	29.5	27.4	8.3	7.1

(*o*) Abnormal amount of flint in lower specimen.
(*p*, (*q*), (*r*) Local, extra quantity of magnesia in lower specimen.
(*s*), (*t*) Excessive amount of magnesia in lower specimen.
(*u*) Abnormal amount of flint in upper specimen.

101	98.2	98.8	1.2	0.8	0.6	0.3
102	64.4	60 4	30.5	34.2	4.3	4.8
103	94.7	93.1	4.6	4.8	1.0	1.4
104	80.2	79.5	13.2	14.7	5.6	4.3
105	98.2	96.9	1.2	1.6	0.6	1.1
106	63.4	63.3	31.6	31.7	3.8	4.1
107	98.2	99.0	1.6	0.5	0.3	0.4
108	65.0	65.0	29.1	29.6	5.1	5.0
109	94.8	86.9	2.5	4.3	1.8	7.7
110	73.1	64.3	16.5	22.3	9.1	11.6
111	94.5	88.4	2.7	8.3	1.9	2.6
112	54.4	54.4	35.2	36.2	8.4	7.7
113	98.1	76.2	0.9	3.7	1.0	18.2
114	64.6	55.4	26.2	33.8	8.5	9.7
115	95.1	97.7	1.9	0.9	1.7	1.4

Without discussing in detail, at present, this instructive table, several things are evident at a glance, viz : that

1. Alternate strata of limestone and dolomite make up the mass.

2. The dolomite layers carry the most insoluble materials, as a rule.

3. Specimens taken from the top and bottom of the cut (thirty feet apart, or less) differ *sometimes* as notably from one another as specimens taken from different beds but, *as a rule*, each layer is nearly homogenous, so far as two or three analyses can show such a rule.

4. Not one of the so-called dolomite layers has enough carbonate of magnesia to make it a true lithological dolomite. They are all merely more or less magnesian limestones.

5. Carbonate of magnesia is not absent from any bed in the whole series ; but in an extensive range (such as from No. 84 to No. 115), out of thirty-two beds *twelve* show less than two per cent., *three* show less than three per cent., and *one* goes up to four and six-tenths per cent. The remaining sixteen beds, alternating with other sixteen with great regularity, carry from thirty-six to fourteen per cent., *nine* of them ranging between thirty six and thirty, *five* between thirty and twenty-five, *one* sinking to seventeen, and *one* to fourteen per cent.

The alternation in these thirty-two beds may be represented to the eye thus :

Per cent. of Carb. Mag.	Nos. of Beds selected from the Series.
35 and over.	
30 "	.... 87 ... 89 ... 91 ... 93 ... 95 98
25 "	84
20 "	
15 "	 97
10 "	
5 "	
0 "	... 85, 86 ... 88 ... 90 ... 92 ... 94 ... 96 99

Per cent. of Carb. Mag.	Nos. of Beds selected from the Series.
35 and over	... 112
30 "	100 ... 102 ... 106 ... 108 ... 114
25 "	
20 "	
15 "	... 110
10 "	... 104
5 "	... 103
0 "	... 101 ... 105 ... 107 ... 109 ... 111 ... 113 ... 115

It is especially remarkable that so few of the beds occupy an intermediate position, chemically considered, between nearly fixed extreme limits of lime and magnesia.

TABLE 2.

In this table the beds are grouped by fives, and averaged.

	Lime Carbonate. Bottom.	Lime Carbonate. Top.	Magnesia Carb. Bottom.	Magnesia Carb. Top.	Insol. Matter. Bottom.	Insol. Matter. Top.
Beds 1 to 5	394.15	399.50	82.10	84.55	21.30	15.40
" 6 " 10	423.90	430.45	52.35	47.65	21.70	21.20
" 11 " 15	448.40	450.70	43.35	35.85	9.00	11.30
" 16 " 20	454.10	411.80	37.30	75.10	7.80	12.60
" 21 " 25	399.00	395.45	78.50	80.10	21 90	23.10
" 26 " 30	398.45	401.00	72.25	59.25	27.50	38.94
" 31 " 35	403.80	397.35	62.20	68.55	30.80	29.90
" 36 " 40	404.80	406.80	77.60	73.85	15.50	17.00
" 41 " 45	430.10	405.65	62.50	69.95	15.40	23.50
" 46 " 50	373.10	382.30	98.40	95.50	23.90	18.40
" 1 " 50	4129.80	4081.00	666.55	690.35	194.80	211.25
Average.......	82.59%	81.62%	13.33%	13.81%	3.99%	4.22%
" 51 to 55	413.4	430.7	57.2	48.2	22.8	19.9
" 60	395.5	392.7	76.7	76.6	24.7	27.7
" 65	357.5	387.4	91.3	84.7	44.5	25.3
" 70	371.1	392.8	97.4	76.8	26.9	26.4
" 75	434.5	436.1	43.0	43.0	22.0	20.9
" 80	373.6	398.0	82.3	70 7	38.0	29.7
" 85	394.1	403.9	82.6	60.5	26.5	32.0
" 90	400.7	410.6	72.4	73.5	25.5	23.4
" 95	376.5	371.7	95.8	92.1	25.5	34.1
" 96 — 100	391.5	391.4	80.8	82.0	25.2	21.3
" 51 — 100	3908.4	4015.3	779.5	708.1	283.6	260.7
Average.......	78.17%	80.31%	15.59%	14.16%	5.67%	5.21%
" 101 — 105	435.7	428.7	50.7	56.1	12.1	11.9
" 106 — 110	394.5	378.5	81.3	87.4	20.1	28.8
" 111 — 115	406.7	372.1	66.9	82.9	21.5	39.6
" 101 — 115	1236.9	1179.3	198.9	226.4	53.7	80.3
Average.......	80.46%	78.62%	13.26%	15.09%	3.58%	5.35%

Beds 1 — 50	4129.80	4081.00	666.55	690.35	194.80	211.25
" 51 — 100	3908.40	4015.30	779.50	708.10	283.60	260.70
" 100 — 115	1236.90	1179.30	198.90	226.40	53.70	80.30
" 1 — 115	9275.10	9275.60	1644.95	1624.85	532.10	552.25
Grand average of 115 beds...	80.655 %	80.668 %	14.30 %	14.13 %	4.627 %	4.802 %

To show how worthless *small groups* are for analytical purposes it is only necessary to *combine* the *top and bottom* specimens of *ten beds*, and notice the absence of any marked regularity, thus:

TABLE 3.

Beds 1 to 10......	L. C. 82.40	M. C. 13.33	I. M. 3.98
Beds 11 to 20......	83.25	9.57	2.03
Beds 21 to 30......	79.69	14.50	5.57
Beds 31 to 40......	80.63	14.11	4.66
Beds 41 to 50......	79.55	16.32	4.06

but, on the other hand when grand averages of fifty beds are taken, a picture is obtained of the pretty uniform distribution of the two carbonates throughout at least this part of the formation, thus:

TABLE 4.

Average of 100 *specimens* (taken from top *and* bottom*) of fifty beds.

Beds 1 to 50....	82.15	13.57	4.11
Beds 51 to 100....	79.54	14.87	5.44
Beds 101 to 115....	79.54	14.17	4.47
Beds 1 to 115....	80.662	14.215	4.715

I shall now give a specimen of the results to be obtained by grouping the *low* magnesian beds together and the *high* magnesian beds together and for the present leave the discussion of the data presented above to others.

I select 14 limestone (A) beds alternating, with singular regularity, with 15 magnesian beds (B, distinguished by black-letter) viz.: beds **87**, 88, **89**, 90, **91**, 92, **93**, 94, **95**, 96, **97**, **98**, 99, **100**, 101, **102**, 103, 104, 105, **106**, 107, **108**, 109, **110**, 111, **112**, 113, **114**, 115; and the result is as follows:

TABLE 5.

	Lime Carbonate.		Magnesian Carb.		Insol. Matter.	
	*Bottom.**	*Top.**	*Bottom.*	*Top.*	*Bottom.*	*Top.*
(A)	96.62	93.47	1.97	2.58	1.24	3.57
(B)	63.83	63.00	27.93	28.52	7.25	7.24

Of the 164 percentages here represented, five are abnormal, as may be noticed by consulting the last part of Table 1. These are included, however, in Table 5. If we combine all the bottom and top analyses of Table 5, without excepting any, we get the following general average :—

* Not of the bed, but of the R.R. cutting.

Table 6.	Lime Carb.	Magnesia Carb.	Insol. Matter.
(A)	95.05	2.27	2.40
(B)	63.41	28.22	7.24

but if we throw out the 5 abnormal analyses, we get the slightly different general average :—

Table 7.	Lime Carb.	Magnesia Carb.	Insol. Matter.
(A)	95.77	2.06	1.42
(B)	63.41	28.22	7.24

and this must be taken as the best expression of the chemical distinction between the purer and the more magnesian limestone layers of our Siluro-Cambrian (Calciferous-Sandstone) Formation, No. II, which we can make at present.

It shows plainly enough that the magnesian limestones are very far from being typical dolomites.

It shows also that the presence of magnesia at the expense of lime is connected *normally* with a high percentage of alumina silicate.

This, it seems to me, goes one step towards settling the *mechanical* theory of the origin of the magnesian carbonate on a sound basis. Although we may have to seek long for the source of the sediment, as a whole it must have a source which is common also to the clay.

Difficulties multiply upon us in studying such data. No satisfactory explanation of the bedplate structure of the mass has yet been offered. If the deposit be in the main mechanical and not chemical, it is strange that such sharp distinctions between layer and layer should have been made in the bed of a deep ocean. It is still more strange, that (on this hypothesis) strongly marked local abnormal analyses should be encountered.

This leads me to say that the above investigation is imperfect because carried on in a vertical plane only. It should now be repeated in a horizontal plane. It is desirable to learn whether the *geographical* changes may not be great enough to convert a limestone bed here into a dolomitoid there, half a mile (or perhaps 100 yards) distant. If this prove true (and the possibility of it is indicated by the abnormal analyses), then a new difficulty arises in the way of a sound theory of the origin of the bed plates ; and confuses still more any mechanical theory of the sediments.

Finally, it is evident from Table 4, that if we take 50 beds together and compare them with the 50 lying next beneath them, in other words, when we compare together two masses of the formation one or two hundred feet thick,—it is evident that, in one long age of deposit, more clay and magnesia were present in the ocean than in the preceding (or succeeding) long age.

We have then a large curve of variation, including many small curves, much more strongly marked than in the large one ; like the monthly curves superposed upon the annual path of the moon.

Were it not reckless to hazard a suggestion that the source of the magnesian element is to be sought for in some theory of the ejection and distribution of volcanic dust, so that each short time of volcanic disturbance has left its own record in a dolomite bed,—we might proceed one step further and find in the larger differences indicia of ages of greater or less volcanism.

Daubrée in his "Synthetical Studies and Experiments on Metamorphism, &c.," says (see Smithsonian Report for 1861, page 269):

"We know that certain dolomites result from the transformation of limestone. This epigeny may be explained by the action of combinations of magnesia or carbonate of lime. There is, however, nothing to prove that this transformation into dolomite has always been produced by the same agents, and that the dolomite of Campo-Longo, for instance, with its tourmalines, corundums and various minerals, is to be assimilated with the dolomite of the other parts of the Alps and of Nice, or those which are near the deposits of calamine in Belgium.

But there are dolomites, and this is the case with the greatest numbers situated in regular beds, which are often horizontal, constituting very extensive geognostic formations. When they contain remains of testaceous mollusca the shell has disappeared; they are often crystalline and riddled with holes in such a way as to suggest a substitution. It is possible that the principal part of these last dolomites was directly precipitated. But on account of the disappearance of the shells we must admit, with Elie de Beaumont, that this second case allies itself with the first, by the reaction which the medium has exerted on the matter precipitated, a reaction of such a kind that the carbonate of lime has disappeared. Indeed we notice that pure limestone never alternates with them."

This is certainly not the case in respect of the 115 beds of our section; for certainly the limestone beds of Table 7 (A), page 121 above, with only 2 p. c. carb. mag. and 1.4 p. c. insol. matter, have a right to be classed with pure limestones.

The disappearance of shells by solution is not one of the noticeable features of the limestone strata under discussion in this paper; and they do not, as a rule, exhibit any cavities assignable to such a cause. They are non-fossiliferous, not because of the destruction of fossils, but because of the absence of large forms of life in the original sediments.

The researches of Mr. E. T. Hardman, of the Geological Survey of Ireland, published in No. 7 of the Proceedings of the R. Irish Academy, Vol. II, Ser. II, Jan. 1877, valuable as they are, give us little assistance, because his specimens were taken from the walls of caverns in cavernous limestones, where metasomatic action was in open activity.

In the Jahrbuch der K. K. Geol. Reichsanstalt, XXV, 1875, p. 293. MM. Doelter and Hörnes discuss the subject and assign 1. to the slightly magnesian limestones a directly organic origin; 2. to sporadic normal dolomites a later metamorphosis by percolation; 3. to the largest part of the dolomitoid rocks an original organic origin, with subsequent change of the fossils by magnesia salts during or shortly after deposition, and still later local lixiviation and concentration.

The Philosophy of Christianity. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, February 7th,* 1879.)

Job xxviii, 12–28.

Philosophy is "the love of wisdom."

The Philosophy of Christianity is the love of Divine Wisdom. Its corner-stone is the maxim of John: "In the beginning was the Word, and the Word was with God, and the Word was God."

The capacity and the love of investigation are both due to the fact that "there is a Spirit in man: and the inspiration of the Almighty giveth [him] understanding."

In many of our colleges there is a literary society, in which the requisite qualification for membership is distinguished scholarship. It is designated by the three cabalistic letters Φ Β Κ, which are the initials of the Greek words, φιλοσοφία βίου κυβερνήτης, "philosophy the guide of life."

The Christian philosopher, while recognizing the importance of correct guidance in matters pertaining to our present transitory life, attaches the greatest value to the life everlasting. He therefore accepts as his highest rule of faith and practice, both for time and for eternity, the saying of his Master: "this is life eternal, that they might know thee, the only true God, and Jesus Christ, whom thou has sent." Not simply that they might believe, but that they might know; that the eternal verities of life and immortality have been brought to light through a divinely appointed and divinely anointed Messenger, so that "he may run that readeth" them.

This claim may seem presumptuous to those who have been accustomed to look upon physical science as the only guide to certainty, and who have thought of religious belief as the result of education and circumstance, as something beyond our control, something for which we are in no way accountable and which is, therefore, of little comparative consequence. But the Christian, aware of the influence of belief upon character, feels that there are many things to be feared from faulty belief, while there is nothing to be feared from the clear and absolute knowledge of truth.

The Apostle to the Gentiles exhorted the brethren to "prove all things; hold fast that which is good." He did not, however, limit himself to "things seen" or to logical deductions from the temporal experience in which all men alike participate, although he showed himself to be a formidable antagonist in every arena of disputation. He saw that the search for truth may be prosecuted in two directions: first, in the direction of dependence, under a teachable spirit, waiting and seeking for enlightenment, and rewarded by the satisfaction of religious want; second, in the direction of independence or self-assertion, under a more haughty and confident spirit, forgetful of the sources as well as of the limits of knowledge, devising philosophic or scientific systems. In the field of inquiry to which he was especially devoted, he admonished the followers of that which is good to "rejoice ever more. Pray without ceasing. In everything give thanks. * * * Quench not the spirit. Despise not prophesyings."

These different directions of investigation give differences of character to the results of investigation. Philosophy is not religion; neither of these important pursuits can fill the place of the other; each may, however, help the other. Philosophy is a study, religion is an instinct; philosophy is theoretical, religion is practical; philosophy is a doctrine, religion is an experience. A religious philosophy is better than a godless philosophy, because it looks at truth under more varied relations. A philosophical religion is better than a fanatical religion, because it is in harmony with all the mental faculties. But a philosophy which seeks, on the authority of a supernatural revelation, to fetter the intellectual interpretation of the physical universe, narrows the mind, while it checks the intellectual and moral progress which are important ends of religious teaching; a religion which is limited to the acceptance of philosophical inferences, may satisfy an indolent æsthetic curiosity, but it lacks the earnestness and enthusiasm of a living faith which impels its possessor to a steadfast continuance in well-doing, a faith which shrinks from no obstacle and welcomes martyrdom in preference to a surrender of its convictions.

"The fear of the Lord is the beginning of wisdom." This truth was recognized by Auguste Comte, the advocate of so-called Positivism, when he taught that intellectual development is, first, theological; next, metaphysical; and lastly, positive. A thousand years before the Christian era, David and Solomon had taught the Jews, and Buddha had taught the Hindoos, the vital doctrine which Comte distorted and corrupted, but they were not like Comte, so foolish as to remove the corner-stone after building the superstructure. They did not believe that the science of phenomena was more positive than the knowledge of God and the knowledge of principles, or that a system, which was founded in error and which continually added error to error, could finally culminate in "positive" and unquestionable truth.

Five hundred years after those early sages had directed the attention of lovers of wisdom to the beginning of wisdom, the disciples of Zoroaster in Persia, of Confucius in China, and of Pythagoras in Greece, participated in the wide-spread reformatory movement, which accompanied the restoration of Jehovah-worship at Jerusalem and the settlement of the Old Testament canon under Ezra. They prepared the way for Socrates, who, like Pythagoras, shrank from the seeming arrogance which was involved in the title "sophist," or wisest, and claimed to be merely a "philosophos," or lover of wisdom. Even the sophists generally regarded theology as the highest science. Socrates, agreeing with them in this estimate, believed himself to be a special ambassador of God to the citizens of Athens, acting under the continual guidance of a *daimon*, or divine influence, which kept him from falling into error.

Another semi-millenium beheld the birth, in Bethlehem of Judea, of a teacher whose words were received, by his disciples, as coming with an authority such as had never been known before. Claiming to be the anointed leader for whom the Jews had long been looking, representing his mission to be the fulfilment of "the law," which was "a shadow of good things to come, and not the very image of the things," he sought not to destroy aught that was good or true in previous systems. Still pointing to God as the source of all truth and all power, still finding the highest wisdom in the great truths of religion, he counted all earthly knowledge and all earthly possessions as dross in comparison with the heavenly inheritance. "For what shall it profit a man, if he shall gain the whole world, and lose his own soul?"

We thus see that in all the most highly civilized nations of antiquity the wisest men, almost without exception, believed in some means of communication between man and his Maker, and looked upon the ministers of religion as the special recipients of divine oracles. The true followers of Jesus of Nazareth have uniformly claimed that their system of religion is the highest system that has ever been promulgated, appealing both to the intrinsic excellence of its doctrines and to the results of their lissemination for evidence that their claims are well-grounded. They may, therefore, naturally regard the Philosophy of Christianity as the highest of all philosophies, and as the most profitable study to which human attention can be directed.

Christ himself, although he taught "as one that had authority, and not as the scribes," gave continual evidence of great personal modesty and humility. Although never derogating in the slightest degree, from the conscious dignity of his divine mission, he often rejected the flattering tributes with which his disciples sought to honor him, directing them to the Father whose will he came to accomplish. He did not even attempt to found a church or to frame a consistent system of doctrines during the time of his own ministry, but he left his hearers to make such application of his teachings as would best satisfy their various individual needs and promote their spiritual growth. The wisdom belonged to him; the philosophy to his disciples. His gospel, "good tidings of great joy," was the announcement of a Saviour, who should "save his people from their sins." His purpose was neither to destroy nor to change the divine methods of education, but to fulfil typical prophecies; to throw a stronger light upon the relationships of man to his Maker; to temper personal independence by a clearer sense of personal responsibility; to communicate a knowledge of the personality of God, His personal interest in His intelligent creatures, and the personal help, which He vouchsafes to all who feel a need of help and are willing to accept it. Free grace and free will; the offer of all requisite guidance; the power of choice whether the guidance shall be received or rejected; the voluntary assumption of all the risks which may attend a wrong exercise of the choice; and "the way of salvation" through him in whom "dwelleth all the fullness of the Godhead bodily;" such are some of the chief lessons of Christianity.

"Blessed are they which do hunger and thirst after righteousness: for they shall be filled." All nature teems with the evidence of physical adaptations to physical needs. Those who are spiritually enlightened will find still stronger evidence of abundant provision for all spiritual needs. The daily bread for which we are taught to pray is indeed the "bread of life," the bread which will satisfy to the uttermost all the hungering both of body and of soul. The Father who feedeth the fowls of the air, providing for the wants which He has implanted in His humblest creatures, is not unmindful of the more important wants of the being who was made in His image, and who was endowed with "dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth."

All true philosophy, Christian philosophy in an especial manner, is always cautious, teachable, longing for greater knowledge and greater faith, glad even to welcome reproof when it tends to the correction of mistakes. It looks towards the infinite as well as the finite, towards the absolute as well as the relative, towards the unknowable as well as the knowable, under a conviction that even where it cannot hope for a full satisfaction of all its longings it may gain strength by wrestling with difficulties, and with the unhesitating assurance that the higher its aims the more profitable will be its victories. While modestly acknowledging the limitations which have been imposed upon it, it answers the fundamental questions,—(a) What? (b) How? (c) Why?—by asserting (a) the possibility of knowledge, (b) by means of consciousness, (c) because the Creator of man's consciousness designed it for the acquisition of truth.

Any intimation of a possibility that human power, human wisdom, or human design may be the highest power, or wisdom, or design in the universe, or any hesitation to deny such a possibility, the Christian philosopher regards as an unfortunate manifestation of ignorance. Such ignorance may be excusable in those who are honestly seeking for truth in other directions, and wherever it exists it is the part of true modesty to acknowledge it. But if the ignorant man should try to impose his ignorance upon others, as an insurmountable barrier to knowledge, or if the Christian should hesitate to affirm the absolute and undeniable truth of his answers to the three essential questions of philosophy, no pretense of modesty could shield him from the charge of blasphemous arrogance.

Every philosophical or religious system which has any claim to consideration, must have its dogmas; its positive convictions; its formulated truths or articles of belief;* its "necessary expression in ideas, of the feelings and moral and spiritual laws and conditions which the unity and relationship of heart, conscience, will and intellect in many require should be maintained."† Such dogmas, instead of setting aside the Baconian methods, are the most obvious results of observation and experiment and legitimate logical deduction. But while dogmas are useful, dogmatism, in the sense of arrogant assertion and with a denial of any of the

* Krauth-Fleming. *Vocab. of the Philos. Sciences.*

† H. W. Bellows.

rights of critical investigation, is unphilosophical and suicidal. The nescient or "agnostic" philosopher has the same right to approach any truth whatsoever from his side, as the Christian has from his. The discoveries of each may become greatly helpful to the other, and by joint cooperation they may both, at last, attain to a broader generality of apprehension than either could have gained alone. The Christian's start, from positive knowledge and justifiable assertion, has, however, an immense advantage over his opponent's ignorant groping in the dark and despair of satisfactory attainment.

The dogmatism of science involves greater inconsistencies and is, therefore, more unreasonable than the dogmatism of religion. The modest positivist, when he stigmatizes the popular faith as an outgrown and worthless garment, a "*caput mortuum*," is urged by a spirit of the same kind as the bigot, when he bespeaks, for any form of truth-loving research, the ban of fanatical outlawry, the "*odium theologicum*." But the modesty which doubts its own capability of attaining any higher assurance than that of sense, has no excuse for theorizing, or for claiming assent to anything which is not attested by undoubted sensible evidence. The bigoted enthusiasm, on the other hand, which rests in a blind unreasoning faith and believes that any contravention of its prejudices may be followed by endless misery, is impelled, as if by a natural instinct, to the immediate adoption of such measures as seem most likely to avert a calamity which it so greatly dreads.

Notwithstanding all the teleological consequences which are implied in the admission, probably there are few, perhaps there are none, who would be unwilling to grant that the forces, which man uses for accomplishing his limited purposes, are the same as God uses for accomplishing His unlimited purposes. The Christian philosopher finds it no less evident that the knowledge and designs of the Creator, however much they may differ in degree, do not differ in their essential characteristics from the knowledge and designs of intelligent creatures; he is, therefore, at a loss to understand the difficulties which many persons honestly avow, in recognizing the manifold evidences of an All-wise, as well as Almighty Ruler, who is always "upholding all things by the word of his power."

May not a principal source of those difficulties be found in the hesitancy of a too skeptical spirit? Doubt is very good in its proper place and within proper bounds; obvious errors should certainly be avoided; novel and startling theories should not be accepted until they have been tested by the most searching and conclusive scrutiny; it may even be well to indulge in an occasional exercise of critical acumen upon possible mistakes, which may have crept into popular creeds, either through the supposed teaching of a popular leader, or through some enigmatical and perhaps accidental inadvertence. But the detection of a petty error is of far less consequence, while it may require a much greater outlay of time and ingenuity, than the grasp of an important truth. The philosopher may safely presume that any belief, which has withstood, for ages, the attacks of cavilers, must have some solid groundwork of truth. He can make the truth his own only by fully understanding it, but he may often find satisfaction even in a partial comprehension of doctrines which have given intellectual strength and comfort to many generations of deep thinkers. He will surely gain more wisdom by a diligent looking after truth than by a sharp and cynical search for error.

Paul's advice is well supplemented by Peter's : "But sanctify the Lord God in your hearts : and be ready always to give an answer to every man that asketh you a reason of the hope that is in you, with meekness and fear." The advantages of high ideals have been recognized in all ages. When every throb of our spiritual lives is accompanied by a feeling of God's presence, the perceptive, as well as the imaginative faculties are quickened, and our enlightened insight penetrates intuitively to reasons, both of hope and of complete assurance, which a materialistic philosophy could never find and could never understand.

All philosophy must necessarily be based upon human nature. Our love of wisdom can only extend to what we can recognize, however dimly, as manifesting wisdom ; our capabilities of knowledge are limited by our capacities for knowledge.*

The mathematical necessity which requires that all Consciousness should be manifested under the three primary relations of Motivity, Spontaneity, and Rationality, is tacitly recognized in the modern classification of mental faculties as Presentative, Representative, and Intuitive. This subjective aspect of our spiritual nature finds objective intellectual satisfaction in systems of Religion, Morals and Science.

The subjective exercise of Consciousness, in the primary relations or faculties, is manifested in Feeling, Will and Thought, which are indications of objective Need, Power, and Purpose.

Both the aim and the goal of Consciousness are subjectively developed in Faith, Desire, and Understanding, which find complete objective provision in Revelation, Sanctification, and Inspiration.

If we designate the Motive, Spontaneous and Rational forms by the symbolic letters M, S, R, these relations may all be readily grouped, as in the following synopsis :

Subjective.

	M.	S.	R.
R.	Presentation.	Representation.	Intuition.
S.	Feeling.	Will.	Thought.
M.	Faith.	Desire.	Understanding.

Objective.

	M.	S.	R.
R.	Religion.	Morals.	Science.
S.	Need.	Power.	Purpose.
M.	Revelation.	Sanctification.	Inspiration.

Consciousness is the surest of all things. It is, therefore, unphilosophical

* See Trans. Soc. Phil. Amer. xii, 491-5, 468-73.

to try to trace its origin to material or unconscious substance, of which nothing can ever be known, except the qualities which Consciousness itself attributes to the supposed occasion of its own least important experiences. The conviction of material reality is, however, so strong that we should accept it as a matter of instinctive belief, and, therefore, as a truth of inspiration.*

Since thought is stimulated directly by will, Reason is apt to believe herself independent, and to forget that all her powers, as well as all the facts and premises upon which she exercises those powers, are given by the Creator for the special uses which he designed. Scientific investigators often forget that they can reach truth only so far as it has been divinely "unveiled" or revealed, and that all error is the result of too great confidence in the unaided strength of imperfect human reason.

All the needful revelation that man has been able and willing to accept, has been offered to him, in all ages. In order that he may derive the greatest possible help from the offer it is necessary that his will should be wholly given up to the divine will. "They that wait upon the Lord shall renew their strength." This waiting should not be confined to the religious instincts. It is no less important in the training of the will and in the enlightenment of the reasoning faculties. The inspiration of "unconscious cerebration," during the quiet watches of the night, often untangles a knotty clue which has led the self-asserting mind into a labyrinth of desperate perplexity; the sanctification, which rewards the opening of the door to the Saviour who stands and knocks, always leads to a "change of heart" and often transforms the habitual character in a way that may be rightly regarded as miraculous; the inshining light of immediate revelation gives a clearness of vision and a certainty of knowledge which are known only to those who have rightly learned both to open and to use their spiritual eyes. In every case willingness must accompany ability. Help is never forced upon us; if we choose to trust solely to our own delegated strength, we are free to do so and we may often make valuable attainments in so doing, but if we wish most fully to appropriate the prophetic assurance, "the crooked shall be made straight and the rough places plain," we must feel the need of help, and be willing to seek for it where alone it is to be found.

Christian philosophy discards the use of none of our faculties; on the contrary, it is the only philosophy which insists on the right development of them all. Scientific writers often speak as if nothing should be left to faith, but everything should be decided by reason. The Christian, while committing himself to nothing that is unreasonable, places faith above reason, and sees that reason always errs when faith is discredited. The most implicit faith is always given to that which is self-evident to the believer; his faith in what he believes to be self-evident to others comes next in order and is hardly less confident. The man who should attempt, by any reasoning process, to prove what is self-evident, or even to make it plainer than it is

*Loc. cit. pp. 495-503; 467-8; 504-34.

already, would only show himself to be one "that darkeneth counsel by words without knowledge."

All knowledge must not only begin in faith, but it must also proceed by faith, end in faith, and rest on faith. So long as our faith is weak in the full self-evidence, of our premises, of their logical connection, of the legitimacy of our reasoning faculties, or of their rightful exercise, all our inferences will be vitiated by doubt; we may reach some degree of probability, but no certainty. Of these reasonable requirements the legitimacy of our reasoning faculties underlies all the others. We can have no other reasonable assurance of that legitimacy than our conviction of the wisdom and truthfulness of the Author of our being. The highest faith is, therefore, religious faith; the highest religion is the one which offers the most satisfactory provision for all the spiritual needs of man, in all ages and under all circumstances.

None of our faculties have been made in vain. If the human race, in its infancy, was more given to theology than it is in the present day, its devotion was due to a greater sense of its needs. If the devotion led to any exaggerated development of a faith which looks to eternity, who will say that it displayed less true manhood than like exaggerations of a reason which looks only to earthly temporalities, and prides itself in "oppositions of science falsely so-called?"

True science will not only gladly accept, but it will even eagerly seek, all the help that it can get from every quarter. Assured of the perfect harmony of all truth, and of its many-sided relations, it will see that no truth can be fully understood until it has been studied in its several primary bearings on the triform intelligence of man; that the proper culture of intelligence looks to a complete and symmetrical growth instead of a monstrous, distorted, one-sided growth; that the loftiest revelations of faith yield the most soul-satisfying food for "the scientific uses of the imagination;" that the most complete sanctification of desire is attended by the greatest earnestness of purpose; that the fullest inspiration of understanding is shown by the clearest recognition and the most cheerful acknowledgment of the divine origin of the inspiration; that the dicta of all the mental faculties should be accepted, compared and reconciled, so as to give the broadest possible views of truth; that whenever inclination or avocation give the mind a special bias in one direction, special pains should be taken to learn what religious, moral or scientific acquirements are needed in order to maintain the equipoise of perfect manhood.

God's revelations in the book of nature, are as old as creation. Man, after the lapse of thousands of years, learns the alphabet, spells out a few of the simplest sentences in the record, and sets himself up in the pride of his new attainments, as the intellectual lord of the universe. He forgets that the lesson must have been set before it could be learned; that it may be learned sooner by those who are ready to listen to the Teacher, than by those who try to pick it out by themselves; and that it is never learned without the Teacher's help, although the help may be so skilfully given that the scholar is not aware of it.

The cheerful recognition of the intimate connection between religion and wisdom, was not confined to the early sages. In all historical times the wisest men have felt and acknowledged that it was their highest aim and their highest privilege to read and comprehend even the simplest thoughts of God. The boasted intellectual progress of the last three centuries is rightly credited, in large measure, to Bacon's revival and skilful unfolding of the inductive method; but the religious reformations of Wiclif and Huss and Jerome and Luther had preceded Bacon and prepared the way, through clearer expositions of heavenly truth, for a fuller understanding of worldly truths. Comte attacked theology and metaphysics, at the outset of his career, with Quixotic zeal and Quixotic blindness; but he ended by deifying humanity as a fit object for the worshiping instinct of man, and by promulgating a system of more arrogant metaphysics than ever bewildered the followers of the haughtiest Grecian sophist. The leaders of scientific thought in our own day, with few exceptions, are believers in God; many of them, perhaps a larger relative number than at any earlier period, are also devout believers in Christian revelation, and their belief is more weighty because it is not merely traditional, but springs from deliberate examination and conviction. The godless theories and ungodly lives which degrade humanity are due to the ignorance of smatterers, not to the teachings of earnest and hardworking investigators.

Christianity, more thoroughly than any previous system, teaches the essential identity of secular and sacred truth. To the Pharisees who would fain regulate all observances by their own narrow interpretations of religious doctrines, it says: "The Sabbath was made for man, and not man for the Sabbath;" to the Greeks who ignorantly worshiped the Unknown God, it says: "For in him we live, and move, and have our being;" to those who needlessly embitter their lives by over-anxious thoughts for the morrow, it shows the providence of the Father who watches over the ravens and the sparrows and the lilies and the grass of the field; to those who would set up their own pride or prejudice as a standard of merit, it says: "What God hath cleansed, that call not thou common." It invests all days, all acts, all thoughts, all pursuits with a holy dignity, so far as they may be made tributary to the highest welfare of a single individual, and inculcates full consecration in the injunction "Thou shalt love the Lord thy God with all thy heart, and with all thy soul, and with all thy strength, and with all thy mind."

While truth is one, interpretation is legion. Difference of interpretation does not necessarily imply error in any of the holders of views which may appear to be irreconcilable, unless we regard all partial truth as actual error. Imperfect beings can only gradually be brought towards perfection; in their upward growth an endless variety of shortcomings may need an endless variety of helps, and the truth which is most helpful, in consequence of the greatest number of possible unfoldings, is, for that very reason, the highest truth.

If we extend the definition of Reason so as to embrace in its province all departments of knowledge, we may designate its three primary subdivisions as Pure Reason, Practical Reason, and Logical Reason.

Pure Reason corresponds pretty satisfactorily to Kant's *Reine Vernunft*, in so far as it is the faculty of the highest intuitions. It holds all the direct revelations of faith, all positive or *a priori* certainty, all absolute and incontrovertible knowledge. Of absolute knowledge we have examples in pure mathematics, and in every axiom or proposition which carries with itself the perception of its necessary and universal validity. From the decisions of pure reason there can be no appeal. No professed infallibility, of pope or conclave or synod or man or body of men, can shake the assurance with which we accept the decisions of self-evidence. Others may think us in error, either through want of the clear insight which we enjoy, or through misunderstanding some of the details or bearings of our decision. Whatever we know to be true, no one else can know to be false, however much he may doubt it or however absurd he may think it. The Christian philosopher ranks among the most valuable portions of his absolute knowledge the facts of his own religious experience; the certainty of spiritual being; the self-evidence of a SELF-evident source and authority for self-evidence; the necessary Being of a Planner and Lawgiver to prepare the plans and enact the laws of the universe.

Practical Reason is nearly represented by Kant's *Praktische Vernunft*. It works in the field of morality, for the formation of character; furnishing motives for the guidance of the will; fitted, under the divine sanctification of desire, for the inauguration of noble purposes; giving the real knowledge which makes by far the largest portion of our intellectual attainments. Real knowledge embraces every fact which we are compelled to believe by the constitution of our minds, but of which we do not perceive the absolute necessity. Absolute and real knowledge are often so closely united that it is difficult, especially for persons who have not been thoroughly trained in habits of nice discrimination, to tell where the absolute ends and the relative begins. For all practical purposes, the authority of a truth, which is valid under all the relations by which it is surrounded in our apprehension, is just as binding as the authority of a truth which is valid under all possible relations. Moral certainty is as much the gift of God, and therefore as obligatory, as self-evidence. Both physically and spiritually, the absolute knowledge of others may become our real knowledge, provided we are satisfied of their truthfulness. By practical reason we learn that we are surrounded on every side by limitations which we cannot overleap; that we are, to some extent, the creatures of circumstance; but that, within our bounds and under all possible circumstances there are such things as right and wrong, duty and responsibility; that we must, therefore, have so much freedom of choice and action as is necessary for the exercise of our responsibility. God has provided for the satisfaction of our needs by giving us a real knowledge of what will elevate our character, as well as by giving us an absolute knowledge of what will elevate our thoughts.

Logical, or Empirical Reason is the faculty which is commonly regarded as the crowning glory of man, by those who look upon reason and faith as mutually antagonistic. It is, however, rather an evidence of intellectual weakness than of intellectual strength; because its sole office is to unfold what is given us by pure and practical reason, and because it is exposed to all the mistakes which may arise from undue assumption of premises as well as from fallacious inferences. Kant calls it *Urtheilskraft,* the power or faculty of Judgment. It works largely in the field of science, for the classification of phenomena; examining especially the information which comes to us through the avenues of bodily sensation; confining itself, therefore, mainly to the interpretation of the material universe; and attaining, by its unaided efforts, only to problematical knowledge. Problematical knowledge covers everything which we believe to be true, but the truth of which depends on circumstances which it is impossible for us to determine with certainty. The vacillations and inconsistencies of scientific theories and systems are due, at least partly, to the attempts to disregard or discredit the testimony of the only faculties which can give us positive knowledge.

Fortunately for the interests of truth, and fortunately for science itself, such attempts are always vain. Whether we are aware of it or not, the inspirations of understanding compel us to act under the instinctive promptings of our highest faculties. We may scoff at metaphysics if we will; yet, if we study at all, we speedily find ourselves trying to explain and coördinate the physical facts which we accumulate by observation and experiment. The question, *what,* is necessarily followed by the question, *how;* fact points and leads irresistibly to theory and law. For the completion of possible knowledge the question, *how,* is naturally followed by the question, *why;* theory and law indicate such accordances of thought and will, as may be readily understood if we believe that they represent the activity of a Thinker and Willer, and such as cannot be satisfactorily explained on any other hypothesis. In order that any physical phenomena may be brought within the domain of scientific thought, we must have faith in the validity of the simple presentation, enough curious desire to keep up a proper representation, enough understanding to distinguish the general from the special and the essential from the accidental.

Religion, entrenched in the citadel of faith, has always been helped by antagonism, gaining new strength from every new struggle. Skepticism, assuming protean forms and continually shifting its ground, tries in vain to dislodge its antagonist, and at every assault furnishes new weapons to be turned against itself. The old truths, the primitive beliefs of our race, are still as precious as ever; beyond the reach of death and decay, they continue to hold forth the promise of participation in their own eternal youth and vigor, to those who will accept and rightly use them. Such acceptance and use always bring a full assurance of knowledge, which shrinks from no controversy that is worthy of notice. But skepticism is too apt to forget the two fundamental rules of controversy: that for every individual, self-evidence outweighs all other evidence; and that, whenever self evidence is not attainable, only qualified judges are competent to decide mooted questions.

Philosophy neither needs nor seeks any suppression of facts, and it is not fettered by any theories, however skilfully they may be framed or however haughtily they may be set forth. It grants to science the right of self-imposed limitation to the field of material phenomena, and it accepts material laws as the true keys to material facts, but it looks to moral and spiritual laws as the only keys to the facts of moral and spiritual life. It does not go to a doctor for legal advice, or to a theologian for scientific instruction; it cares little for a deaf man's judgment of a symphony of Beethoven, or for a scientific theorist's views upon a question of religious experience; but it welcomes from every quarter, from Religion, Ethics and Science alike, any new revelation of the eternal truths of God, and it always strives to reach such clear insight into the harmonies of truth as will help it to dispel the mists of human error. No truth is so insignificant that its place would be better filled by a plausible falsehood; none is so formidable that it can overthrow any other truth. The "may be" of the shrewdest conjecture, the "perhaps" of the wisest hypothesis, may be helpful to the investigator, and the philosopher will always gladly accept every well-established result to which they may lead; but they count for nothing against the "surely" of self-evidence or the "therefore" of experimental knowledge.

"A thoughtful writer," cited by Dr. Pusey in a late Oxford sermon, says: "Special studies, which bring into play any special aptitude of intelligence without paralyzing the rest, are conformable to the wants of nature. Exclusive studies, which amass a sort of conjectural life upon one point of the mind, leaving the rest in inaction, are but abnormally developing the excresences of intellectual life; so when special science forms men who are eminent, exclusive science produces judgments which are false. Exclusive science is the only one injurious to religion, but it is also the only one opposed to it. What withholds man from faith is not the knowledge of nature which any one has, but the knowledge of religion which he has not."

The Christian philosopher would gladly share this knowledge with others, but he can point out no other way for its attainment than that of direct revelation. He is often astonished at the condescension of God; he asks, with David, "what is man, that thou art mindful of him, and the son of man, that thou visitest him?" If any satisfactory answer can be found to the question he believes that it should be sought by looking upwards, and not downwards; by following the leadings of the highest spiritual truths, and not by sounding the quagmires of material truth; by studying the records of Supreme Power and Wisdom, not by stopping short at the laws of protoplasm and chemical affinity and molecular motion.

The materialist boasts of the positive knowledge which can be attained by the senses, and regards nothing as worthy of investigation which cannot be verified by sensorial observation and experiment. The Christian recognizes the value of the sensorium as an instrument of mind. and the reverence with which he regards his experimental religious knowledge, leads him to appreciate, at its fullest worth, experimental secular knowledge. But the worth is spiritual, not material. Beauty and order and law are spiritual attributes. The microcosm of each individual is what his spiritual discernment sees it to be, even as the macrocosm of the universe is what God saw it to be, when "he spake, and it was done; he commanded, and it stood fast," and when he "saw everything that he had made, and behold it was very good."

The deceptions of sense are proverbial. We learn, by experience, to correct such as are practically harmful, but the correction involves an exercise of judgment, an assertion of the controlling authority to which sense always is, as it was intended to be, subservient. If each of our senses may sometimes deceive us we can get no valid authority from any combination or comparison of mere sensorial findings. But if the spiritual interpretation of every finding has always a relative truth, a way is opened for supersensual knowledge. The unsoundness of any claim that such interpretations are "the evidence of the senses" may be made more glaring, by showing that sense-deception is not exceptional and rare, but normal and universal.

Take the sense of sight. The most advanced physical science of our day teaches that light and shade, color and visible form, are due solely to wave-motions in the luminiferous æther. These motions are received by an optical instrument, consisting of a combination of lenses and transparent media of various refracting powers. Whatever doubts any one may have as to the Contriver of this wonderful instrument, there can be no doubt that it was made with a specific design for a specific end or purpose; that it was designed to meet certain wants or needs of its possessor, and that its purpose is vision. There is little room for doubt that the æthereal vibrations enter the eye, and are transmitted to the brain, where Consciousness receives them, not as wave-motions, but as a beautiful and inexplicable panorama of blended ideal harmonies and contrasts. Light as we know it, and light as a material agency, are two entirely distinct realities. The spiritual power of the soul transforms the simple motions into conceptions, supplementing creative purpose by introducing a new order of things, and showing that the highest reality requires, for its continued existence, the continual exercise of intelligence.

Turn next to hearing. The unanimous verdict of the most competent judges is again in favor of motion, as the physical instrumentality of all the impressions which reach us through this important sense. The waves, however, are now in a much grosser medium, and are received by a much more sluggish apparatus. While the slowest visible light waves vibrate more than three hundred million million times in a second, the swiftest audible sound waves do not vibrate more than seventy-five thousand times in a second. The frequency of vibration is, therefore, more than four thousand million times as great in light as in sound. The atmospheric waves strike the drum of the ear, awakening answering vibrations in the organs of the inner ear, where they are received by the delicate branching fibres of the auditory nerve and sent to the brain. There Consciousness receives them, not as waves, nor as motions of any kind, nor even as light, but as transformed, by the soul's spiritual activity, into a new order of spiritual conceptions; conceptions which have a reality of the highest degree, but a reality which exists only so long as it is upheld by the power of intelligence.

Taste and smell are more nearly alike than any other two senses, and they may be examined together. The influence of wave motion is not so evident in them as in sight and hearing, but there is no reason for doubting that the gustatory and auditory and all other nerves transmit their impressions to the brain and receive their influences from the brain, by waves or beats. Tyndall's investigations show a striking resemblance between odors and vapors in their absorption and radiation of heat; sapid substances are always soluble, and taste is not excited until some solution is made. Both these senses, therefore, require a preliminary breaking up of cohesion, and consequent increase of active elasticity. The "kinetic theory of gases," which was first proposed by Daniel Bernouilli, supposes that they are formed of material particles, animated by very rapid movements, and that the tension of elastic fluids results from the shock of their particles against the sides of the vessels which enclose them. In discussing the theory most physicists, and perhaps all, have assumed the motions of the particles to be rectilinear, but cosmical analogies indicate a probability that they may be more often elliptical, and perhaps often parabolic or hyperbolic. The likelihood of continual internal motion, of some kind or other, amounts to moral or practical certainty; the probability that taste and smell are in the same category as sight and hearing, objectively as well as subjectively, is, therefore, incalculably great, and if some skilful physiologist should announce the discovery and measurement of waves of smell and taste, the discovery would awaken great interest but little or no surprise. While awaiting the discovery we know that the throbs of the different nerves, which terminate in the mouth and nose, finally reach the brain, where Consciousness receives them, not as waves, nor as motions of any kind, nor even as light nor as sound, but as taste and smell. The spiritual wonder-worker again uses its transforming power to set forth new orders of conceptions; conceptions full of living reality, but a reality which requires the action of intelligence, both to call it into being and to maintain its existence.

The sense of touch seems so completely to underlie all the others, that they are often spoken of as modifications of touch. There are, however, some special considerations, connected with the general sensitiveness of the skin, which are worthy of notice. Many of the most important bodily sensations, at least in a physiological point of view, are dependant on temperature. One of the most interesting modern physical treatises is Tyndall's "Heat as a mode of motion." In that work, the successor of Faraday recounts the experiments of an American-born citizen, Benjamin Thompson, commonly known as Count Rumford, together with subsequent confirmatory experiments of remarkable nicety and remarkable fruitfulness, by Joule, Mayer, Colding, and others. Those experiments all point to molecular motion as the source of heat, and their recognized importance is so great that the new science of heat, or "thermodynamics," ranks as one of the chief physical sciences. Some even go so far as to think it the only physical science, or at least the fundamental science. The genial glow of the hearth-fire may quicken the circulation; the quickened circulation may enliven the spirit; but the spiritual enlivenment and the pleasant sensation of warmth by which it is accompanied are both very different from motion, and from all other sensations. They are both realities of a higher order than any mere physical fact; realities that are only possible in and through intelligence.

The other tactile sensations as well as the renderings of the muscular sense may be referred to various degrees of resistance, dependent upon the aeriform, liquid or solid condition of the body which awakens the sensation. We have already seen that elasticity may be explained by motion, and even the most solid bodies are often highly elastic. The advocates of the atomic hypothesis commonly regard the ultimate atoms as very hard, but the mathematical requirements of the relation between heat under constant pressure and under constant volume point to great elasticity. The new chemistry, and Lockyer's late spectroscopic discoveries, also have the same ultimate pointing. They regard all the chemical elements as based on the hydrogen atom, and it has been shown* that the elasticity of hydrogen is so simply related to the elasticity of the luminiferous æther that hydrogen may be merely condensed æther. All the particles of steel and platinum and of all other material substances are supposed to be in endless motion, through orbits of minute extent which are traversed in brief periods with great velocity. The resistance of such orbits to any change of relative position increases in proportion to the square of the velocity, so that any desired degree of rigidity might be obtained, without any actual contact of particles, by simply giving them velocity enough. The nervous action which is excited by the resistances of physical impenetrability, is transmitted to the brain, where it is received by consciousness, not as motion; not even as light, nor as sound, nor as taste, nor as smell, nor as warmth, but simply as resistance; a spiritual reality of a higher order than anything which is merely material; a reality which is made by intelligence and which is lost as soon as intelligence ceases to wield its upholding power.

We thus see that the "evidence of the senses," so far from being a correct transcript of outward realities, is always as deceptive as the seeming quiet of the seeming general flat terrestrial plane, and as the seeming daily revolution of the sun and moon and stars around our seeming centre of the universe. Our natural and irresistible conviction, that the senses report

*Proc. Am. Phil. Soc., xii, 394; xiii, 142.

things as they are, experiences a shock when we find that there is no more resemblance between the material type and the spiritual reality, than there is between the letters of the alphabet and the ideas which they serve to convey from one intelligence to another. We then begin to see the importance of distinguishing the secondary or delegated cause, both from its immediate consequence and from the Great First Cause; we understand the shrewdness which led the scholastic wranglers to say that there is no light in the sun, no sound in a bell, no sweetness in sugar, no fragrance in a rose, no heat in fire, no cold in ice, no hardness in a diamond; the fundamental doctrine of Berkeley, as expounded by Kant, that "all phenomena are merely subjective representations in consciousness," becomes very suggestive; we learn that the universe, as we know it, could only have been made by intelligence, and that it can only be upheld by intelligence; we know that our consciousness, limited in all directions as it is, has, nevertheless, enough delegated power and authority to enable it to make, uphold, direct and govern all the subjective realities which are essential to its own welfare; we know, also, that such delegated power and authority could only have been delegated by a still higher subjective Spiritual Being.

Must we then reject all belief in objective reality? By no means. Even the apparent immobility and disk-like shape of the earth, as well as the constant daily and yearly apparent motions of the heavenly bodies, have a practical and relative truth which we are compelled to act upon and which is always helpful. We can never attain to absolute knowledge of anything which we have not made our own by subjective experience, but we have a real or practical knowledge of everything that awakens an instinctive belief in its reality. Some men will doubtless continue to argue for ages to come, as others have argued for ages past, on the one hand against the possibility of motion, on the other against the possibility of free agency. But the former will show their practical disbelief in their own theories by their own bodily changes of place; the latter, by their continual exercise of free-agency, their satisfaction when they have done right, and their remorse when they have done wrong. There is nothing so self-evident that men may not try either to refute it or to make it plainer, and mystify themselves by so doing. Arguments have been framed to prove that black is white, that one equals two, that Achilles could not overtake a tortoise, and the fallacies have been so artfully covered that many persons have tried in vain to detect them; nevertheless they have not been beguiled into accepting any of the specious sophisms, although they may have had their faith shaken in the infallibility of the reasoning faculties.

The proper co-operation of all our faculties will always lead us to such truth as God intended we should reach by their help. The difference between the lower, obscure, problematical or practical truth, and the higher, self-evident, subjective or absolute truth, is an indication of educational purpose. If we are satisfied to rest in the lower, we have no right to complain that the higher is hidden from us; if we shut our eyes to the self-evidence that is offered us in one direction, we have no right to ask for proof in another, proof which would be necessarily sophistical if it could be plausibly framed. The man who is either blind or color blind, or who has any other bodily defect, has an imperfect instrument for the use of his spiritual ability, and the imperfection will affect all his work ; but it will not prevent his reaching the absolute and the relative knowledge which are best for him, provided he employs his ability to the best advantage. If his limitations unfit him for the reception of any truths but those of physical or natural science, let him devote himself to the labor for which he is best fitted ; but let him not scoff at other truths, and above all, let him not waste time and strength in seeking to solve, by scientific or "positive" methods, problems which can be solved only by metaphysical or by theological methods. Philosophy and religion offer to science the help which is needed in order to make knowledge complete and symmetrical. If the help is rejected, every attempt to supply its place, by means which God has not sanctioned, will surely fail.

Berkeley's teachings have greatly modified modern materialistic theories. The old idea of inertia, as the essential property of matter, and as implying complete passivity under the controlling influence of immaterial force, is nearly obsolete. Not only is force continually spoken of as material, but will is at the same time spoken of as the "highest form of force." Every writer may be allowed to define the terms which he uses, in his own way, and a complete system of science may be, undoubtedly, built upon a definition of matter as "a substance which may be either conscious or unconscious, either living or dead, either active or incapable of action, either directing or directed, either originating or originated." But there is always danger that a generalization, which embraces opposite qualities in a single conception, may lead to inadvertent reasoning in a circle and to the begging of important questions. It is well that the controlling supremacy of intelligence, upon which Berkeley insisted so strongly, should become more generally recognized, but it is not well that any needless risk should be run of assuming, in defiance of all positive proof, that anything which has once been subordinate can ever develop itself into supremacy over what has once been supreme. Even if we enlarge our ideas of matter so as to embrace all possible forms of being, we do not remove a single difficulty thereby. The same questions come crowding up before us, only under different forms. Instead of asking, "what are spirit, and soul, and mind, and will, and force," we ask, "what are consciousness, and life, and action, and government, and origination." In spite of all our attempts to reconcile the unreconcilable, the eternal facts remain, that there are spiritual phenomena in the field of consciousness and time, and physical phenomena in the field of inertia and space ; that all attempts to subordinate the former to the latter have always failed, and that the physical exists only to serve the wants and purposes of the spiritual.

It is not strange that mechanical philosophers should sometimes think that all consciousness is connected with a brain, for the highest organic mechanism that is directly and sensibly tributary to consciouness is undoubtedly to be found in the human brain. But the Christian sees evidences of the sway of consciousness everywhere; in the rudimentary nervous systems of insects and molluscs; in the busy industry of coral-building polyps; in the shapeless jelly of the amœba; in the development, from a single cell, of the most complicated vegetable and animal forms; in the structure of crystals; in the formation of compounds, with new properties, by chemical affinity; in the continual renewals of creation during each returning year; in the unity of plan which is manifested in the arrangement of planets and of spectral lines; in the modifications of that plan which are displayed in vegetable growth and in stellar systems; in all the indications of life, and law, and order, and purpose, and adaptation of means to ends with which the universe is filled. If steam engines could think, they might regard steam as the source of all the varied and intricate designs which are wrought out by machinery, with much more reason than man can give for regarding the brain as the source of consciousness.

The more mechanical consciousness becomes, either in its immediate or in its mediate manifestations, the less is the liability to mistake. The instinct of animals is more unerring than the reason of man; crystallization and organic growth follow established design more closely than instinct; the cell, which was meant for one part of the body, rarely goes to any other part; machinery accomplishes its results with greater uniformity than manual labor; the calculating machine computes difficult tables with more certainty than the most skillful mathematician. Mechanical philosophy may naturally regard mechanical perfection as the best evidence of superiority, but a higher philosophy esteems freedom more highly than automatism, and consequently finds in the possibility of imperfection, evidence of a high degree of perfection. Man, sinful as he is, and "born unto trouble as the sparks fly upward," is a nobler creature, from the very fact that he has the power to choose between right and wrong, than he would be if he were compelled always to act from unerring instincts. Now, he is capable of indefinite progress; then, he would have been stationary; now, virtue and merit and satisfaction in the performance of duty are within his reach; then, he would have been a mere slave; now, he has a distinct personality, created in the image of God, made a little lower than the angels; then he would have been a mere machine.

Liebnitz and Coleridge and Cousin all gave great prominence to the doctrine that "Systems are true by what they affirm, but false by what they deny." "The heavens declare the glory of God;" but "the fool hath said in his heart, there is no God." We may affirm that consciousness is connected with a brain, but if we say that all consciousness is connected with a brain, we deny the positive assertions of others and make a gratuitous assumption which is scientifically untenable. We may admit, with Hæckel, that every organic cell has a conscious "soul life;" that in the infusoria a single cell performs all the different functions of life; that, *perhaps*, in the higher organisms, the numerous single cells give up their individual independence, and subordinate themselves to the "state-soul" or "personal soul," which represents the unity of will and sensation in the "cell-association;" and that his theory brings all natural phenomena into a mechanical causal connection, as parts of a great and uniform process of development. But if we deny that there is any higher soul or life or power or wisdom than is manifested in single organic cells or groups of cells, or if we deny that every "mechanical causal connection" must have a mechanic to make the causal connection, or if we deny any other theory which is more satisfactory to its upholders than our own, we overstep all scientific bounds and our words are as worthless as the babble of a child. We may accept the alternative, "natural development or supernatural creation of species," and we may explain the two hypotheses in such way as to present no necessary antagonism; but if we deny the necessity of an intelligent author for every established order and an intelligent originator for every consistent plan, we only show our own foolishness. We may believe, with Cousin, in an impersonal reason which pervades the universe like a spiritual sea or atmosphere, which is the mediate source and endless supply of all finite knowledge and all material development; but if we deny the existence of a personal reason which is still higher, our vanity leads us into arrogant blasphemy. If we open our intellectual eyes to the light of the highest philosophy, we may see that the truths of affirmation, in all philosophical systems, are partial recognitions of this higher truth which includes them all: wisdom "was set up from everlasting, from the beginning, or ever the earth was."

Modern science is too prudent to make such denials, and none of them have ever been made by men whose opinion is worthy of the slightest consideration. The methods of observation and experiment only lead to the discovery of what is; they furnish no grounds for positive assertion of any kind, beyond a simple statement of facts. But the natural disposition to theorize, which is praiseworthy when it is employed merely as a help to investigation, often leads men to attach too much importance to ingenious hypotheses, and to suppose that the explanation which they accept is the only reasonable one. Moreover, the commendable caution, which leads honest and ready investigators to publish nothing that has not been thoroughly tested by their special methods, is apt to be misunderstood. If men, whose talents, education and calling give them a peculiar aptitude for research, hesitate to affirm a mooted doctrine, their admirers often take the hesitation for a denial. The supposed denial has, for them, both the fascination of novelty and the witchery of authority; they therefore adopt it eagerly, priding themselves on their independence of thought and their superiority over the prejudices of education and tradition.

It therefore behooves every one, whose views are likely to influence others, to be very watchful lest he become instrumental in breaking down any of the barriers against immorality. If his assurance of important spiritual truths is not sufficient for him to speak with positive certainty, he should at least guard against such misinterpretations of his teachings as he is unwilling to accept, and he should claim the same rights and the same authority for students in other fields as he claims for himself. Let his scientific reputation be as high, and his physical discoveries as brilliant as they may, he may feel himself honored by the avowal that he is a lover of wisdom, like David and Solomon and John and Paul, and by owning that their experimental knowledge of the spiritual truths, which they proclaimed, was as positive as his own experimental knowledge of the physical truths which he proclaims. He cannot show that physical truth is more important than spiritual truth, nor that the scientific writers of our day are more honest, more capable, more careful, or more thorough than the religious writers of the early Christian days. Let him not claim, then, even by the faintest shadow of implication, that the prophets and evangelists and apostles were less competent judges in their special field of experience, than he is in his, or that their assertions are less trustworthy than his own.

Büchner offers the following dilemma: "Either the laws of nature rule, or the eternal reason rules; the two would be involved in conflict every moment; the sway of the unchangeable laws of nature, a sway which we cannot call a rule, would allow of no conflicting personal interference."* The dilemma itself is well stated, but it is difficult to see how any one who believes in "eternal reason" can accept his solution. How can laws, having "a sway which we cannot call a rule," rule anything? What are "laws" and "eternal reason?" Before we attempt to dogmatize, we should try to express our meaning so plainly that it cannot be easily misunderstood. To the Christian philosopher, the assertions that "the two would be involved in conflict every moment," that the laws of nature are unchangeable, and that their sway "would allow of no conflicting personal interference," seem like mere gratuitous assumptions.

The primitive meaning of law, as defined by Webster, is: "A rule, *particularly* an established or permanent rule, prescribed by the supreme power of a state to its subjects, for regulating their actions." Between the laws of man and the highest human reason there is rarely any conflict. No human laws are unchangeable, but the more reasonable they are the less likely are they to be changed. If they were in accordance with eternal reason what ground can any one have for thinking that "the two would be involved in conflict every moment?"

The primitive and etymological meaning of nature, is "that which is born or produced." By metonymy nature is taken to represent the producer, and Darwin defends this use of the word in language which seems to imply his undoubting belief that the producer is intelligent. Büchner says: "Nature is a single totality sustained by an internal necessity."† This definition might be interpreted to include "the eternal reason" as a part of nature, but it seems likely from the terms of his dilemma, that he agrees with most other German philosophers, in contrasting nature, as the material world, with the world of intelligence. If such is his meaning, and

* Cited by Krauth.

† Ibid.

if he intends to assert that the material universe is sustained by an internal necessity which is independent of any supernatural influences, he is simply begging the question.

What are called "the laws of nature" are merely the generalizations of our own minds. They represent facts, of order, and harmony, and mutual relationship, which have been observed so often that we look upon them as invariable, and nearly every provision which we make for future contingencies is grounded upon our confident belief in such invariability. If we were to ask how a religious or political organization is governed, we should think it a very unsatisfactory answer to be told that "the laws of the organization rule." It is equally unsatisfactory to be told that the laws of nature rule, when we ask, what governs nature? We are not children, to be stopped in our questionings by a simple "because," or to be contented with the assurance that certain orders of fact occur because those orders of fact always occur. Yet what more do they offer us who talk of "the sway of the unchangeable laws of nature?" Who will say that protoplasm or chemical affinity rules the conscious movements of the infusoria, or the amœba, or the higher organizations which use nerves and ganglia as the instruments of consciousness.

However we may try to account for the origin of consciousness, we cannot divest ourselves of the belief that consciousness is the ruling power of its own polity. Even if we can bring ourselves to think that the "cell-soul" is the product of the material forces which organized the cell, we cannot help thinking that, after it is "developed," it rules the cell; even if we define matter so as to include all phenomena, the only ruling force that is self-evident is the force of will. Seeing an established or permanent rule in the material universe, which resembles the "established or permanent rule prescribed by the supreme power of a state to its subjects," we reason from analogy and call the natural rule, as well as the human rule, a law. Extending the analogy, we look upon the "laws of nature" as rules prescribed by the supreme power of nature. The Christian philosopher extends the analogy still further, and finds that all his questionings are satisfactorily answered by a simple acceptance of the revelation, that the supreme power is an Omnipresent, Almighty, "Eternal Reason," and Will, and Love. According to the only intelligible conception which he is able to frame, of the laws of nature and the eternal reason, we have no grounds for saying that "the two would be involved in conflict every moment." On the contrary, any conflict is an absolute impossibility. "The sway of the unchangeable laws of nature, a sway which we cannot call a rule," continues only so long as God wills; the laws are unchangeable only while their Author does not wish to change them; there can be no such thing as "conflicting personal interference," because at the moment when there would be an interference, provided the laws had an independent existence, the change in the Divine Will makes a corresponding change in the laws.

In this conception all the terms are used in their simplest, most obvious, and most general acceptation. If the teachers of a different doctrine have a well defined notion of the laws of nature, which enables them to give up the idea of an intelligent Ruler, it would be much better that they should express the notion by some other term than law, and they should by all means give such clear definitions as will enlighten the understanding of their readers. If they have no such notion, they use "words without knowledge." The use may be honest, and free from intention to deceive, for every one is liable to an inconsiderate employment of terms which have been familiar from childhood. But a professed searcher for truth, who believes that the majority of thinking men have, for ages, been blinded by error, can hardly be excused for forcing their expressions into a meaning which they would unanimously repudiate. Such a course may lead to one of those endless wars of words which constitute a large portion of the fancied oppositions between science and religion, but they hinder, instead of helping, the spread of knowledge. When science claims the right of free discussion, the right must be granted, but only in legitimate ways. The etymological bond between *reor* and *res*, *reason* and *real*, *think* and *thing*, is only one out of many indications that philosophy is only concerned and can only deal with ideas; that the ideal is, as Plato taught, the only reality to which we can possibly attain; that all manifestation, material as well as spiritual, is only the expression of ideas; and that nothing can be gained by trying to banish or ignore the highest ideas which have been revealed to men and to shut them within the narrow bounds of manifestation, of which we can know nothing except through subordinate ideas.

The highest philosophy, while it seeks for nothing but the truth, will be satisfied with nothing short of the whole truth; truth to the whole triplicity of human nature; truth which can harmoniously promote all the purposes of revelation, sanctification and inspiration.

A strong feeling of spiritual need, with the implicit dependence upon the intimations of faith which is its natural accompaniment, gives philosophy a leaning towards mysticism; the happiness, which accompanies every satisfaction of the need, awakening a thankfulness to the Giver of all good and a recognition of His benevolence which lead to theories of *optimism*. An energetic, self-asserting will, with an accompanying disposition to yield to every impulse of desire, gives a tendency towards dogmatism; the abuses of freedom, which characterize "the natural man," giving belief a subjective bias which is shown in systems of *pessimism*. Active reasoning powers, leading to a continual exercise of thought upon speculative questions, give rise to skepticism; the impossibility of reaching any conclusion, in which something is not taken for granted, convicting finite reason of inherent weakness, throwing a shade of doubt over every commonly accepted belief, and tending towards *nihilism*, or a denial of all reality. Christianity assigns each group of theories its proper limits, by teaching that "God is good;" the human "heart is deceitful above all things, and desperately wicked;" "the natural man receiveth not the things of the Spirit of God, for they are foolishness unto him; neither can he know them, because they are spiritually discerned." There is no inconsistency in believing: 1, that the created universe is the best possible, when considered with due regard to all the purposes of creation ; 2, that our world is the worst possible, in view of the evil which has resulted from the intentional interference of human liberty ; 3, that no certainty can be reached by a reason which starts with the assumption of its own independence, and refuses the guidance which is offered by its Creator.

Aristotle says, "philosophy began in wonder."* Wonder leads naturally to admiration, admiration to investigation. Through wonder we learn, and the facts which we thus acquire constitute the largest, as well as the most important portion of our knowledge. Through admiration we become attentive, attention giving distinctness and thoroughness to knowledge. Through investigation we unfold the truths which we have already ascertained, and although we are not directly led to new truths, we discover new relations, which may excite new wonder and admiration, thus leading indirectly to the knowledge of new facts. Wonder, admiration and investigation all aim at the highest conceivable ends. Each of them finds special ends of its own, which are so important that they are sometimes looked upon as all-embracing. But the partial can never be so comprehensive as the general ; the satisfaction of one want is inferior to the satisfaction of all. The fondness for study and investigation is implanted in us for the formation of character, and no better test can be given, of the importance of any belief or pursuit, than the influence which it is likely to exert, either in elevating or in degrading the soul. The order in which the fundamental questions of philosophy naturally arise, tends to lead the mind from effect to cause, and from cause to final cause or purpose ; from creation to creative power, from creative power to creative design ; from manifestation, and power, and purpose to the Source of all things, the only true God, who is at once Upholder, Creator and Designer. Physical science very properly recognizes the fact that the investigation of final causes and of other metaphysical problems is out of its province, but for that very reason it should not reject the help which theology and philosophy are always ready to give it.

There is no field of natural science which is not full of pointings, backward to the unconscious, and forward to the conscious. Matter is manifested in various forms which are known as chemical elements ; elements combine to make compounds of various properties ; both elements and compounds often occur in crystaline forms, each crystal being built upon a definite plan ; through the mystery of life inorganic matter becomes organic, the simplest manifestations of organizing force transforming the mineral into the vegetable, and higher manifestations making vegetable life tributary to animal life ; both in the vegetable kingdom and in the animal kingdom there are many gradations, from lower to higher species and genera and orders and classes ; the visible creation culminates in man, who boasts his pre-eminence mainly on the ground of his superiority in intelligence.

Throughout this ascending scale of being, in which, at every step there

*Cited by Krauth.

is something added to the step below, there are unmistakable evidences of a unity of design, such as would result from a unity of Supreme Intelligence. The likeness of finite intelligence to Infinite Intelligence, is shown both by the power of partially comprehending the designs of the Creator and by the power of scientific anticipation, which sometimes leads to important scientific discoveries.

Evolution, development, execution of purpose, are facts of every day experience. Religion, Morality and Science are all called to deal with them, each according to its own methods. Science, of its own choice, has taken the mechanical method, which is the lowest of all, although it may be as important as any, provided it is employed in the proper spirit. All the details of evolution and development, which can be discovered by the most untiring search, are portions of God's truth, and we owe many thanks to the earnest, hard-working men through whose diligence they are made known to us. But evolution as a fact or law expressing a Divine method, is one thing; evolution as a self-sufficient theory, is quite another thing. The fact must be accepted, just so far as it is shown to be a fact, and no further; the theory is only a child's answer to questions of the highest import.

The engineer, deeply interested in the workings of an intricate machine, may study it in all its parts, watching the bearing of every joint, and lever, and cog, and band upon the result which the whole combination was intended to bring about, and admiring the simplicity of contrivance which, by avoiding all superfluity, displays the inventor's wondrous skill. His own knowledge may be enlarged by the study, and he may find himself greatly helped by it in subsequent important professional undertakings. But what should we think of his scientific wisdom, if he should try to enlighten us in regard to the orgin of the machine, by telling us that the atom-souls give up their individual independence and subordinate themselves to the molecular-souls; that the molecular-souls, in their turn, subordinate themselves to the joint- and lever- and cog- and band-souls; that the joint- and lever- and cog- and band-souls subordinate themselves to the machine-soul; that ali the lower forms of consciousness thus become tributary to the higher consciousness of the machine's state-soul or personal soul, which represents the unity of will and purpose in the atom-association; and that thus all the phenomena of the machine are brought into a mechanical causal connection as parts of a great and uniform process of development? If we study the mechanism of the eye and ear, and the contrivance by which they are fitted for their intended purposes, can we show any greater wisdom by suggesting a similar explanation as final and sufficient? Religion, Morality and Science may all be satisfied by accepting the teaching of David and Solomon, and in no other way: "He that planted the ear, shall he not hear? He that formed the eye, shall he not see?" "The hearing ear, and the seeing eye, the Lord hath made even both of them."

There can be no question that a too great and exclusive absorption in the study of outward nature, will lead us towards materialism, and that materialism will tend to dwarf our spiritual growth. There is little risk, while physical research continues so rife as it now is, of our becoming too spiritual; consequently there is little risk in the spread of spiritual instruction, as an antidote to the philosophy which ignores all spiritual control. These grand maxims should be indelibly impressed on every mind, and above all on the minds of physical investigators; that "we have a higher warrant for believing in God than for believing in any other truth whatever;"* that the simplest exercise of thought proves the existence of spirit, while the existence of matter "as a distinct entity has never been proved, and is seriously questioned;"† and that, even after we have granted the reality of an inert, unknowing somewhat, which underlies material phenomena, we should still look to the wisdom which sways, as higher than the ignorance which is swayed.

Our age is often called an age of materialism, but when we compare it with previous ages we may find much to be said in its favor, while the faults, with which it is justly chargeable, lie partly at the doors of Christian believers who have neglected their religious duties. Most investigators, in every age, limit their researches to fields in which there is the greatest likelihood of discovery, and in which general interest may be most readily awakened by direct appeals to the senses. This is in accordance with evident Creative Design, for the senses are the only known avenues of intercourse between the spirit of man and the material universe, and the beginnings of education come through such intercourse. The great end of education is, however, spiritual, and if our spiritual teachers do not keep pace with the age, we must all suffer loss. We need, therefore, educated guides, as well as educated followers; a body of apostles, prophets, evangelists, pastors and teachers,‡ capable of understanding and rightly qualified for interpreting and reconciling, the truths which skillful decipherers have drawn from the Bible of creation, as well as those kindred truths of kindred revelation in the Bible of Scripture, and in the Bible of the soul.

Although timidity has hitherto greatly blocked the way against such interpretation, we have reason for congratulation in the unconscious shaping of physical theories by spiritual intuitions. Newton, near the close of his Principia, says: "This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion ot an intelligent and powerful Being;" and in his third letter to Bentley: "It is inconceivable that inanimate brute matter, should, without the mediation of something else which is not material, operate upon and affect other matter without mutual contact;" La Place supposed the velocity of gravitating action to be instantaneous, a velocity which is impossible save through a spiritual medium; Tyndall, in speaking of the "potency" of matter, expressly admits that he does not seek to degrade spirit, but to elevate matter, and in his Manchester lecture he indignantly disclaims "that creed of atheism which has been so lightly attributed to him;" Huxley avows himself a spiritualist, rather than a materialist; Maudesley regards will, as the highest

* Ex-President Thomas Hill.

† Rowland G. Hazzard.

‡ Eph. iv, 11.

form of force; Maxwell says that the progress of science has "tended to deepen the distinction between the visible part, which perishes before our eyes, and that which we are ourselves, and to show that this personality, with respect to its nature as well as to its destiny, lies quite beyond the range of science;" Barker, in his address before the chemical section of the American Association, quotes the definition of matter, as "that which is essential to the existence of the known forms of energy, without which, therefore, there could be no transformations of energy;"* Cope, in discussing the origin of the will, speaks of "the goodness of God as the anchor of the universe;" Draper, addressing the Chemical Society, says: "Shall a man, who stands forth to vindicate the majesty of such laws, be blamable in your sight? Rather shall you not, with him, be overwhelmed with a conception so stupendous? And yet let us not forget that these eternal laws of nature, are only the passing thoughts of God;"† Frothingham, in the very extremity of his radicalism, makes the following acknowledgments: "Still, that whatever power there is, is alive, in every atom of space, in every instant of time, is put beyond controversy, and manifest, let us add, in a much higher form in mind than in visible matter." "It is impossible for me not to believe that the universe is governed by an intelligent will."

Berkeley himself could hardly have found fault with any of these statements; he would have felt little fear of any materialism which defines matter in terms that would be equally applicable to spirit. Quotations might be indefinitely multiplied, to show that the best devotees of modern science, while they fearlessly assert their right to vindicate the truth of their own discoveries and to accept every inference which may be legitimately drawn from them, admit, in their best moments, that there is a realm beyond the reach of their physical analyses and experiments. In that realm it is the right of religion and morality to work, and by faithful work they may check all tendencies of science which are one-sided or otherwise dangerous. Whoever has a knowledge of spiritual truth, which is as sure as that of John and Paul, may look for a success akin to theirs; whoever presents the results of his religious experience, as clearly and forcibly as Tyndall and Darwin and Huxley present the results of their physical experience, will find that faith and reason, going hand in hand, become mutual helpmeets.

Christian philosophy says to its upholders: Yours might have been, much more largely than it is, the credit of that growing recognition of spiritual power which makes the defenders of truth so hopeful; it is not yet too late for you to resume the armor of your early leaders and renew their career of conquest. Be not afraid to acknowledge the ignorance which you cannot conceal, be bold in asserting the truth of what you know, and science, forgetful of her apparent hostility, will gladly shake hands with you, sitting at your feet as an eager learner of truths which round and supplement her own discoveries.

* Stewart and Tait.

† "The laws of nature are the thoughts of God."—Oersted.

The most thorough-going evolutionists are the fullest believers in the modifying influences of struggle, want, annoyance; all of which are evidences, more or less striking, of an indwelling consciousness which promotes development. The amount of variation which man has assisted in producing, in pigeons, cattle, and other domesticated animals, is often quoted in order to show that neither specific nor generic differences are sufficient to need any unwonted intervention of creative power for their production. In geology and astronomy there are like tendencies to avoid cataclysmic hypotheses, and to seek an explanation of past changes in the earth and in the heavens through such mediate causes as are still at work. These tendencies are not objectionable unless they lead us to forget that the creation of a new cell calls for an exercise of supernatural power as truly as the creation of a universe; that the miracle of every moment is as wonderful as the miracle of developing order out of chaos; that the Upholder of all things is also the Maker of all things; that any relaxation of his mighty energy would be followed by instant and universal confusion. If we keep all these things in mind, our sense of the continual presence of God will lend a solemnity to all our undertakings which will incline us to trust in him as our all-sufficient help and shield.

"In discussing the material combinations which result in the formation of the body and the brain of man, it is impossible to avoid taking side-glances at the phenomena of consciousness and thought. . . . Though the progress and development of science may seem to be unlimited, there is a region beyond her reach, a line with which she does not even tend to osculate. Given the masses and distances of the planets, we can infer the perturbations consequent on their mutual attractions. Given the nature of a disturbance in water, air, or æther, we can infer from the properties of the medium how its particles will be affected. In all this we deal with physical laws, and the mind runs freely along the line which connects the phenomena from beginning to end. But whenever we endeavor to pass, by a similar process, from the region of physics to that of thought, we meet a problem not only beyond our present powers, but transcending any conceivable expansion of the powers we now possess. We may think over the subject again and again, but it eludes all intellectual presentation. The origin of the material universe is equally inscrutable."*

Thus physical research, which starts from faith, and proceeds by faith, ends by sending us back to faith; "the substance of things hoped for, the evidence of things not seen;" for the answer to all our inquiries about the highest realities. Our confidence in the results which have been reached through faith in the phenomena of the lower field, should give us still greater confidence in the phenomena of the higher. The evidence of abundant provision for all the wants of our material nature furnishes a well-grounded assurance that an equally satisfactory provision has been made for all the wants of our spiritual nature.

No doctrine can ever gain extended acceptance, unless it is based upon

* Tyndall, "Heat as a Mode of Motion 4th ed., § 723."

some evident phase of truth. However desirable general knowledge may be, it is attainable only through the accumulation, repetition, and complete mastery of specific facts, by means of definite practical lessons. This is especially true in the case of religion. Drop everything that is or has been denominational, and you will have little left save a vague philosophical abstraction, in which most men may agree, but in which few can find any satisfaction. The "absolute" of the metaphysician; the "supreme" of the scientist; the "all" of the pantheist; represent conceptions towards which the mind is irresistibly driven, but at which all meaning is lost. That which is void of relation, cannot be made the object of thought by beings who think only under relations.

As soon as we admit relativity and attribution, we see that God would cease to be Almighty if He had not the power to reveal himself, in relations of love and sympathy and help, to his intelligent creatures in whom he has himself implanted a wish for love and sympathy and help. Hence arises the metaphysical conception of an "absolute-relative," which accords with the Biblical revelation of an All-wise, Almighty and Ever-living God, who is "not a God afar off," but always and every where near at hand. Under a vague perception of the manifold ties which may subsist between man and his Maker, systems of polytheism arise, of which the most philosophical forms are found in the trinities of the Hindoos and Egyptians. The hidden truth, which they represent, rests upon the mathematical necessity that a relative spiritual nature, like that of man, must be triform; either affected, self-influencing, or affecting; either emotional, voluntary or intellectual.

The revealed doctrine, "God said, Let us make man in our own image, after our likeness," is thus in perfect harmony with the highest philosophical inference of natural religion, and with the "catholic faith" of the Athanasian creed, which worships "one God in Trinity and trinity in unity, neither confounding the persons nor dividing the substance." The conception of the dogma, in the old mythologies, was dim, ill-defined, and generally tritheistic; its deep spiritual meaning was set forth in the Jehovah, Adon, and Ruach, of the Hebrews, the Father, Son, and Holy Ghost, of the Christians.

Religion, as well as science, should always be practical, progressive and aggressive in the adaptation of its unchanging principles to the changing requirements of human progress. Truth is so impregnable that it should court criticism, rather than shun it; our interpretations of truth may be vacillating, but if they are, we cannot give them stability by refusing to examine them. Religion has nothing to fear, save from its own fearfulness; nothing to hope, save in such hopefulness as springs from its own everlasting ground work of truth. Science, resting on reason, asserts its claims with a boldness which almost disarms opposition and carries nearly everything before it; Religion, resting on faith, timidly clings to its traditions, but shrinks from the inevitable contest which is to give them new life.

Our children, with all the natural curiosity of youth, fascinated by the wonderful rapidity of discovery and the charms of novelty, may easily be led to confound hypotheses with facts, unless we provide some means for their proper enlightenment. They may also be easily led to see that all truth is harmonious; that there are different kinds of truth, adapted to different spiritual requirements; that the existence, the appreciation, and the authority of truth, are all due to spiritual existence; that spirit is superior to matter; that only through faith in the inspiration of the Almighty is any exercise of our reasoning powers or any attainment of knowledge possible; that faith is, therefore, higher than reason, and it is important that our faith should have the foundation of God, which standeth sure.

Let us not hope or desire to banish either bigotry or radicalism. As long as men differ in taste and ability, they will also differ in their leanings towards opposite extremes of thought. Men of one idea fill a useful place in the economy of culture, for their very extravagance may serve as a warning; their devotion, as an example; their leadership, as an inspiration; their antagonism, as a needful restraint. Few walk so safely in the golden mean, that they are never misled by the mists of error; few can be awakened to a knowledge of their own mistakes, so quickly and so thoroughly, as by wrestling with counter mistakes. He who seeks for a symmetrical growth in truth, should first seek to know himself. If his intellectual vigor is so great as to make him haughty and headstrong, he needs to learn the helplessness of reason and the power of faith; to see that all our boasted intellectual triumphs are limited to the acceptance of conclusions, which rest upon simple faith in propositions that cannot be proved. If his faith in his creed, his teachers or his companions, degenerates into the credulity of ignorance, he needs to learn that faith was given us only as a helper, not as a tyrant; that moral and religious growth should be accompanied by intellectual growth; that worldly probation was designed for the proper exercise and training of all our powers, in order that we may come "unto the measure of the stature of the fulness of Christ;" that a reasonable faith should always be accompanied by a faithful reason.

It is with nations and with ages as with individuals. Each community and each period, represents a certain stage of progress, a certain capacity of development, a certain want of guidance. Although history often seems to repeat itself, each apparent repetition is shaped by new conditions. Old questions are continually coming up, but they are continually answered under new phases of experience. The thoughts of Socrates and Plato have left an impress upon humanity which can never be obliterated; the great religions of antiquity prepared the way for Christianity; the claims of Christianity, as a final and culminating revelation "in the dispensation of the fulness of times," rest on its completeness and on its adaptation to the wants, not of a single age or of many ages, but of all ages. The triumphs of reason, when guided by faith in the intimations of truth which are given, with more or less clearness, to all men, are shown in the lasting vitality which pervaded the teachings of the great questioner and the "academic swan;" the triumphs of faith, when moulded by the sturdy intellects of skilful priests and devotees, maintained the old religions during their severally allotted reigns; the joint triumphs of reason and faith, under "the shining light, that shineth more and more unto the perfect day," are henceforth to be won by Christian champions, through such diligence of labor and harmony of action, as will promote a thoroughly symmetric spiritual and intellectual growth.

Christianity, as thus interpreted, becomes the culmination of all philosophy, as well as the culmination of all religion, for any system of complete truth must satisfy all the demands of secular investigation, as well as all the needs of eternal warfare. Few, perhaps none, are fully aware of the mighty influence which the Christian training of nineteen centuries has exerted on the habits of thought, and on the mental calibre, of every individual in modern civilized communities. Scoffers, wearied with the inconsistencies which mar the characters of professed religionists, and dazed by the enchantment which is lent by distance, sometimes extol the purity of heathen faiths, or the superiority of philosophical systems to all forms of faith. But impartial observers find in the Bible, as nowhere else, an embodiment of the best truths of all ages, expressed with a grand simplicity which is without parallel, and suitable for a ready application to all wants.

There will always be a large intellectual class, acknowledging an Omnipresent Ruler who is All-loving, Almighty and All-wise, whom they delight to worship as their Heavenly Father, but of whom, through fear of "dividing the substance," they hesitate to speak in terms which might be interpreted as claiming a knowledge of mysteries that are beyond their comprehension. There will always be a much larger class, so filled with a sense of their own weakness and unworthiness, that they yearn after a still closer and, as it were, brotherly relationship of sympathy and suffering, under which they may be emboldened to approach the throne of grace with the prayer of David: "Let the words of my mouth, and the meditation of my heart, be acceptable in thy sight, O Lord, my strength and my redeemer" There will always be a third class, rejoicing in the belief that God is a Spirit, who is to be worshiped in spirit and in truth, who offers them at all times the spiritual guidance which is best suited to their immediate spiritual condition, and who will require nothing at their hands but a simple, childlike acceptance of that guidance and consequent obedience to their clearly perceived intimations of truth and duty. Each of these views is a relative and partial view. In each class there will always be many who think, that even if it should be true that partial truths may answer all the positive requirements, the bare necessities of our nature, such harmonious development of our faculties as is most desirable, can only be attained through the study and acceptance of all the primary phases of belief, and the search for the fundamantal postulates which unite them all and give them all their vitality.

Faith cannot take the place of action or of reason ; action cannot take the place of faith or of reason ; reason cannot take the place of faith or of action. The province of faith is, however, the highest, because it deals directly with eternal verities, and because it furnishes the sole authority for action and reason ; the province of action is next in order of dignity, because it determines character ; the province of reason is the lowest, because it deals mostly with temporal and worldly relations, and because it indicates a defective intelligence, which can only slowly and laboriously reach a clear understanding of the contents of simple intuitions.

None of the facts, either of theology or of metaphysics or of physics, can be gainsaid. Some of them are naturally, and some are spiritually discerned. They may all be KNOWN, because God has revealed himself, not only as Power and as Way, but also as Wisdom and Love, as Truth and Life. In the coincident union of perfect humanity and perfect wisdom is found the Divine image, in which man was made and by which we are able to have the positive assurance, of full and indisputable self-evidence, in regard to all things which God has been pleased to reveal to us and which we are willing to accept. Theories have no binding authority upon any one, and they have no value except as they may be made tributary to the discovery or to the application of new truths or new harmonies. Theologians, metaphysicians and physicists should all be mindful of the behest, "*ne sutor ultra crepidam;*" they should also remember that the best interpretation of any truth is the one which accords most fully with all other truths. The highest philosophy is that which is best fitted for the highest capabilities of immortal intelligence. The surest foundation for philosophy is the one on which Christianity is built, the Rock of Ages, the Eternal Word and Wisdom of God.

Stated Meeting, January 3, 1879.

Present, 5 members.

Vice-President, Mr. FRALEY, in the Chair.

A letter requesting exchanges of Proceedings, was received from Mr. P. Casamajor, Corresponding Secretary American Chemical Society, No. 11 East Fourteenth street, New York City, dated January 1, 1879. On motion the name of that Society was ordered to be placed on the list of correspondents to receive the Proceedings.

A letter requesting exchanges was received from Prof. Carus, editor of the Zoologischer Anzeiger, through Mr. E. L. Mark, Instructor in Zoology in Harvard University, dated 48 Shephard street, Cambridge, Mass., December 23,

1878. On motion the Zoologischer Anzeiger was ordered to be placed on the list of correspondents to receive the Proceedings.

Donations for the Library were received from the Imperial Russian Academy and Geographical Society; the Astronomical Observatory at Dorpat; the R. Prussian Academy; the Austrian Geological Institute, and Geographical and Anthropological Societies; the Societies at Emden and St. Gall; the Annales des Mines, and Revue Politique; the Commercial Geographical Society at Bordeaux; the R. Belgian Academy; the R. Astronomical, Geological, and Zoological Societies, and London Nature: Mr. James Henry; the R. Irish Academy; the Canadian Naturalist; the Boston Natural History Society; the National Academy of Sciences; the Bureau of U. S. Geological Surveys of the Territories; Mr. W. H. Howgate; and the Argentine Scientific Society.

The death of Dr. Carl Friedrich Rokitansky, at Vienna, July 23, 1878, was announced by the Secretary.

The death of Dr. Hermann Lebert, at Vevay, was reported from Leipsig, by Dr. Felix Flügel.

The report of the judges and clerks of the annual election was read, by which it appeared that the officers and members of Council for the ensuing year, were elected as follows:

President.

George B. Wood.

Vice-Presidents.

Frederick Fraley, Eli K. Price, E. Otis Kendall.

Secretaries.

J. L. LeConte, Pliny E. Chase, George F. Barker,
J. P. Lesley.

Councillors for three years.

Alfred L. Elwyn, Benj. H. Coates, Benj. V. Marsh.
George H. Horn.

Curators.

Hector Tyndale, Charles M. Cresson, Daniel G. Brinton.

Treasurer.

J. Sergeant Price.

Pending nominations 871, 872, 873 were read.

Mr. Lesley was nominated as Librarian; and the meeting was adjourned.

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*A Contribution to the Geology of the Lower Amazonas.**

By Orville A. Derby, M. S.

(*Read before the American Philosophical Society, Feb.* 21, 1879.)

In the following sketch of the geology of the region of the Lower Amazonas I have attempted to give a résumé of the most important results of the studies made by, and under the direction of, the late Prof. Ch. Fred. Hartt, in whom Science mourns the loss of one of its brightest ornaments in North America, and of its chief and ablest expounder in the southern continent. It is, for the most part, condensed from an extensive report, prepared by Prof. Hartt as chief of the Geological Commission of the Empire of Brazil, the publication of which has been delayed, in consequence of the financial condition of the Empire and of the untimely death of the chief of the Commission.

The history of the explorations on which this sketch is based is briefly as follows: In 1870, Prof. Hartt, with a party of students, visited the Amazonas, ascending the Tocantins and the Tapajos to among their lower rapids, and examining the high lands of the vicinity of Santarem, Monte Alegre and Ereré. In the following year he returned, accompanied by myself, re-examined the Ereré and Tapajos regions and explored the table-topped mountains between Prainha and Monte Alegre, sending me, in the meanwhile, to Obydos and afterwards to the island of Marajó. These explorations gave rise to a number of special papers, published in the American scientific journals. On assuming direction of the Brazilian Geological Survey, Prof. Hartt engaged Mr. Herbert H. Smith, a member of the party of 1870, who was then on the Amazonas, to continue the geological exploration, and he afterwards sent me, with Dr. Francisco José de Freitas, to the same region. Together with these two gentlemen I re-examined the Ereré region, and ascended the Maecurú (Gurupatuba of the maps), as far as the fall called Pancada Grande. After this exploration, Mr. Smith continued the examination, which he had already begun, of the

*A Portuguese version of this report is also being published in the *Archivos do Museu Nacional* of Rio de Janeiro, Vol. II, 1878.

region about Alenquer, ascended the river Curuá de Alenquer as far as the Bem fica fall, and afterwards revisited the lower Tapajos. Dr. Freitas and myself ascended the Trombetas and I afterwards revisited Marajó. The Devonian fossils have been studied by Mr. Richard Rathbun, while I have myself determined those of the Silurian and Carboniferous.

Having been intimately associated with Prof. Hartt in all the Amazonian work, I can claim but little originality in the conclusions drawn from the observations and presented in this article, the most of them having been presented by my illustrious teacher in his various publications, or brought out in our discussions on the subject, in such a way that it is now impossible to determine the authorship of each idea. The work of the last explorations by Messrs. Smith, Freitas and myself, in which Prof. Hartt, had no part, was mainly the determination of the character and age of the Ereré uplift, and of the extension and relations of the various Palæozoic deposits on the northern side of the Amazonas. It is proper to state that in regard to the Cretaceous age of the Ereré sandstone and the date of the elevation of the anticlinal, Prof. Hartt reserved his opinion for a more careful examination of the evidence that I had to present on that point, than he was ever able to make. I am confident, however, that if he had made such an examination, I should have been able to convince him of the accuracy of my observations and conclusions.

The river known to geographers by the name Amazonas has, like many other rivers, various names which are applied by the inhabitants along its banks to different parts of its course. These popular designations of Amazonas, or Baixo (Lower) Amazonas, Solimões and Marañon, mark approximately three sections of the valley, which are very distinct in physical characteristics and have very different geological histories. They may, therefore, be advantageously retained to designate the lower, middle and upper portion of the great river.

The differences in these three sections are due to the relations of the valley with the component parts of the South American continent; so that in order to understand the structure of the valley, we must bear in mind the general features, long since recognized, of that continent. This is composed of three distinct mountainous regions, more or less united by elevated plains, in which are excavated the great depressions occupied by the fluvial systems of the Orinoco, Amazonas and Rio de la Plata. The Andes form a long, narrow strip of great elevation, along the western coast, and the mountains of Brazil and of Guiana, considerably less elevated than the Andes, occupy extensive areas in the eastern and northern portions of the continent. The space between these three elevated regions or nuclei of the continent is occupied by vast elevated plains, generally less than three thousand feet high, except in a narrow strip between the highlands of Brazil and Guiana, in which the continuity of the plains is entirely interrupted by the depressed valley of the Amazonas. It is also to be noted that between the Andes and the two elevated regions of the eastern part of the continent, the continuity of the plateaux is almost destroyed by the great cuts made by the Rios Paraguay and Madeira in the south, and the Rios Negro and Orinoco in the north, and only a comparatively slight continental depression would be required to entirely separate these regions. In fact, the region of Guiana may be considered an island, in consequence of the existence of that geographical phenomenon, the Cassiquiarí, uniting the Orinoco and Rio Negro.

The Amazonas, unlike the Orinoco and the La Plata in this respect, has relations with all three of the mountainous regions above indicated. The upper part, or Marañon, belongs exclusively to the Andes; the middle, or Solimões portion, is in the region intermediate between the Andes and the highlands of Brazil and of Guiana; and the Lower Amazonas, from the mouth of the Rio Negro to the sea, is between these two last masses of highlands.

From a purely geographical point of view, the Lower Amazonas and the Solimões might be united in a single section, because the differences between these two portions are, at present, much less than those between the Marañon and the rest of the great stream. Taking into consideration, however, the geological structure, and especially the conditions which geology shows to have existed in former times, it will be seen, as I hope to prove, that this division of the valley into three sections is a natural one.

An examination of the hydrography of the Amazonian basin, taken as a whole, reveals much more noticeable differences in the three portions than are seen in the valley properly so called. The Marañon and its great southern tributaries in the Andean region, the Huallaga and the Ucayael, descend from great elevations in the cordilheiras, and flow northerly in the general direction of the trend of the mountains, until, escaping from them, the Marañon takes an easterly direction, in which it presents a notable contrast with the Ucayale which, although it has descended to a comparatively low level, a long distance above its mouth, still continues to flow in a northerly direction, as if it were forced for some reason, to follow the margin of the mountainous region. The northern tributaries of the Marañon, including the Napo which empties nearly opposite the mouth of the Ucayale, descend from the Andes of Equador in a south-easterly direction, directed by the slope of the mountains. The area drained by the Marañon and its tributaries is very long in the direction north-south, but very narrow in the direction east-west.

In the Solimões region, on the contrary, the region drained on the north is rectangular in shape, the longest axis of the rectangle extending east-west, parallel with the river, and the tributaries in this region, including the Rio Negro, flow in valleys of slight elevation in an easterly direction, subparallel with the Solimões, as if they were crowded down towards the south, and directed in their courses by a line of highlands, uniting the mountains of Guiana with the Andes. The southern area, drained by the Solimões and included between the Ucayale, the Madeira, and the eastern prolongation of the Andes in Bolivia, is of triangular shape. The tributaries in this area rise in the plateau east of the Andes, at moderate elevations (the source of the Purús is according to Chandless at an elevation of only 1,088 feet above the level of the sea), and, as Chandless has already pointed out, flow in their upper courses in a general easterly direction, as if directed by an imperceptible slope from the Andes.

In the Lower Amazonas region, the mountains of Guiana are comparatively near to the river, and, in consequence, the northern tributaries are small and flow directly towards the main river, with a slight deflection towards the east. On the southern side, on the contrary, the great plateau of central Brazil extends from near the Amazonas to the headwaters of the Paraguay and the mountains of Goyaz. The great tributaries, Tapajos, Xingú and Tocantins, traverse this plateau in a northerly direction, and descend to the level of the Amazonas by a steep incline that commences a short distance above their mouths. I have purposely omitted to mention the Madeira, because this river is related to all three of the sections of the basin. One of its tributaries, the Guaporé, rises in the highest part of the central plateau of Brazil, and appears to flow along a margin of that plateau (the so-called Cordilheira de Parecis), until it joins the Mamoré which, like the Beni and Madre de Deus, descends from the high Andes of Bolivia, circling round the great eastern projection of the Andes, in the district of Santa Cruz de la Sierra. The lower Madeira, which forms the division between the regions of the Solimões and the lower Amazonas, flows north-easterly, subparallel with the great features of eastern Brazil, viz: the mountain chains of the coast and of Minas Geraes, and the valleys of the upper São Francisco and upper Paraná. Farther on I shall have to speak of the significance of this fact.

Let us now consider in greater detail, the physical and geological features of the Lower Amazonas region, the immediate subject of this article. What most impresses the traveler on the Amazonas, after the enormous extension, width and volume of the river, the labyrinth of its side channels and the richness of its flora, is the great extent of the *varzea* or flood-plain that, monotonous as the sea, accompanies the river in a broad belt on each side, from the mouth to the foot of the Andes. Being generally well wooded, the forest gives this flood-plain a false appearance of dry land, and the traveler is very liable to be deceived regarding its true character and extent. To form a true estimate of its importance, it is necessary to ascend one of the few eminences which occur along the margin of the river, as those of Monte Alegre, Santarem and Obydos. From these elevations there is seen a great marshy plain, almost on a level with the river, diversified with lakes and island-like groups of trees, and intersected by numerous anastomosing lateral canals, *furos* or *paraná-merins*, which plain extends for many miles to the highlands of the opposite side, visible in the distant horizon. In this vast plain, the river, great as it is, appears a narrow ribbon of water, almost lost in the immensity of its ancient bed, for the *varzea* can only be considered as a portion, which has been filled up, of the original bed of the river, or, rather, of the estuary which preceded the riverine condition. In this great depression, the river curves from side to side, now approaching one bank, now the other, but rarely reaching the foot of the highlands, except at a few points in the vicinity of Santarem and Obydos.

Below the mouth of the Xingú, the *varzea* which, with rare interruptions, forms the banks of the river, as well as the innumerable islands (with the exception of the eastern portion of Marajó), is densely wooded, the rubber tree being particularly abundant and characteristic. From the same point to the mouth of the Rio Negro it is frequently open, and covered with coarse grasses and marsh plants. In certain parts, as in front of Santarem and Obydos, it is sufficiently high along the margins of the river and canals, to be above the reach of the ordinary annual floods, and in these parts there are a few plantations of cacáo, and some cattle farms; but for the most part the *varzea* is uninhabited, excepting for a few months during the rubber season, in the wooded portions, and during the dry season, in the region of the open plains, when the herds are driven from the highlands to take advantage of the pasturage. Besides margining the main river, the *varzea* extends innumerable branches into every break in the margin of the highlands, produced by the valleys of the tributaries, whose own flood plains are so closely united to that of the Amazonas, that it is often difficult to determine where the valley proper of a tributary terminates and where that of the Amazonas begins.

The highlands or *terra firma* are very variable in character and elevation, but may be classed in three divisions, viz: low plains, high plains, and irregular or mountainous regions. The first, having only a few feet of elevation above the *varzea*, are slightly developed in the lower Amazonas region, above the mouth of the Xingú; but from that point to the sea, the low plains are of considerable extent and importance, forming the campos of the island of Marajó and a wooded belt on each side of the river, which belt, in the vicinity of Pará, has a considerable extension towards the south. The elevated plains lie on the southern side, at a considerable distance back from the river, behind the low plains just mentioned, in the region about Pará; but to the westward they approach more and more nearly to the river, until finally they appear on its banks, in the bluffs of Cuçury, a little below Santarem, and afterwards on the same side, in the Serra dos Parintintins, near Villa Bella. On the northern side they form a series of high table-topped hills, which, lying a few miles back from the river, commence almost in front of the mouth of the Xingú, and, under the names of Serras de Almeirim, Parú, Velha Pobre, Parauáquára, etc., extend westward behind Monte Alegre as far as, or beyond, the river Trombetas. The same plains appear also in the lower highlands of Monte Alegre and Obydos.

Where they have not suffered denudation these plains form table-lands, highest on the northern side of the river, where those just mentioned reach an elevation of about 1,000 feet, while those of Santarem and others on the southern side have less than half this elevation. In many regions they have been reduced by denudation to low, gently undulated plains, like those of Prainha, Monte Alegre, Santarem and Obydos, in the midst of which there appears occasionally a conical or flat-topped peak, to attest the original character of the plain and the extent of the denudation. The table-lands and their slopes are generally wooded, while the lower undulated plains are open and grassy, covered with a barren soil of loose sand. In the interior, on both sides of the river, these table-lands appear to rise gradually in height, until they become united with the more elevated plains of central Guiana and Brazil.

The last division of the highlands, that of the hilly or mountainous country, is represented, near the northern bank of the Amazonas, by an isolated group of mountains, in the vicinity of Monte Alegre and Ereré. These rise abruptly in the midst of a plain to a height of 1,000 feet, and are, in general, rocky or sandy and barren. Associated with these mountains and having the same geological structure is a low, stony campo. Ascending the tributaries on both the northern and the southern side, there is found, in the regions of the rapids, at a distance varying from 50 to 200 miles from the main river, a hilly country, whose highest points are, in general, lower than those of the Ereré group of mountains. These hilly regions are usually well-wooded, with many valuable kinds of timber, the Brazil and sapucaia nut trees (*Bertholletia excelsa* and *Lecythis grandiflora*) being very abundant and characteristic. To these hilly regions succeed, on the north, the high mountains of Guiana and, on the south, the table-lands of central Brazil.

The differences above noted in the different regions of the highlands or *terra firma* depend on the geological structure of the valley, and before describing minutely the different formations, it may be well to present a general sketch of the geology of this part of the valley, and indicate the relations of the regions above described.

Prof. Hartt has well described this structure as follows;* "The Amazonian valley first appeared as a wide strait between two islands or groups of islands, one now forming the base and nucleus of the Brazilian plateau, the other, on the north, the plateau of Guiana. These islands first appeared at, or shortly after, the beginning of the Silurian Age."

In this canal, before the elevation of the Andes, were deposited a series of beds, representing the Upper Silurian, Devonian, Carboniferous and Cretaceous, which appeared successively in dry land on each side, narrowing the strait between the two islands. Prof. Hartt continues: "Before the rise of the Andes the valley of the Amazonas consisted simply of two gulfs united by a narrow strait. The Andes were thrown up across the mouth of the western gulf, converting it into a basin, though it probably had an outlet both to the north and south. The whole continent was afterwards depressed, so that the waters covered widely the Guayanian and Brazilian plateaux, and the Tertiary beds were deposited there, varying in thickness, coarseness or fineness, according to the conditions under which they were formed. * * * *

*Journal of the American Geographical Society, Vol. III, p. 231, 1872.

"When the continent was once more brought above water, the plateaux, leveled by their new acquisition of strata, first rose; but, by and by, the present water sheds, joining the great plateaux with the Andes, came above water and the Amazonian valley became a Mediterranean, communicating eastward with the Atlantic by a narrow strait. The soft Tertiary beds of the province of Pará were rapidly denuded by the action of the sea during the rise of the land. Probably, while Guiana existed as an island, the Amazonas felt the influence of the equatorial current, which may have aided in carrying away the results of denudation. In the end, the Tertiary beds were completely swept away over an immense tract of country; the Serras of Parú and the similar mountains to the northward were left as monuments of their existence. * * * While the Tertiary sheet was being denuded away, the streams from the highlands were cutting for themselves valleys through the same beds, and these, forming estuaries, were widened to a greater extent than it would have been possible for the streams themselves to have done. During this epoch of denudation deposits were formed, not only in the interior sea, but also in the gulf into which it opened to the east. * * * As the rise continued, the interior sea, now shallowed by much sediment and freshened by the tribute of a thousand streams, was rapidly narrowed in area, and the river Amazonas, properly speaking, which hitherto emptied into a lake at the foot of the Andes, began to extend its channel, following the retreating waters."

The above quotation explains clearly the origin of the *varzea*, of the low plains of Pará, and of the higher plains of the interior of the province. In the hilly regions the inclined beds of the formations older than the Tertiary, including the Cretaceous, the Palaeozoic and the Archean, appear in virtue of the denudation of the overlying Tertiary sheet.

The rocks of the ancient islands, the first lands that appeared in the ocean in which the continent was forming, have been profoundly metamorphosed, being converted into granite, gneiss, quartzite and metamorphic schists, and by reason of this, the extent of these islands may be approximately determined by the study of the distribution of the metamorphic rocks. Those of the north appear in the high mountains of Guiana, along the boundary between Brazil and Guiana and, decreasing in elevation towards the south, extend to a line that, beginning near the Atlantic and the mouth of the Amazonas, in about latitude 1° N., extends a little south of west, to the confluence of the Rio Branco and Rio Negro, between latitudes 1° and 2° S. Along this line, which represents the ancient coast, the metamorphic rocks are in general only exposed in the valleys, by the denudation of the Tertiary beds. To the west of the mouth of the Rio Branco they extend to, or beyond, the upper Rio Negro.

On the Brazilian side, the metamorphic rocks only form high mountains in regions far distant from the Amazonas; but they are met with under the other formation in the greater part, if not in all the elevated portions of Brazil. In the Amazonian region, they form the rapids of the rivers Tocantins, Xingú, Tapajos and Madeira, the line of exposures passing the

Tocantins between 3° and 4° of south latitude, the Tapajos between 4° and 5°, and the Madeira between 8° and 9°, at the rapids of São Antonio. The lower Madeira appears to mark approximately the western limit of the ancient metamorphic region, because in the next river to the westward, the Purús, the rocks under consideration were not met with by Chandless, in the course of his careful exploration. The parallelism of the course of the lower Madeira with the great surface features of eastern Brazil, where the metamorphic rocks are thrown into great folds, trending north-easterly, has already been noted. It seems possible that the Madeira is directed by such a fold, or, what is more probable, by a margin of the metamorphic region, which should there have that direction. It is possible that the Guaporé also marks another margin of the same region, which being transverse to the folds is independent of their trend. It is certain that in the Guaporé region there was a canal between the metamorphic region of Brazil and a similar one in Bolivia, the Chiquitos region of D'Orbigny, comparable with the strait between Brazil and Guiana, now occupied by the Amazonas.

As in eastern and central Brazil, the metamorphic rocks of the Amazonian region can be naturally divided into two very distinct series, of which one, the most ancient, consists of crystalline rocks, including gneiss, gneiss-granite and syenite, and the other, more modern, of altered, but in general non-crystalline rocks, consisting of quartzites, metamorphic schists and crystalline limestones. The older series corresponds in character and geological age with that of the Serra do Mar and Serra do Mantiqueira, in the provinces of Rio de Janeiro and Minas Geraes, which was referred by Prof. Hartt to the Laurentian. This series has been but little studied in the Amazonian region. Castelnau speaks of gray gneiss on the Tocantins above the first rapids, and Chandless met with gneiss in a similar position on the Tapajos. Sñr. Ferreira Penna, of Pará, informed me that the rapids of the Xingú are formed by gneiss and diorite, and showed me specimens of the first, consisting of flesh-colored feldspar and quartz with a small proportion of black mica, the rock in hand specimens appearing massive and granitoid. The lower rapids of the Madeira are also formed of gneiss, but I have seen no specimens or descriptions of the rock. On the northern side, gneiss was met with *in situ*, by Sñr. Penna, in the rapids of the Araguary, a small river emptying into the Atlantic, a little to the north of the mouth of the Amazonas, and pebbles of the same rock were met with in the explorations of the Geological Commission, on the rivers Maecurú, Curuá, and Trombetas. I am informed by the engineer, Maj. Coutinho, that gneiss is the prevailing rock on the Rio Branco, except at the mouth, where he found red syenite. I found this last rock also in a zone about half a mile in width, at the second rapid of the river Trombetas, and saw pebbles ofthe same on the Maecurú, coming from some point above that reached by our explorations. I could not determine, in the short time at my disposal on the Trombetas, whether the rock is stratified or not, and it is possibly of eruptive origin. The syenite consists principally of flesh-colored feldspar, with a small mixture of hornblende and small scattered spots of a green mineral in decomposition. Quartz is entirely lacking.

The rocks of the second metamorphic series are well exposed in the first rapids of the Tocantins, where they were examined as far as the Cachoeira de Guariba, by Prof. Hartt in 1870. The following notes are taken from his manuscripts. Ascending the Tocantins, the river is at first margined by bluffs of Tertiary sands and clays which, as the rapids are approached, recede from the river and the metamorphic rocks begin to appear. The first exposure of these last met with, is "A granular quartzite, very hard and with a saccharine fracture, the rock being much traversed by quartz veins. The stratification is very obscure and the rock appears to have a sort of slaty structure. In some places it is very compact, bluish and cherty, and is so cut up by veinlets as to appear honey-combed on decomposition. Next appears, at the Ponta do Noberto, a talcose rock, badly decomposed, but appearing to have an easterly dip. Above this is a bed of compact reddish quartzite. From the Praia dos Mortos there extends a long line of similar rocks, with an easterly dip. At Jequirapuá, I found the following section, given in ascending order :

1. Shaly sandstone.
2. Compact white sandstone, rather fine grained, the grain being clear. It weathers brownish, and is traversed by quartz veins.
3. A thin band of purple shale, stratification obscured by faults and oblique slips.
4. Heavy band of ferruginous shale, much decomposed.
5. Bed of very compact bluish, whitish and reddish mottled quartzites.
6. Red shale much traversed by little veins. Just below Alcobaça, I observed quartzite with a north-east dip. At Alcobaça are heavy beds of bluish quartzite, very hard and presenting surfaces polished by the river."

Compact quartzites were observed at various points above Alcobaça, in one place with the strike corresponding with the direction of the river, forming long rocky islands or lines of rock. The dip is well marked, being a few degrees north of east, the angle being about 40°.

"Just below the Cachoeira (rapid) de Tapanhúaquára are green schistose rocks, dipping eastward, and much diorite. In the schists I found amianthus and serpentine. The rocks that choke up the river and form the rapids are, as far as I could determine, a series of gray quartzites, interstratified with thin beds of finely laminated shale. The upper end of the high wooded Ilha das Pacas is composed of a mass of hard, vitreous-looking, bluish or reddish quartzite, much traversed by little quartz veins. On the left bank opposite are ledges and skerries of a slaty rock, with a strong easterly dip. The islets of Janaúquára are bare masses of a hard cherty rock, whose relations to the other rocks I did not determine.

"At Porta de Braga, a bluff projection on the left bank of the river, the shore is encumbered by very large masses of iron ore, in part a mammillary hematite. The rocks of the vicinity, consisting of quartzites and sandstones, have a strong easterly dip. As I remember it, the deposit appears to be superficial, and I doubt if it is of economic value.

"Opposite the Praia Grande is a very long narrow line of rocks, running south a few degrees east, and flanked by the schistose rocks, which here present the ordinary eastward dip. The line of rocks is formed by a narrow outcrop of diorite, which I suspect to form a dyke. This diorite is much cracked and, decomposing concentrically, the fragments give rise to a confusion of rounded blocks.

"Near by, the slaty rocks again appear, with the cherty rocks apparently overlying them in discordance of stratification. These latter rocks may therefore be of much later origin. In one place I thought that I observed signs of horizontal stratification. Near the upper end of an enormous sand bank, called Praia Grande, the slaty rocks crop out again, the strike being N. 30° W. and the dip 27° E.

"The Cachoeira de Guariba is formed by the outcrop of a series of metamorphic rocks, an alternation of shales, quartzites and limestones, extending across the river, forming a sort of dam. The strike here is somewhat irregular, but usually a few degrees west of north, the dip being eastward and at a moderate angle. I could not ascend above the Cachoeira de Guariba, from lack of time and of a proper boat. From all that I was able to judge, the metamorphic rocks must extend much further up the river, and it would be very important to have them examined. Whether the whole series that I saw belongs to the same geological horizon or not, I was unable, in the absence of fossils, to determine, but, after my studies of the Carboniferous and Devonian of the Amazonas, I think there can be little doubt that the series is Silurian.

"It is interesting to note the dip of these rocks, which is pretty constantly towards the east, the strike being remarkably northerly. The fact of the occurrence of trap dykes is also important. I saw no porphyries like those of the lower falls of the Tapajos, and I cannot help thinking that the Tocantins beds above described are newer than those of the Tapajos."

The metamorphic rocks of the rapids of the Tapajos were described by Prof. Hartt in the Bulletin of the Cornell University. They consist of quartzites and other rocks similar to quartzites, but without apparent granulation, the beds being traversed by enormous dykes of porphyry and diorite. They are very compact, of a red or chocolate color, frequently marked by little green points, due to some undeterminable mineral in decomposition. In hand specimens the amorphous rocks appear to be igneous, a few scattered crystals of feldspar giving them the appearance of porphyry; but seen in mass, the water-worn surfaces show with great distinctness, lines of lamination and wave and ripple-marks, which prove conclusively the sedimentary origin of the rock. The beds are inclined 15°–20° S. E., the strike being N. 30°–40° E.

The porphyry of the dykes is evidently eruptive. It consists of a compact, amorphous, feldspathic base of a dark chocolate color, in which are scattered crystals of red feldspar, rounded grains of quartz and little masses of the green mineral above mentioned. There was also observed in the cachoeiras, two exposures of crystalline rocks which appear to form dykes, but this character was not well determined. One of these is fine-grained and dark-colored, the other consists of light-red feldspar, with grains of quartz.

We found on the Trombetas a series very similar to a part of that of the Tapajos. It is exposed in the third cachoeira, called Quebra-potes, and also in the lower course of the river Cachorro, which empties into the Trombetas just above that cachoeira. The rock varies in color, some beds being dark red, others purplish, and like that of the Tapajos it is marked by green spots. The mass is amorphous, feldspathic, sometimes with small grains of glassy quartz, and it may be classified as felsite or eurite. The stratification is very distinct, and the lamination, wave and ripple-marks are as clearly shown as in any modern sandstone. The beds of felsite rest on those of the syenite already described, which is also marked by green spots, and dip 20° N. E., the strike being N. 30° W. Resting unconformably on this series are beds of sandstone, containing Upper Silurian fossils.

This last observation is important, proving as it does that the metamorphism of the rocks and the dislocation of the beds must have taken place during the Lower Silurian or Archean. I am convinced that this conclusion can be extended to the whole metamorphic region. The similarity on lithological characters of the rocks of the Trombetas and those of the Tapajos is such, that it can scarcely be doubted that the formations in the two localities are identical. The difference in strike, from N. N. W. on the Trombetas, to N. N. E. on the Tapajos, can readily be admitted in a single system of upheaval, which can include also the disturbed rocks of the Tocantins, where the strike is N. or N. N. W. It should be observed that, while the compact quartzites of the Tocantins resemble the rocks of the Tapajos and Trombetas, the rest of the Tocantins series, consisting of granular quartzites, talcose schists, and crystalline limestones, recall the rocks of the rivers Araguay, and upper Tocantins, and of the mountains of Goyaz and Minas Geraes.

It has long since been observed that the metamorphic rocks of Brazil, Guiana and Venezuela have in general a north-easterly strike ; later observations, however, have shown that the strike is often variable, frequently taking a north westerly direction. It seems probable, therefore, that the epoch of metamorphism and upheaval of the ancient rocks was the same in eastern Brazil and Guiana as in the Amazonian region, that is to say, it was anterior to the Upper Silurian.

The evidence in respect to the epoch of metamorphism and upheaval afforded by other regions of Brazil is very scanty, but, as far as it goes, it sustains this generalization, although it must be confessed it is as yet insufficient to entirely confirm it. In the provinces of Bahia and Sergipe there is a series of beds of undetermined age, but which appears to be either Devonian or Carboniferous. These beds have been disturbed without being metamorphosed, and they rest unconformably on gneiss, and are overlaid unconformably by Cretaceous deposits. The metamorphism of the gneiss in this region was, therefore, early Palæozoic or Archean. In the southern provinces, the evidence is more conclusive. In Santa Catharina and Rio Grande do Sul, beds, whose Carboniferous age appears to be well proven, lie horizontally above inclined metamorphic beds. These Carboniferous deposits extend across the province of Paraná to the southern part of the province of São Paulo. Near Ponta Grossa in Paraná, Mr. Wagoner, assistant to the Geological Commission, found, underneath the Carboniferous beds, others, also horizontal, containing Devonian fossils. In that region, therefore, we may refer the upheaval and metamorphism to a period anterior to the Devonian, and probably, as on the Amazonas, to one anterior to the Upper Silurian.

We have seen that the metamorphic rocks present two distinct series, of which one, consisting of crystalline rocks, was, with all probability, referred by Prof. Hartt to the Laurentian. It is probable that this series had been metamorphosed and disturbed before the deposition of the second non-crystalline series. It is true that there appears to be a concordance in stratification between the two series, but it is by no means certain that this concordance is perfect, and that the older series had not been disturbed (probably in the same general direction), before the great general movement of upheaval, which affected and gave character to the whole metamorphic region of Brazil, if not of the entire continent.

In regard to the age of the second metamorphic series, we have by elimination reduced it to the ages intermediate between the Laurentian and the Upper Silurian, that is to say, the Huronian and the Lower Silurian. It seems probable that both are represented, and, accepting Prof. Hartt's supposition, that the rocks of the Tapajos are more ancient than those of the Tocantins, we may provisionally refer those, with the felsites of the Trombetas, to the Huronian, and these to the Lower Silurian, a reference which accords with another opinion of Prof. Hartt, that is, that the granular quartzites (itacolumites) and talcose schists of Minas Geraes belong to the Lower Silurian.

At the end of this movement of upheaval and folding, the primitive islands of Brazil and Guiana had received enormous additions to their original areas, and extended to the limits already indicated, in treating of the distribution of the metamorphic rocks, leaving between the two islands a strait, some three or four degrees of latitude in width, in the narrowest part. From that time, which was during, or at the end of, the Lower Silurian commenced the proper history of the Amazonian valley.

In this strait was deposited, without great oscillations of level or upheavals, comparable with those that had disturbed the metamorphic series, a series of beds gently inclined from the margins towards the center, representing the formations from the Upper Silurian to the Cretaceous, inclusive. There were, however, before the deposition of the Tertiary beds, considerable eruptions of trap and diorite, and local disturbances in at least one region, that of Ereré. This region is so important in the study of the geology of the Amazonas, as to merit special description.

Situated on the margin of the *varzea*, and about two leagues to the westward of the village of Monte Alegre, there is an isolated group of mountains, consisting of numerous, small monoclinal ridges, separated one from another, and disposed in an ellipse around a central plain, of which the elevation is a few feet at most above the level of the Amazonas. The major axis of the ellipse is some ten or twelve miles long, and lies in the direction of E.–W. The principal mountain, called Serra de Tajurí, is about 350 metres high, and is situated on the north-east side of the ellipse; from Tajurí, a curved line of low ridges extends to the second serra in size, that of Ereré, which is on the southern side, and has an elevation of 250 metres; then come the smaller serras of Aroxí, Maxirá, Paraizo, Julião and Urucury, the last being placed at the western end of the ellipse; between this and Tajurí there is a considerable number of low serras, without names, which have never been explored. All of these serras present an abrupt slope towards the central plain, and a gentle slope, following the inclination of the strata, on the opposite side. This inclination, which varies from 10° to 20°, is N. N. E. in Tajurí, E. in the ridges between Tajurí and Ereré, S. in this last, and W. in Urucury. This variation in dip proves that this group of mountains is only the remnant of a great anticlinal, of which the central, and by far the larger, part has been denuded away. This opinion, respecting the structure of the region, is supported by the structure of the low Serra de Paitúna, which is situated outside of the ellipse, some three or four miles to the south of the Serra de Ereré, with which it is parallel. As was to be expected from its position in relation to the other mountains, Paitúna was found to be a synclinal ridge. It is possible that to the northward of Tajurí there are other synclinal ridges, similar to Paitúna.

There have not yet been definitely recognized in other parts of the valley, any elevations, corresponding in age and structure to those of Ereré. I have reasons, however, for believing that, in the vicinity of Obydos, the Serra de Curumú and perhaps that of Cunury may belong to the same system. Near the margin of the metamorphic region, on the Guiana side at least, the Palæozoic beds are gently inclined, at an angle of 5°–10°; but in general these beds appear to lie horizontally.

The first member of this Palæozoic series of the Amazonas is the Upper Silurian. The rocks of this age appear on the Guiana side, in a belt of a few miles in width, which extends in the direction east-west for a considerable distance, if not along the whole southern margin of the metamorphic region of Guiana. They have been recognized on the Trombetas, Curuá and Maecurú, and from specimens brought by Sr. Ferreira Penna, from the Maracá, a small river which empties nearly opposite the western end of Marajó, I judge that they extend eastward nearly to the Atlantic.

These rocks have been best studied on the Trombetas. They there appear in a belt four or five miles wide, forming the first and part of the second cachoeira. They were also found, well exposed, in a hill of some 100 metres of elevation, called Oiteiro do Cachorro, situated on the right bank of the river of the same name, a little above its confluence with the Trombetas. The lower part of this hill is composed of felsite, above which the Upper Silurian beds form a magnificent overhanging cliff. In the lower part of the second cachoeira, called Vira-Mundo, the Silurian beds rest on syenite. The dip is approximately 5° S. S. W., the strike being N. 65° W. I estimate the total thickness of the series at about 1,000 feet.

The character of the beds is remarkably uniform. They consist almost exclusively of hard argillaceous and micaceous sandstones, generally thin-bedded, but with some massive beds of pure sandstone. The color is very variable, being white, yellow, red or purplish, but the predominant color is some shade of red, generally mottled or banded. Limestones are entirely lacking, and schists are rare and of slight importance, as regards their thickness, but interesting on account of their peculiar characters. One set of beds of cherty schist, about 20 feet thick, is found at the base of the series, in contact with the syenite. This rock looks like one that had suffered some alteration, and this appearance might be taken to prove that the syenite is of igneous origin, and that it had been ejected after the deposition of these beds, effecting an alteration in them. As, however, the altered appearance is less marked in the part of the schists which is in immediate contact with the syenite, than in the upper portion of the bed, I believe that their peculiar appearance is due to some other cause. Another schist of undetermined thickness occurs at the base of the cliff, forming the front of the Oiteiro do Cachorro. It consists of a soft clay, impregnated with alum, which also occurs abundantly in free crystals.

At the foot of the Cachoeira Vira-Mundo, and just above the cherty rocks above mentioned, there is a bed of fine-grained, yellowish sandstone, containing a few fossils of which we collected with considerable difficulty sufficient to determine the age of the formation. The fossils are all in the state of casts and, except a species of *Beyrichia* and a fragment of a Trilobite, are all Molluscan. The most common is an *Orthoceras*, which is however indeterminable. The genera, *Rhynchonella, Orthis, Chonetes, Strophodonta, Lingula, Pholidops, Bucania, Conularia* and *Ctenodonta* are represented. Among these the species *Orthis hybrida* Sow., *Lingula cuneata* Conrad, and *Bucania trilobata* Conrad are recognizable. In the Oiteiro do Cachorro are thin beds of shaly sandstone, with well marked fucoids, apparently of the species *Orthrophychus Harlani* Conrad. These fossils indicate a close correspondence with the Medina sandstone of the Niagara group. Throughout the whole series worm-tubes are abundant.

The same series of beds were met with on the Curuá and Maccurú, with characters identical with those just described for the Trombetas. On these rivers the Silurian rocks form cachoeiras, that were impassible with the means at our disposal, and for this reason we did not succeed in reaching the base of the series, where the fossiliferous beds occur. Worm tubes and indeterminable fucoids were, however, met with. The Upper Silurian has not yet been recognized on the southern side of the valley, but, as all the sections on that side are very incomplete, it is by no means certain that they do not exist. It is possible that the cherty beds of the Tocantins, mentioned by Prof. Hartt, may belong to this series ; but as cherts are common also in the Devonian and Carboniferous, it is impossible, in the absence of specimens, to form a definite opinion respecting the age of those of the Tocantins.

The Devonian is best exposed on the northern side of the valley, where it forms a broad belt, bordering the narrower Silurian belt, and disappears under the Carboniferous deposits, to reappear farther south in the Ereré anticlinal. The beds of this age are variable in character, and may be divided by differences in the rocks and fossils into three groups, which, for convenience, may be named for the locality in which each was best studied, the Maecurú, the Ereré and the Curuá group. It must be remembered, however, that all three of these groups are represented at each of the above localities.

The first, or Maecurú group, consists of a few beds of coarse, white or yellowish sandstone, which, on the Maecurú and Curuá, have a thickness of thirty feet. On both of these rivers this group is well exposed, with a dip of about 5° S. S. W. The rock is hard in some layers, but very friable in others, and is highly fossiliferous. On the Trombetas it is represented by a bed of sandstone, so friable as to be almost a bank of sand, and at Ereré only a portion of the upper bed is exposed, and no fossils were found at either of these localities. The fossils are impressions, colored and somewhat consolidated by oxide of iron ; they are beautifully preserved, and so abundant and varied that, with a few hours' work, we made an enormous collection, containing about seventy-five species. Trilobites are represented by species of *Homalonotus*, *Dalmania*, *Phacops* and *Prætus* ; Gasteropods by *Bellerophon*, *Holopea* and *Platyceras* ; Lamellibranchs by a large number of species of the genera *Modiomorpha*, *Limoptera*, *Edmondia*, *Grammysia* and others. The most interesting fossils are, however, the Brachiopods, which have been carefully studied by Mr. Rathbun, who has described* twenty-one species from the Maecurú, of which thirteen were also found on the Curuá in equivalent beds, nine in the overlying beds of the Ereré group, and six in the lower and middle Devonian of New York. Of the species common to this group and that of Ereré, those that are abundant in one are generally rare in the other, and this, with the numerous species which are limited to each group, gives a special expression to the fauna of each, which justified their separation. The most abundant and characteristic Brachiopods of the Maecurú group are *Amphigenia elongata* Hall, *Spirifera duodenaria* (?) Hall, *Strophodonta perplana* Hall, *Rhynchonella dotis* (?) Hall, *Vitulina pustulosa* Hall, *Streptorhynchus Agassizii* Hartt, and new species of *Chonetes* and *Orthis*. The two first and the last new species were not met with at Ereré. It will be seen that these fossils indicate a close relationship to the Corniferous group, which bears about the same stratigraphical and palæontological relation to the overlying Hamilton group, as does the Maecurú group to that of Ereré. These last two may, therefore, be considered as the Brazilian equivalents of the North American formations.

* Proceedings of the Boston Society of Natural History, Vol. XX, pp. 14-39, 1878.

The Ereré group occupies a considerable area in the central plain between the mountains of Ereré, but so sub-divided, denuded and disturbed by eruptions of trap, as to present serious difficulties for study, which were, however, overcome by Mr. Smith in 1876, who succeeded in making a complete section and in proving, by means of fossils, the unity of the group. Mr. Smith calculated the total thickness at about 200 feet, divided between thirteen distinct beds, of which the greater part consist of fine-grained, micaceous sandstone, disposed in thin beds, with subordinate beds of black shale. The sandstone is generally white or yellowish, but exposed to the weather, it becomes reddish, and the shale often weathers white. Near the base of the group there are a few beds of a compact cherty sandstone, that breaks with great regularity into cubical blocks. Fossils are more or less abundant in all of the beds, those of the shale being different from those of the sandstone. The same beds were met with on the Maecurú and Curuá, but less sub-divided, with fewer fossils, and without the shales. The thickness of the group on the Curuá appears to be less than at Ereré. The fauna is very similar to that described from the Maecurú group, but, except in the class of Brachiopods, it is less rich, both in species and individuals. Mr. Rathbun has described twenty-four species of Brachiopods,* two of Trilobites, eight of Lamellibranchs and six of Gasteropods.† Of the first some have already been mentioned ; thirteen are limited to this group, of which the most abundant and characteristic are *Retzia Jamesiana* Hartt,‡ *Retzia Wardiana* Hartt, and *Discina lodensis* Hall. *Spirifera Pedroana* Hartt, although it appears rarely in the Maecurú group, is, by its abundance, one of the most characteristic fossils of the Ereré group.

The third or Curuá group consists almost exclusively of black and red shales, passing at times into shaly sandstone. These beds form low cliffs along the rivers Maecurú and Curuá for a considerable distance, lying almost horizontal, except where disturbed by eruptions of diorite. On the Trombetas the black shale forms two short cliffs on the river bank, and the red shale is badly exposed on a lake near by. At Ereré these rocks are exposed in the eastern part of the plain, and in the base of the serras, particularly that of Tajurí, the front of which is composed almost entirely of these shales. The black shale forms the lowest bed, the thickness of which, on the Curuá, is estimated by Mr. Smith at 300 feet. It is well laminated, almost slaty in structure, and in the lower part contains numerous large, calcareous and arenaceous concretions. The first are bluish black in color, have well developed cone-in-cone structure and emit, when struck with a hammer, a strong odor of petroleum.

The reddish shale lies above the black, having more or less the same thickness. It is generally chocolate-colored, mottled with spots of a darker hue and banded, parallel with the stratification, with white, yellow or

* Bulletin of the Buffalo Society of Natural Science, Vol. I, No. 4, 1874.

† Annals of the Lyceum of Natural History of New York, Vol. XI, May, 1875.

‡ It is but just to mention that the gentleman, to whom this species is dedicated, has more than any other, not specially devoted to science, contributed to the progress of geology, not to say of science in general, in Brazil.

black. The rock consists of clay, mixed with a considerable proportion of finely-divided mica and sand, the last often forming independent layers, a few inches thick. The only fossils found in these shales were Fucoids, of the genus *Spirophyton*, and small fruit-like bodies, resembling very much a flattened currant, consisting apparently of a thin pellicle enclosing two to six small grains. The *Spirophytons* are apparently identical with those described by Prof. Hall, from the Hamilton group of New York. They occur abundantly in all the localities, in both the black and red shale, near the junction of the two.

On the Curuá and Maecurú the red shale, which is undoubtedly Devonian, is followed by beds of coarse sandstone which, according to Mr. Smith, are at least fifty feet thick on the Curuá. This is followed by fossiliferous Carboniferous beds. The red shale is also overlaid by coarse sandstone, in the mountains of Ereré, but it is not certain that this sandstone is of the same formation as that of the Curuá.

As regards the extension of the Devonian series, it has been recognized as far west as the river Uatumá, a small river between the Trombetas and the Rio Negro. On the southern side of the valley, there are, on the Tapajos, shales containing *Spirophyton* and calcareous concretions, which were referred provisionally to the Carboniferous by Prof. Hartt, but which seem to me to be Devonian, and I refer to the same age the black shale found by Sñr. Penna on the Xingú.

Of all the Palæozoic deposits of the Amazonas, those of the Carboniferous occupy the most extensive area and, at the same time, present the greatest difficulties to study. Composed for the most part of soft beds, they suffered extensive denudation, during the interval between the close of the Carboniferous and the beginning of the Tertiary, during which time they were, for the most part, exposed above the level of the sea; by the deposit of the great Tertiary series they were concealed, over immense areas, and where they have been again exposed by the denudation of the Tertiary, they have again suffered destructive denudation. At present, the exposures are poor and unsatisfactory, rendering very difficult the determination of the relations of the different beds and the vertical extension of the series. Mr. Smith, who has best studied these deposits, is of the opinion that their total thickness is not less than 2,000 feet, and, although the data for this calculation is very defective, I cannot say that it is exaggerated.

The horizontal extension is more easy to determine. On the Tapajos the rocks of this series appear at intervals, from a point just below the rapids to near the village of Aveiros, a distance of about eighty miles. It is possible that they extend still farther north to near the mouth of the Tapajos, since I am credibly informed that, near Santarem, a bed of limestone occurs, which is most probably of Carboniferous age. To the westward of the Tapajos, they have been recognized by Chandless on the Mauhé-assú, a small river between the Tapajos and Madeira, and I consider it probable that they extend as far west as the latter river. I have information that leads me to believe that they exist to the eastward, on the Xingú, and I think it probable that they will yet be found on the Tocantins. On the opposite or northern side of the valley, they occur close to the margin of the river, in the vicinity of Alenguer, in front of Santarem, and extend for a considerable distance towards the north, along the rivers Curuá, Maecurú and Trombetas ; to the west, they extend at least as far as the Uatumá, already mentioned, and to the east, as far at least as the Jauary, near the village of Prainha.*

The rocks consist of soft shales and sandstone, and of limestone, which last, although of but slight thickness, is the most important, because, having resisted denudation better than the other rocks and being highly fossiliferous, it forms an admirable base of reference in the study of the Carboniferous series. The best exposures of the limestone are on the Tapajos, both above and below the village of Itaitúba, where it is quarried to burn for lime. The thickness is about twenty-five feet, some of the beds being of very pure limestone, of a blue or light brown color, others being darker and somewhat argillaceous and silicious. The fossils being silicified, and consequently more durable than the rock in which they are enclosed, become detached by the slow dissolution of the limestone, and often appear loose, as on the beach in front of Itaitúba. Cherty masses are common in the limestone, and aside from these, two other kinds of chert occur in loose masses which, in the opinion of Mr. Smith, come from some unknown beds above the limestone. One of these kinds decomposes to a white, chalky mass, the other, which forms large, rounded boulders in front of Itaitúba, takes on, in decomposition, the appearance of a porous sandstone. Cherts of various kinds are very abundant in the whole Carboniferous region, and are often highly fossiliferous, but the beds from which they originate are as yet unknown.

Above the limestone at Itaitúba, there are beds of soft, brown sandstone and of shale, of unknown extension, and below there is a heavy series of green, red and black shales, some of which contain *Spirophyton* and are most probably Devonian. Of the Carboniferous rocks of the Mauhé-assú, the only notices we have are of the limestone, which is identical in character and fossils with that of the Tapajos. Passing now to the northern side, we find a thick bed of limestone at the foot of the Serra of Tajurí, in the Ereré region, where it is associated with a yellowish mottled sandstone, much appreciated by the people for whetstones. The exposure, however, in this locality is so unsatisfactory, that it was impossible to determine its relation to the other beds of the serra. In the region between the Maecurú and Curuá, there are exposed, over an extensive area, a variety of beds, which Mr. Smith attempted to arrange in a section which, although somewhat defective, is of considerable interest.

* In this sketch of the character and extension of the Amazonian Carboniferous, I have, aside from the observations of Prof. Hartt and myself, drawn largely from the excellent studies of Mr. Smith on the northern side of the Amazonas, and am also indebted to Mr. Coutinho, the first discoverer of Amazonian fossils, and to Messrs. Chandless, Brown and Rodrigues, for notices of its existence in regions, not visited by the members of the Geological Commission.

On the Curuá, Mr. Smith found, above the beds of undoubted Devonian age, a small series of unfossiliferous sandstones, and then at Praia Grande, loose silicified fossils, identical with those of Itaitúba, which indicate the presence of a bed of limestone. Above this there is a series, the estimated thickness of which is 600 feet, composed of alternations of soft sandstones and sandy shales, of which certain layers near the upper part, exposed at a place called Pacoval, are highly fossiliferous. At lake Cujubim, near the river Maecurú, the section begins below with massive beds of yellow sandstone of undetermined thickness; then comes two feet of hard sandstone, followed by a bed five feet thick, of impure, silicious, fossiliferous limestone, which is separated by ten feet of sandstone and shale from a bed of equal thickness of pure limestone, containing fossils identical with those of Itaitúba; above this are soft beds of sandstone and shale, with fossils identical with those of Pacoval on the Curuá. In various other localities in the vicinity of Alenguer, Mr. Smith found exposures of sandstone and shale of very varied characters, which appear to belong above the series at Cujubim, and to represent, in part at least, the upper portion of the Curuá section. Mr. Smith well observes that the variation in the character of these Carboniferous beds, in both their horizontal and vertical extension, indicates deposition in shallow water, during subsidence. The limestone appears to be always near the base of the series.

The exposures of Carboniferous rocks on the Trombetas are so unsatisfactory, that they scarcely do more than prove the existence there of sandstones, shales and limestones, with fossils identical with those of the other localities.

The Carboniferous fauna of the Amazonas is very rich, containing more than a hundred species of Brachiopods, Lamellibranchs, Gasteropods, Corals, Bryozoans, Echinoderms, Fishes and Trilobites. Of these, I have already published descriptions of the Brachiopods of the Tapajos,* and hope soon to give descriptions of the remainder. The fauna shows the closest relationship to that of the Coal Measures of the Western States, more than half of the species being identical. I have already shown that the Bolivian and Peruvian Carboniferous faunas, as far as they are known, are equivalent to the Brazilian, and to that of the North American Coal Measures.

The following are some of the most important species common to the three regions: *Spirifera camerata* Morton (*S. Condor* D'Orb.), *Athyris subtilita* Hall, *Retzia Mormonii* Marcou (*R. punctulifera* Shumard), *Productus Cora* D'Orb., *Productus semireticulatus* Martin, and *Chonetes glabra* Geinitz. The following are, among others, in addition to the above, common to Brazil and the United States: *Spirifera rockymontana* Marcou, *Spirifera planoconvexa* Shumard, *Spirifera perplexa* McChesney, *Myalina kansasensis* Shumard, *Allorisma subcuneata* Meek and Hayden, *Aviculopecten occidentalis* Shumard, *Aviculopecten carbonaria* Stevens, *Schizodus Wheeleri* Swallow, *Lima retifera* Shumard, *Entolium aciculatum* Swallow, *Bellerophon carbonarius* Cox, *Rhombipora lepidodendroides* Meek, and *Synocladia biserialis* Swallow.

* Bulletin of the Cornell University (Science), Vol. I, No. 2, 1874.

No satisfactory sub-division of the Carboniferous beds of the Amazonas can as yet be made. The fossiliferous beds at the different localities appear to belong to the same limited horizon, and to present always the same fossils. It is true that Mr. Smith found at Curumú and Curucaca, near Alenguer, fossils having a different aspect from those from the other localities, but they are so poorly preserved as to be unrecognizable. The fossils of the calcareous beds are mostly Brachiopods and Corals, while Lamellibranchs are most abundant in the shales and sandstones; but there are many species in common, and the beds are so closely related stratigraphically, that I am inclined to consider the differences in their fossils as due to differences in the nature of the sediments, rather than to a difference in horizon.

While the Palæozoic deposits were being laid down in the Amazonian region, it is to be supposed that the other margins of the ancient Archean and Silurian islands received their quota of deposits and, in fact, in the southern part of Brazil, in the regions now constituting the provinces of Rio Grande do Sul, Santa Catharina, Paraná and the southern part of São Paulo, extensive Carboniferous and Devonian beds were laid down. It is stated also that Carboniferous deposits are to be found in the provinces of Maranhão and Matto-Grosso, on the Guaporé and Upper Paraguay; but, although this seems extremely probable, the fact is not as yet well verified. In the Andean region enormous deposits were formed, during the whole of the Palæozoic. The best known of these are the Carboniferous beds, which appear in the central part of the Cordilheiras, at lake Titicaca, and in the province of Arque in Bolivia; and on the eastern slope of the Andes, at Cochabamba and Santa Cruz de la Sierra, in Bolivia, and on the upper Pachetea, in Peru.

The beds referred to the Cretaceous. have only been recognized with certainty in the mountains of Ereré. We have seen that the Curuá shales of the Devonian series, form in general the base of these mountains. In one place, near the base of Tajurí, these shales are followed by Carboniferous limestones, but in general the Carboniferous beds are lacking throughout the Ereré region, and the Devonian shales are followed by heavy beds of coarse, hard sandstone. In a section made in a hill between Tajurí and Ereré, there are three distinct beds of coarse massive sandstone, separated by beds of micaceous sandy shales, the whole series having a thickness of about 300 feet. Of these three beds of sandstone, the upper or middle, or the two united, form the principal mass of the Serras of Ereré and Paitúna. In the first of these serras were found, in 1871, fragments of fossilized wood, which were referred by Dr. Dawson to the dycotyledonous group of plants, and in the last voyage we found, in Paitúna, a thin bed of argillaceous sandstone, intercallated in the coarser beds of the serra, which was crowded with fossil leaves, belonging to various genera of the same group of plants.

The leaves and woody structure of tropical plants have been too little studied to permit of the specific, and perhaps the generic, determination of these plants. They are, however, of the utmost importance in the determination of the age of the formation, which can hardly be older than the Cretaceous, and since these fossils are in disturbed beds, which are overlaid by the horizontal deposits referred to the Tertiary, we cannot well consider them as more modern than the Cretaceous.

Fossil leaves, very similar in appearance to those of the Serra de Paitúna, have been found at Tonantins on the Solimões, at Uatapucará on the Tapajos, and at Prainha on the Lower Amazonas, in beds that appear to be Tertiary or recent. A critical examination is required to prove whether or not these fossils from the different localities are identical, or belong to the same horizon. For the present it seems to me most probable that they are distinct, those of Paitúna being the most ancient. It is worthy of note that the fossil leaves at Prainha are in beds of clay and conglomerate that are slightly inclined, and it is possible that, notwithstanding their modern appearance, they may prove to belong to the Cretaceous.

These fossils being in the upper bed of sandstone, the age of the lower beds and of the intermediate sandy shales, between the limits of Upper Devonian and Cretaceous, is undetermined. They are, however, so similar in lithological character, to the fossil leaf beds, that I refer them provisionally to the Cretaceous. What is well proven is, that the elevation of the anticlinal of Ereré took place during, or after, the Cretaceous age. In this connection I may add, that the beds of the numerous Cretaceous basins along the eastern coast of Brazil are always more or less disturbed and inclined.

Near the mouth of the Trombetas we found inclined beds of sandstone, containing pebbles of shale which appear to me to have come from the Devonian or Carboniferous beds, which occur farther up on the same river. In the same region there is a high serra, called Curumú, composed of hard sandstone, the beds of which appear, as seen from a distance, to be inclined, and I suspect that in that region will be found the equivalents of the Ereré Cretaceous beds.

To the south of the mouth of the Amazonas, between Salinas and Bragança, Sñr. Penna has lately discovered fossiliferous limestone, similar to that of the Cretaceous basins of Pernambuco and Sergipe. In the Solimões region there is also, according to Chandless and Coutinho, an extensive Cretaceous area, on the river Purús, characterized by the remains of *Mosasaurus* and turtles.

The disturbances which all the formations thus far described have suffered, were accompanied by eruptions of igneous rocks. In the metamorphic region, the syenite and perhaps a part of the granite may belong to this category, a question that can only be solved by further study. In the same region, and also throughout the Palæozoic region, diorite is very common, forming immense dykes, and sometimes apparently forming sheets between the strata of sedimentary rocks. Another igneous rock of doubtful character, which I have referred to as trap, forms numerous narrow dykes in the Ereré and Alenguer region, traversing both the Palæozoic and the Cretaceous beds. The surface is always decomposed, presenting a scoriaceous appearance, and enclosing crystals of quartz and fragments of the adjacent sedimentary rocks, these last being often so slightly metamorphosed, as to still preserve traces of fossils. The beds traversed by the dykes are somewhat altered, for a distance of a few feet from the point of contact.

The Tertiary beds have been so often mentioned in the course of this article, that little remains to be said regarding their character and distribution. They are distinguished from those of the older formations by their horizontal position, and by the absence of fossils and of eruptive rocks. They consist of sandstones and clays, of brilliant and varied colors, such as white, red, yellow and blue, combined in different shades, so as to produce a very striking effect in the cliffs, which are very frequent along the tributaries, but rare along the main river. The rock is in general very slightly consolidated, except an occasional bed or patch, in which a cement of oxide of iron has produced the coarse ferruginous sandstone, found scattered over the surface thoughout the whole of the Amazonian highlands.

The Tertiary series is best presented in the serras known under the collective name of Serras de Parú, which are seen from the river, from Almeirim to near Prainha. These are mountains of circumdenudation, perfectly level on top, and of an elevation of about 1,000 feet. The one nearest to Prainha, called Parauáquára, was visited by Prof Hartt in 1871, who found the structure well presented in the steep, bare front of the mountain. The beds, whose thickness corresponds approximately to the height of the mountain, consist of sandstones and clays, of various colors, disposed in nine distinct divisions. From Parauáquára westward, the series of table-topped hills extend for a long distance, but, lying farther back from the river, they cannot be seen, except from some high point as, for example, the mountains of Ereré. From the Maecurú, I saw a rounded peak, rising above the general level, apparently an island of some older formation, in a sea of Tertiary sandstone. In the vicinity of Monte Alegre there are deposits identical in character with those of Parauáquára, which were evidently laid down after the elevation of the Ereré anticlinal. These deposits, like those of Alenguer and Obydos, have suffered a destructive denudation, which has considerably reduced their original height, which probably was never equal to that of the Serras of Parú.

The Tertiary beds of the southern side of the valley, are, in the Santarem region, considerably lower than those of the north, the difference being probably due to the inclination of the bottom of the Tertiary sea, and the smaller quantity of sediment received by the regions farthest removed from the margin of that sea, The highlands behind Santarem are 400 feet high, and do not appear to have suffered denudation that has diminished sensibly their original height. In a bed of blue clay, exposed on the slope of these highlands, I found worm tubes, the only fossils that the Tertiary beds of this region have yet afforded.

This lack of fossils is noticeable, not only in the Lower Amazonian region, but throughout Brazil. In every province there are beds similar in character and position to those just described, but so far they have yielded no fossils, that will serve for their classification, and they have been referred to the Tertiary solely on account of their stratigraphical position. The only Tertiary fossils known from this region are the fossil leaves of Tonantins, and the fresh and brackish water mollusks of Pebas and other localities in Perú. These, however, occur in lignitiferous beds, quite different from those now under consideration, and the relation between the two has never so far as I am aware, been satisfactorily determined. The only division that can at present be made in the region of the Lower Amazonas, is between the beds of the high table-lands, and those of the lower plains about Pará and eastern Marajó. These last, consisting of abrupt alternations of coarse and fine sandstone, generally ferruginous, along with colored clays, are certainly more modern than the former, and belong to the later Tertiary or the Quarternary.

During the deposition of the Tertiary, there were considerable movements of depression and subsequently of elevation, but these movements were, as far as is known at present, unaccompanied by disturbances of the strata or eruptions of igneous rocks.

After the elevation of the Tertiary table-lands, began the alluvial deposits of the *varzea*. They consist, according to circumstances and localities, of sands or clays, or a mixture of the two, a yellowish structureless clay predominating, often having above it a bed of black clay, impregnated with vegetable matter. Part of this deposit was without doubt formed in an estuary, while the river was taking possession of the bed prepared for it; but it is now impossible to distinguish the estuary deposits from those that are purely fluvial. The proofs of the estuary condition are not so much in the characters of the deposits, as in the form of the tributary valleys, which are widened in a manner that can only be explained by the action of the tides.

With the formation of the *varzea*, the geological evolution of the valley of the Amazonas terminated. We cannot in this place enter into a consideration of the interesting phenomena, illustrative of Geology and Physical Geography, of which the *varzea* is the theatre. To witness, close at hand, the operation of many of the processes of which these sciences treat, and which have given form and character to the surface of our planet, I know of no region equal to the Amazonas. Between the water and the land, the river and the *varzea*, there is a constant conflict. Islands are formed and destroyed, or floated bodily down stream, by the continual process of destruction at one end, and of formation at the other; lakes, *furos* and *paraná-merins* are being formed, to be again filled up; tributaries extend themselves into the territory proper to the main river, or this throws out one of its lateral channels, to appropriate to itself a part of the valley of a tributary. The conflict, however, is unequal; the force of the river, irresistible as it is in its great floods, is spasmodic in its action, and can be met by a weaker, more constant one, such as is afforded in aid of the growth of the land, by the vegetative force.

Rank behind rank, the various aquatic and marsh plants advance into every shallow, building it up to the common level over which the floods pass, adding new sediment, instead of carrying away that already accumulated. In this way the land is slowly extending itself, confining the river more and more to its proper channel; but this process cannot materially alter the character of the valley, unless aided by some convulsion of nature.

Much yet remains to be done on the Lower Amazonas, in filling in the details of this imperfect sketch, which will, I trust, be found to be accurate in the main, and which will serve to show how interesting the region is in itself, and in its relation to the rest of the Continent. Of the Upper Amazonas or Marañon region, enough is already known to show its surpassing interest and importance. Between the two, the middle or Solimões region, is an almost perfect blank, in which future explorers will meet with difficulties, even surpassing those presented by the other regions, but will, by well directed efforts, reap results commensurate with the hardihood of the undertaking.

Stated Meeting, January 17, 1879.

Present, 11 members.

Vice-President, Mr. FRALEY, in the Chair.

A letter of acknowledgment was received from the Natural History Society, Emden (100; List).

Letters of envoy were received from the French Minister of Public Instruction; and the Meteorological Office, London, December, 1878.

A letter of thanks for correspondence was received from the Rev. Stephen D. Peet.

A letter respecting exchanges was received from Mr. G. W. Ranck, Curator of the Kentucky Historical Society.

Donations for the Library were received from the Adelaide Observatory; M. P. Volpicelli at Rome; the Geographical Society and Revue Politique at Paris; the Meteorological Office, and Register, and London Nature; the Boston Natural History Society; American Journal of Arts and Sciences; Library Journal in New York; the Franklin Institute, College of Pharmacy, Journal of the Medical Sciences, and Medical News in Philadelphia; the American Journal of Mathematics at Baltimore; Mr. S. H. Scudder; the Botanical Gazette; Mr. G. W. Ranck; and the Ministerio de Fomento in Mexico.

The American Journal of Mathematics of Baltimore was ordered to be placed on the list of correspondents to receive the Proceedings.

The death of the Rev. E. R. Beadle, D.D., LL.D., in Philadelphia, January 6, 1879, aged 66, was announced by the Secretary; and, on motion, Dr. Robt. E. Rogers, was appointed to read an obituary notice of the deceased.

The death of Mr. Morton McMichael, in Philadelphia. January 6, 1879, aged 71, was announced by Mr. Price; and on motion Mr. Fraley was appointed to read an obituary notice of the deceased.

A letter from Mr. P. W. Sheafer, dated Pottsville, Pa., January 6, 1879, reported the result of tests of the visibility of stars in daylight from various depths of the 1600 feet shaft of the Philadelphia and Reading Railroad Company, near that borough:

POTTSVILLE, Pa., January 6, 1878.

DEAR SIR:—The question of seeing stars from deep wells, &c., being unsettled, I requested Mr. Edward Herbert, an intelligent boss miner, now in charge of the deep shaft of the Philadelphia and Reading Coal and Iron Company, near this borough, to test the question so far as he could find the opportunity to do so in his frequent ascents and descents of the Pottsville shaft, especially, which is some 1600 feet deep.

He reports as follows:

"ST. CLAIR, December 20, 1878.

"Myself and one of the workmen have tried this afternoon at several distances in east shaft, if we could see any stars, but failed to see any. The sky was very clear and atmosphere favorable; the shaft is a down cast, and was entirely free from smoke or steam. I fear we will not be able to solve your problem in the affirmative."

In reply to a further inquiry, as to the depth from which observations were made, he replies as follows:

"ST. CLAIR, January 4, 1879.

"We have tested it at different depths, from 100 feet down to 700 and 800 feet, when the sky has been clear, but have so far failed to see any stars.

After we got down 600 feet the atmosphere is not quite so clear as it is nearer to the surface."

If your society can suggest further tests I will be glad to make them.

I am very respectfully your obedient servant,

P. W. SHEAFER.

To the American Philosophical Society,
Fifth Street, near Chestnut, Phila.

Mr. B. Britton exhibited a small and useful specimen-rock crusher for laboratory use, with mortar and pestle, and described its value in the saving of time and labor.

Mr. Lesley exhibited a proof sheet of Mr. J. F. Carll's colored map of the preglacial water basins of North-western Pennsylvania, prepared for the illustration of his forthcoming third Report of Progress in the Survey of the Oil Regions.

Mr. Marks exhibited and explained a new link-work, which he had invented for the use of his students in describing arcs of epicycloid curves, and which can be made practically useful for plotting the outlines of the teeth of wheels. He also exhibited specimens of other Peaucellier cell forms.

On motion, Mr. Lesley was elected Librarian for the ensuing year.

The Standing Committees for 1879 were then appointed, as follows:

Finance.

Mr. Frederick Fraley,
Mr. E. K. Price,
Mr. Benjamin V. Marsh.

Publication.

Dr. John L. LeConte,
Dr. Daniel M. Brinton,
Dr. McQuillen,
Prof. E. Thompson,
Dr. C. M. Cresson.

Hall.

Gen. Hector Tyndale,
Mr. S. W. Roberts,
Mr. J. Sergeant Price.

Library.

Mr. E. K. Price,
Rev. Dr. Krauth,
Dr. G. H. Horn,
Dr. Kinderdine,
Prof. Houston.

Pending nominations Nos. 871, 872, 873 were read, and Nos. 871 and 873 balloted for. No. 872 was postponed on account of the absence of its nominators.

The reading of the list of members was postponed.

On a scrutiny of the ballot boxes by the presiding officer, the following were declared duly elected members of the Society:

Charles B. Dudley, Ph. D., Altoona, Pa.

Philip H. Law, of Philadelphia.

And the meeting was adjourned.

Stated Meeting, February 7, 1879.

Present, 19 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from Dr. Charles Benjamin Dudley, dated Altoona, January 20, 1879; and from Mr. Philip Howard Law, dated Philadelphia, January 20, 1879.

Letters of envoy were received from the Batavian Society of Sciences, Batavia, dated December 15, 1874, August 20, 1875, March, 1876, and October 20, 1877; from the Natural History Society at Chemnitz; and from the Physical Society at Geneva, dated September 15, 1878.

A letter of acknowledgment was received from the Physical Society at Geneva (99, 100).

A letter from Mrs. S. N. Byington, to Dr. Brinton, enclosing a letter from Major J. W. Powell, of Washington, requesting the loan of the manuscript Choctaw grammar, written by the late Rev. Cyrus Byington in 1833, for the purpose of having it published along with Mr. Byington's Choctaw Dictionary, under the editorial care of Prof. O. T. Mason, was read. On motion the Librarian was authorized to loan the manuscript from the Library, for the needful time, on a guarantee of its safe return.

Donations for the Library were received from the Royal Societies of Victoria and New South Wales; the Mining Department of New South Wales; the Academies at St. Petersburg, Berlin, Copenhagen, the Hague, and Brussels; the Natural History Society at Moscow; the Geological Society at Berlin; the Societies at Offenbach, Chemnitz, Geneva and Bordeaux; the Observatory at St. Petersburg; the Geographical Society, Revue Politique, and M. Delesse at Paris; the Royal Astronomical and Meteorological Societies, Meteorological Committee, Lords of Admiralty, and Editors of Nature, London; the Boston Natural History Society; Harvard College; Silliman's Journal; American Journal of Ontology in New York; the Brooklyn Entomological Society; the Pennsylvania Historical Society, Journal of Pharmacy, Editors of Naturalists' Leisure Hour, and Robinson's Epitome of Literature at Philadelphia; the Librarian of Congress, and J. W. Powell, at Washington; Mr. M. C. Reed, Hudson, Ohio; the Botanical Gazette; the Ministerio de Fomento; and the Argentine Scientific Society at Buenos Ayres.

Copies of Proceedings No. 102, and card list of meetings and officers for the year, just published by the Secretaries, were laid on the table.

A letter from the Corresponding Secretary of the Kentucky Historical Society, dated Lexington, Ky., January 20, 1879, was read, and, on motion, the name of that Society was placed on the list of correspondents to receive the Proceedings, from the beginning of the current volume.

A letter respecting exchanges was received from the Michigan Library Association at Coldwater, Mich., dated January 20, 1879.

An obituary notice of the late Robert Frazer, was read by Professor Frazer.

The death of Dr. John B. Biddle at Philadelphia, January 19, 1879, aged 66 years, was announced, and on motion Dr. Henry C. Chapman was appointed to prepare an obituary notice of the deceased.

The death of Judge John Cadwalader, at Philadelphia, January 26, 1879, aged 73 years, was announced by Mr. Fraley, and on motion Mr. McCall was appointed to prepare an obituary notice of the deceased.

A communication, entitled "Preliminary notice of an investigation on *Petrocene*, a product of the destructive distillation of Petroleum, by Samuel P. Sadtler and H. G. McCarter," was read by the Secretary.

A communication respecting some remarkable conjunctions of semi-anthracite and semi-bituminous coal beds in Sullivan county, and certain hygrometric cokes, by Franklin Platt, Assistant on the Geological Survey of Pennsylvania, was read by the Secretary.

A communication, entitled "Some notes upon the collection of coins and medals, now on exhibition at the Pennsylvania Museum and School of Industrial Art, in Memorial Hall, Fairmount Park, Philadelphia, by Henry Phillips, Jr., A. M.," was read by the Secretary.

An essay on the Philosophy of Christianity was read by Prof. P. E. Chase, pursuant to notice given on the card (see page 123 above).

A new combination of Peaucellier cells intended for drawing arcs of large circles and straight lines, by students of the University, was exhibited and explained by Prof. Marks.

Dr. König announced that he proposed to show his new chrometric apparatus at the next meeting of the Society, and give a detailed report of its workings.

The Chairman of the Michaux Legacy Committee, Mr. E. K. Price, read its annual report, as follows:

To the American Philosophical Society:

The Committee on The Michaux Legacy respectfully report:

That the income received from the Government of France, during the last year, was $531.33, of which one-half, $267.16, was paid to the Fairmount Park Commissioners for the purchase of trees; Michaux's Sylva for Park Library, $40; for Dr. Rothrock's Lectures on Botany and Trees in the Park, $280; advertising ditto, $50; Journals of Forestry, three copies, $11.87; planting trees round the University in 1877, $88.80; in 1878, $56.83; printing in 1877, $30.25. The payments last year exceed the income of the year, $168.43; but there is considerable arrears of income unspent.

The Park Commissioners have on hand for the purchase of trees, of Michaux Legacy, $284.98; Cresson Legacy, $379.45.

Dr. J. T. Rothrock delivered a course of lectures on Botany and Trees, in Horticultural Hall, in the Fairmount Park, fourteen in number, to a larger audience, ranging from one hundred to two hundred, than in 1878.

The Committee recommend that Dr. Rothrock should continue his lectures the present year, and that an appropriation out of the income of the Michaux Legacy be made for that purpose, of $280, and $50 for advertising the lectures.

ELI K. PRICE, *Chairman.*

January 24, 1879.

On motion the recommendation embodied in the report was adopted, as follows:

Resolved, That an appropriation be and is hereby made from the income of the Michaux Legacy, of $280, for a course of fourteen lectures in Fairmount Park, by Dr. J. T. Rothrock, on Botany, Sylviculture and Agriculture; and $50 for advertising said lectures.

Mr. Fraley reported, that he had received and paid over to the Treasurer, the quarterly interest from the Michaux Legacy, due January 1, 1879, amounting to $132.43.

A communication was received from Mr. Geo. W. Morrison, Philadelphia, January 3, 1879, respecting a successful coal dust burning apparatus. On motion this communication was referred to the Board of Officers and Council at their next meeting.

And the meeting was adjourned.

Preliminary Notice of an Investigation on "Petrocene," a product of the Destructive Distillation of Petroleum. By Samuel P. Sadtler and H. G. McCarter.

(Read before the American Philosophical Society, February 7th, 1879.)

In the number of *Comptes Rendus* for 16th December last (tome 87, p. 991), which has just come to my notice, appears an article by MM. L. Prunier and R. David, entitled, "sur la nature de certains produits cristallisés, obtenus accessoirement dans le traitement industriel des pétroles de Pennsylvanie."

In this article the authors announce that they have begun an investigation of "Petrocene," a solid residue from petroleum, which they obtained from Dr. H. Tweddle, of Pittsburg, Pennsylvania. They give some general statements as to the several hydrocarbons, the presence of which they consider to have been indicated by the determinations they made of fusing points, boiling points, solubilities, together with crystallizations gotten with picric acid, and with binitroanthracene. Judging in this way, they state that anthracene, phenanthrene, chrysene, chrysogen and other hydrocarbons are present. They give no specific figures of analyses, but say merely that the percentage of carbon varied in their different analyses from 88 to 96 per cent. in 100. After propounding some interesting theories, based upon these indications, they close by promising to communicate the results obtained from a farther study of the subject, if, as they hoped, these should be new.

This same material has been the subject of our investigation for several months past, and we have obtained results which, while not as yet complete, are so far advanced as to be beyond the point of Messrs. Prunier and David's work, as it is stated in their article. We would therefore claim equal right to the field as scientific workers, and shall continue our studies, and hope to push them to an early completion.

The material we have operated on consists of a full set of Dr. Tweddle's preparations, as described by him in the Franklin Institute Journal Vol. 72, p. 204, which was given to one of us some two years ago, by Dr. F. A. Genth, and a bottle of the crude distillate before treatment with petroleum benzine, given to us by Dr. G. F. Barker.

Some weeks of study had indeed been given to these products in the summer of 1877, by one of us in conjunction with Dr. E. F. Smith, of the University of Pennsylvania, which work was interrupted and only resumed, as stated, a few months ago.

The following is a brief and general statement of the ground covered by our work. The conclusions are all subject to revision as the examination of purer products may demand.

We found that the method of breaking up the compound by treatment with solvents did not suffice to give us pure products of constant compositions. We therefore availed ourselves of the method of forming double crystallizations with picric acid from solution in alcohol and benzol. We obtained what appeared to be three distinct crystallizations here—two of deep red crystals and one of brown plates. These were picked apart as they crystallized together, using a hand lens, and exercising great care, and were then submitted to recrystallizations until quite pure and distinct. On breaking up these picric acid compounds with dilute ammonia, we obtained at least two well-marked and distinctly different hydrocarbons. With regard to the hydrocarbon from the third set of crystals we are still in doubt.

Of the two hydrocarbons, one fuses constant at 280°C., and the other at 178°C. We are not able to identify them certainly with any of the known hydrocarbons.

Of both of these hydrocarbons, quinones have been made, and of one of them the alizarine, acting upon the quinone with strong sulphuric acid with heat, and then fusing the dried residue with solid potassium hydrate. The quinone dissolves in sulphuric acid with a dark purple color, and when the nearly black residue of di-sulphoquinonic acid and potassium hydrate are fused together, a dark yellowish-brown color is obtained. From the solution of this, hydrochloric acid precipitates the alizarine as a dark brown flocculent mass.

Several analyses of the quinone and of the alizarine were made. As I hold the whole subject still open to revision, I will not quote them, but merely say that both the quinone and the alizarine derived from the hydrocarbon, fusing at 280°C., indicate a probable composition $C_{16}\ H_{14}$. This would be a dimethyl-anthracene, yet the hydrocarbon does not agree with the dimethyl-anthracene discovered by Van Dorp, and studied by Wachendorf and Zincke.

With this brief mention of the work done, we will defer any further discussion until our results are sufficiently advanced to be presented as a whole. We are now engaged upon the work, and will push it promptly to a completion.

Character of some Sullivan County Coals. By Franklin Platt.

(Read before the American Philosophical Society, February 7th, 1879.)

It has already been noted in giving the detailed description of the coal openings in Sullivan county, that the different coals mined presented wide differences in character, and in one or two instances offered some most unusual features.*

These characteristics may be briefly summed thus :†

* See unpublished Report of Progress, Second Geological Survey of Pennsylvania, GG.

† See the analyses made by Mr. A. S. McCreath, Chemist of the Survey at Harrisburg, given below.

1. That the Bernice coal as mined from the Big Bed, called bed B, is a semi-anthracite coal, of the usual chemical composition of anthracites, but differing from them in appearance and fracture.

2. That the coal bed lying sixty feet below the coal bed B is a semi-bituminous coal, of curious structure; holding much water in combination; and not coking.

3. That in a coal bed opened only one and a half miles east of Bernice, the upper bench is semi-bituminous coal, and the lower bench an anthracite, or more nearly semi-anthracite; with only a six inch black slate parting between these two benches; the semi-bituminous coal bench not coking, and holding a very large percentage of water in combination.

4. That the Forksville coals are semi-anthracites of unusual appearance and structure.

5. That the Laporte coal is really bituminous coal, of very curious structure, holding much water in combination.

In order that the main features of the character of these coals may be more forcibly presented, they are grouped together thus:—

1. Bernice, Sullivan County. Run of mine. Bed B.
2. " " " Top bench. "
3. " " " Middle bench. "
4. " " " Lower " "
5. " " " Cannel-like coal in upper bench.
6. " " " Coal 60 feet below Bed B.
7. " " " " " " "
8. Pigeon Creek, 4 miles east of Bernice. Bed B.
9. $1\frac{1}{2}$ miles east of Bernice. Top bench.
10. " " " Lower bench.
11. $3\frac{1}{2}$ miles S. W. of Forksville. Lip. & Mercer mine. Top bench.
12. " " " " " Lower "
13. 1 mile south of Laporte. S. Hall's Coal.

	1	2	3	4	5	6
Water	1.295	1.840	1.800	2.220	1.950	5.815
Volatile Matter	8.100	9.835	9.650	9.405	9.030	15.085
Fixed Carbon	83.344	76.788	82.373	81.267	63.795	62.329
Sulphur	1.031	.647	.622	.618	.583	.474
Ash	6.230	10.890	5.555	6.490	24.640	16.297
	100.000	100.000	100.000	100.000	100.000	100.000
Color of Ash	Gray.	Cream.	Gray.	Cream.	Cream.	Reddish Gray.

	7	8	9	10	11	12	13
Water......	4.130	2.340	7.930	2.910	.930	.810	6.830
Vol. Matter.	15.270	8.440	21.410	11.780	12.410	13.060	21.930
Fixed Carb.	67.362	80.949	54.099	81.672	75.611	71.679	55.413
Sulphur....	.523	.726	.551	.598	.574	.581	.387
Ash........	12.715	7.545	16.010	3.040	10.475	13.870	15.440
	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Color of Ash.	Reddish Gray.	Cream.	Cream.	Cream.	Gray.	Gray.	Red.

There is no peculiarity about the chemical composition of the coal from the Bernice Big Bed, or B. The analysis closely resembles that of the Lykens Valley coal; it is burned exactly like any of the other anthracites, and differs from them only in appearance and structure. For all purposes it is classed among the anthracite coals, and is sold for exactly the same purposes.

The coal sixty feet below Bed B introduces at once an interesting inquiry, from the fact that although a semi-bituminous coal it does not coke, and re-absorbs moisture rapidly on cooling after being heated to 225°.

In his report upon the analyses of coals from Ohio, Prof. Wormley has noted the characteristic feature of their re-absorbing moisture when allowed to coal after being heated to 212° F.

In his report on the analyses of the coals of Pennsylvania,* Mr. Andrew S. McCreath, the chemist of the survey, reports that the Pennsylvania coals have no such characteristics; and out of many hundreds of coals analyzed by him only four so far have possessed the power of re absorbing moisture rapidly after it has been expelled at 225° F.†

Under such circumstances it is desirable to note particularly the appearance, behavior and composition of these peculiar coals.

Three of them are from Sullivan county, and one from the New Red Sandstone in York county.

No. 1. B. Gross coal, from York county, Pennsylvania, on B. Gross farm, on Liverpool road, three-fourths of a mile north of Liverpool, on the Little Conewago creek. Specimen collected by P. Frazer, Jr. The coal is from the Mesozoic rocks.

"The coal has generally a deep black color, with somewhat pitchy appearance. It is very brittle, breaking with *conchoidal fracture.*

Water at 225°	4.310
Volatile Hydrocarbons	18.482
Fixed Carbon	74.358
Sulphur	.528
Ash	2.322
	100.000

* Report of Progress in the Laboratory of the Survey, M. p. 28, 1875.
† MSS. Report of Progress MM. 1878, now in press.

"The coal yields a bulky ash of a reddish brown color. It has not the slightest tendency to form a coherent coke, and yields volatile matters burning with a non-luminous flame. The water was estimated at 225°, and upon withdrawal of the heat the coal begins to absorb water with great avidity. So that in two hours it has re-absorbed sixty-three per cent. of the amount of water originally present."

Throwing out the water, sulphur and ash, the proportion stands:

Fixed Carbon	80.093
Volatile Hydrocarbons	19.907
	100.000

Volatile Hydrocarbons to Fixed Carbon, as 1 to 4.023.

No. 2. Coal sixty feet below bottom of Bed B, at Bernice, Sullivan county, Pennsylvania.

The coal is for the most part coated with iron oxide and infiltrated silt. It has a dull dead lustre, and is compact and brittle, with very irregular fracture. The coal does not have the slightest tendency to coke and yields gases which burn with a *very* feebly luminous flame. After cooling (water estimation) the coal immediately begins to absorb water and in two hours has re-absorbed about sixty per cent. of the water originally present.

Water	5.815
Volatile Matter	15.085
Fixed Carbon	62.329
Sulphur	.474
Ash	16.297
Color of ash, reddish grey.	
	100.000

Leaving out the accidental impurities, and counting only the ignitible constituents, the proportion stands:

Fixed Carbon	80.514
Volatile Hydrocarbons	19.486
	100.000

Volatile Matters to Fixed Carbon as 1 to 4.132.

It should be noted that this coal specimen was necessarily taken from near the outcrop, which accounts for the oxide of iron coating, the infiltrated silt, and in part for the high percentage of ash.

A second specimen of this same coal (sixty feet below bed B at Bernice) taken from under better cover, was also analyzed by Mr. McCreath.

"The coal does not coke, and the gases burn with a *very feebly* luminous flame. The coal, after being dried, begins to absorb water rapidly, and in two hours has re-absorbed sixty per cent. of the water originally present. This amount is not increased by longer exposure.

Water	4.130
Volatile Matter	15.270
Fixed Carbon	67.362
Sulphur	.523
Ash	12.715
Color of ash, reddish-gray.	
	100.000

On drying at 225° the Coal loses	4.13 %
" " 245° " "	same.
" " 260° " "	4.19 %
" " 340° " "	4.50 %
" " 460° " "	4.69 %
At a dull red heat the Coal loses	12.59 %

But in all these experiments the water re-absorbed is about the same; that is, the coal re-absorbs 2.48 parts of water. Irrespective, therefore, of the amount of water, &c., driven off by heat, the portion re-absorbed is practically constant; and this property is not destroyed, even after all the volatile matter is driven off."

No. 3. Coal from opening one and a half miles east of Bernice, Sullivan county, Pennsylvania. Top bench of coal.

"The coal has a dull dead lustre; it is very soft and crumbling, and has a somewhat shaly appearance with laminated structure. The gases burn with a feebly luminous flame, but the coal does not coke.

Water	7.930
Volatile Matter	21.410
Fixed Carbon	54.099
Sulphur	.551
Ash	16.010
Color of ash, cream.	
	100.000

No. 4. Sullivan county, one mile south of Laporte. From S. Hall's drift.

"The coal has a deep black dull lustre; it is rather friable; contains some slate. It does not show the slightest tendency to form a coherent coke; the volatile matter burns with a *feebly* luminous flame. The coal acts generally in the same way as that from the Bernice lower coal bed.

Water	6.830
Volatile Matter	21.930
Fixed Carbon	55.413
Sulphur	.387
Ash	15.440
Color of ash, red.	
	100.000

Throwing out the sulphur, water and ash, and counting the ignitible constituents only, these coals show the following proportions :

	Coal No. 3.	Coal No. 4.
Fixed Carbon	71.646	71.646
Volatile Hydrocarbons	28.354	28.354
	100.000	100.000

And the proportions of Volatile Matter and Fixed Carbon, are for No. 3, as 1 to 2.527 ; and for No. 4, as 1 to 2.527.

There are several points touching these coals which are noteworthy :

1. They range in proportion of Volatile Matters to Fixed Carbon from bituminous to semi-bituminous coals ; these proportions being 1 to 4.022 ; 1 to 4.132 ; 1 to 2.527 ; 1 to 2.527.

2. They carry an unusual percentage of water ; these percentages being 4.310 ; 5.815 ; 7.930 ; 6.830.

3. The gases driven off burn with a non-luminous flame.

4. None of the coals coke.

5. All of the four coals re-absorb in a short time fully 60 % of the water which has been expelled by raising their temperature to 225° F., in this respect differing from all the other Pennsylvania coals hitherto examined.

Notes upon the Collection of Coins and Medals now upon Exhibition at the Pennsylvania Museum and School of Industrial Art, Memorial Hall, Fairmount Park, Philadelphia.

By Henry Phillips, Jr., A. M.

(Read before the American Philosophical Society, Feb. 7, 1879.)

"*Quem non moveat clarissimis monumentis testata consignataque vetustas?*"
Spanheim.

The object of this display is to present Art as typified upon coins and medals, from the earliest known period until the present time, so as to show the student the nature and character of the development of æsthetic culture as exhibited by the aid of Numismatic science.

The change and advance presented by the inspection of coins and medals is a vast chain of ever closely joining links. From the very beginning of coinage, from the rudest of all ancient coins, the Persian daric or the tortoise of Ægina, to the majestic medallions of Syracuse, step by step every inch of the onward march of Art may readily be traced. The earliest of all known coins exhibit on the reverse only a shapeless punch mark, are the work of unskilled hands, are defective in type, in shape, in inscription, while the latest (or most modern), present complicated and intricate devices of all kinds and natures.

The present exhibition is composed of the collections of coins and medals belonging respectively to the Library Company of Philadelphia, the American Philosophical Society, and the Numismatic and Antiquarian Society of Philadelphia, under the care of which latter Society the collections have been deposited and arranged by a Committee, of which I am the Chairman. A few private individuals have also contributed to the exhibition.

The display may be divided into three great heads, viz: Coins, medals and tokens (embracing jettons), to the main features of which I shall briefly advert, beginning for convenience sake with the second general subdivision.

The case containing the medals of the Societies is a flat one of five trays on the western wall of the main hall of the building to the right of the entrance of the India room. They are of gold, silver, copper, bronze, brass and lead. The first series to be noticed is one consisting of thirty-one bronze medals of large sizes, commemorating victories and notable events in the history of the empire of Russia, from the time of Peter the Great to that of Catharine the second. They are all of very high relief, and bear for the most part on their obverse the nude bust of that Empress, exhibiting her as a young woman, and as time passes on showing the alterations it has caused in her appearance.

There are silver medals given by Kings George First and Second to the North American Indians, usually worn by the sachems as gorgets, and interred with them at their decease.

The one which bears the head of King George the Second is stated, in Vaux's life of Anthony Benezet, to have been cut in America, and is especially worthy of notice on that account, as having been the first medal ever made in this country. It is cut in very bold style, although the reverse is decidedly stiff of execution. The obverse bears the bust of King George the Second, with his titles, the reverse a Quaker seated on the ground is receiving from (or handing to) an Indian the calumet of peace; around is the inscription, "Let us look to the most high who blessed our fathers with peace."

Another silver gorget bears on the obverse an antique view of the city of Montreal, on the reverse engraved the word "Mohigrans," and in script the name *Tangran*, being probably the appellation of the chieftain to whom it had been presented.

The Indian medal of George the First bears on the reverse an Indian, armed with a bow and arrow, taking aim at a stag.

A series of well executed medals represents scenes in the lives of Louis XV., Louis XVI., Marie Antoinette, Lord Howe, Lord Cornwallis, Suwarrow, and others. There are fine medals of Rousseau, Lafayette, Liebnitz, Gauss, Thiersch, R. M. Patterson, David Rittenhouse, Berzelius, Charles XII., of Sweden, Louis XVIII., Napoleon (commemorating the introduction of vaccination), Napoleon and Josephine (accolated), Marquis of Granby, Earl Kildare, one commemorating the millenial anniversary of the Kingdoms of Sweden and Norway, one of King Augustus of Poland, and other celebrated persons and events.

A series represents the "Medallic History of the American Revolution," on which appear Franklin and Washington with various symbolical reverses. There are medals of Pitt, of Penn, and quite a number of Washington, embracing the "Manly," the "Sansom," the "Eccleston," the "C. C. A. U. S.," "He is in glory," &c., &c., &c.; medals commemorative of the peace of 1814, and that of 1783; one given to Defleury upon the capture of Stony Point, a fine gilt medallion of the Earl of Essex, cut by the celebrated Simon, in the days of the Commonwealth.

There is an interesting series of medalets in copper ranging in date from 1584 to 1620, representing various occurrences in the wars between King Philip the Second of Spain, and the United Provinces. A quaint silver medalet of the Sixteenth Century has on the obverse, David playing upon the harp before Saul, and on the reverse, David slaying Goliath. A medal of Sir Humphrey Davy and one of Matthew Boulton are especially noticeable for the boldness and finish of their execution, as well as one cut by Key (the medallist of the United States Mint) for Columbia College, New York city, bearing on the obverse a magnificent female head with the inscription "Light, Liberty, Law." There is also a medal of Hon. Eli K. Price, President of the Numismatic and Antiquarian Society of Philadelphia, issued on January 1, 1879, in commemoration of the Twenty-first anniversary of the foundation of that Society (also cut by Mr. Key).

An especial attention should be given to a remarkably complete series of Papal medals, seven hundred and sixty-four in number, starting from Pope Martin V. (1415), and ending with Pius IX. These medals were deposited by Thomas Hockley, Esq., of Philadelphia, and are in a case by themselves in the main hall. They are of fine execution, and of great historic interest. Among them may be found two engraved by BENEVENUTO CELLINI, one of Clement VIII. (1523–1534), (No. 47), representing Joseph making himself known to his brethren (being in allusion to the Pope's fraternal feelings toward the Florentines, his compatriots, despite their slight gratitude towards him); another (No. 52), of Paul III. (1534–1549), exhibiting a bust of that Pope with Ganymede, and an eagle on the reverse.

Several of the medals refer to the opening and the closing of the *Porta Santa*.

Various medals refer to the wars waged against the Turks by the Spaniards and the Venetians. No. 96 represents the victory of Lepanto in 1571; No. 89 refers to the conspiracy and punishment of Cardinal Caraffa and his accomplices; No. 110 (Gregory XIII.), (1572–1575), commemorates the massacre of Saint Bartholomew; No. 130 the Reformation of the Calendar in 1582; No. 153 (Gregory XIV.), exhibits the Pope giving to his nephew Hercules Sfondrati the banner of the Holy Church, upon his departure to fight against the French Protestants in 1591; No. 181 (Gregory XV., 1621–1622), represents the canonization in 1622 of the Saints Ignatius Loyola, Francis Xavier, Philip de Neri, Isidora and Theresa; No. 243 (Innocent X.), the Holy Ghost, being in reference to the condemnation of the doctrines of the Jansenists; No. 294 (Alexander VII.), represents the Castle of St.

Angelo adorned with statues; No. 313 (Clement X., 1670–1676), commemorates the victory of John Sobieski, King of Poland, over the Turks, and exhibits him offering to the Pope the flags captured from the conquered enemy; No. 338 (Innocent XI., 1676–1689), the condemnation of Molinos; No. 342 refers to the alliance against the Turks formed by Innocent XI., the Emperor Leopold, John III., King of Poland, and the Doge of Venice in 1684; No. 355 (Alexander VIII., 1689–1691), the capture of the Morea by the Venetians from the Turks (we may note that the Parthenon was destroyed by Venetian bombshells in this encounter after surviving the hand of time for centuries after centuries); No. 381 (Clement XI., 1700–1721), represents the mission of Cardinal de Tournon to China; No. 390, the machine by which the obelisk of the Plaza del Monte Cettorio at Rome was elevated; No. 440 the arch of Constantine at Rome; No. 492 (Clement XIII.), the city and fortress of Civita Vecchia; No. 559 (Pius VII., 1800–1823), the bringing back of the Laocoon from Paris to Rome; No. 561, angel delivering St. Peter from prison; No. 572, the introduction of vaccination into the States of the Church; No. 577 (Leo XII., 1823–1829), Saint Peter announcing the opening of the Jubilee; No. 679 (Pius IX.), Rome triumphant wrapped in the Pontifical flag; No. 680, medal for those who exhibited their fidelity to the Pope; No. 686, medal for the Pontifical volunteers; No. 700 and No. 702 relate to the visitation of the cholera in 1854; No. 706, the opening of the railway from Rome to Frascati; No. 728, Daniel in the lion's den, refers to the Piedmontese invasion of 1861; No 744 and 745 commemorate the eighteen hundredth anniversary of the martyrdom of Saint Peter and Saint Paul; No. 754, the Roman exposition of 1870; also, eight special medals of Pius IX., commemoratingthe œcumenical council, and the twenty-sixth and twenty-seventh years of the papacy; in all seven hundred and sixty-four medals.

This magnificent series is replete with interest historical, architectural, artistic and numismatic. Many of the public works and buildings of Rome are figured both in their former and present conditions; churches, basilicas, façades, palaces, aqueducts, armorial bearings, sepulchres, canonizations, victories, are all represented in this (very rarely) complete collection. The workmanship is of the highest order of merit, and the medals are in the finest possible condition. The example of Mr. Hockley is one worthy of imitation by our public spirited citizens, who in so many instances require but the knowledge of a need to be brought to their notice.

According to Henin, there are six grand chronological epochs of coinage, all of which may with great certainty be known from the indications afforded us by the metals, the legends, the form of letters, methods of fabrication and style of art.

First. From the first invention of coinage to the time of Alexander the First, King of Macedonia, *i. e.* from about the seventh century B. C. to the year 454 B. C. This was the rudest epoch of the art; the metal was mainly silver, some little gold, and no copper. The form of the coins was globular and irregular, bearing on the reverse the rude punch mark (*creux* *carrè*), and sometimes the incused figure of the obverse. The legends were of the simplest character, being only the names of cities or magistrates, sometimes from left to right, sometimes in the contrary direction, and sometimes returning in the manner known as *Boustrephodon.*

The artists who produced these coins did so without models or the accessories of a later age, and arrived, nature led, at a style both sublime and true. A remarkable difference exists between ancient and modern coins, the former being of extremely bold execution and high relief, while the latter are comparatively flat and low, the *haut relief* preserving the types of the coins longer after entering into circulation.

Second. From the death of Alexander the First to the time of Philip the Second, the father of Alexander the Great, B. C. 359.

It was during this period that the arts attained a very high perfection in Greece, and it has been believed that the fine engraving upon coins was executed by the hands of artists skilled in the working of precious stones. Copper coinage, but in small quantities, now began to be used as currency, being first struck (in Macedonia), by Amyntas Second (307 B. C.), and is referred to in a passage in "The Frogs" of Aristophanes as having been but lately introduced into Athens. Simplicity was still preserved in art, leading to the grandest results.

Third. From the accession of Philip the Second to the subversion of the Roman Empire by Augustus Cæsar (B. C. 30).

Now the arts had reached their apogee, and coin after coin may be cited as *chef d'œuvres* of the skill of the ancients. The inscriptions became more complex, embracing titles of magistrates, divinities, dates, monograms and similar indications. Regularity and exactness are now more characteristic of the coinage, and the art of striking reached a greater degree of precision than ever before. The mechanical means employed were still simple, and remained so for many centuries ; the remarkable results obtained from such slender appliances are the more noteworthy from that fact.

Fourth. From Augustus to Hadrian (A. D. 117). The decadence of art and the diminution of the importance and prerogatives of the Grecian nations began now more sensibly to make themselves perceptible. The moneys struck by independent cities lessened in number and excellence, and many nations lost their former right of coinage. Copper began to usurp the place of other metals, being issued in much larger quantities than formerly, and the art of coinage commenced to exhibit symptoms of decay, although faint suggestions of former grandeur occasionally occur.

Fifth. From Hadrian to Gallienus (A. D. 260). Great and rapid was the decline of art in this period, full of troubles of all kinds for the empire, surrounded by barbarians, and torn by intestine dissensions.

Sixth. From Gallienus to the fall of the Eastern Empire (1453). The arts fell completely into barbarism during this long interval. There is but little to attract in the coinage of either the Eastern or Western Empires, and much to repel. The coins became harsh and hard, and finally lost all traces of any pretensions to the name of art. The imperial Greek, the Colonial and the Autonomous series had long disappeared, the only circulating medium was the Roman coinage, now became barbarous in the extreme, and small in number.*

The exhibition of coins is in a standing case near the centre of the main room. Naturally it starts with the earliest of all known coinage (about 700 B. C.), the *Persian Daric*, of which an example in silver is shown. It bears on the obverse a kneeling archer, while the reverse is simply the rude punch mark, such as is found only on the most ancient coinages. It is to these coins that allusion is made in the story told of Agesilaus having been overcome by thirty thousand archers, meaning that that amount of Persian daric had been expended to procure his defeat.

Two large silver coins of Athens (known as Tetradrachms from their size), one about 400 B. C., the other perhaps two hundred years later, exhibit the modification of type and change of workmanship. On the reverse, the rude archaic owl in bold relief with great staring eyes has given place to a less aggressive bird; the simple inscription *ΑΘΗ* has received in addition the names of the moneyers; the diota and olive branch lend additional significance to the bird of wisdom. On the obverse, the thoroughly Egyptian type of face displayed on the helmeted head of Pallas has been metamorphosed into the now generally received conventional type of Greek art. In antiquity these coins were known as *maidens*, referring to the spinsterhood of the goddess represented upon them, and also as "owls," from the figure upon their reverse. In one of the Greek dramas a miser is spoken of as having myriads of owls roosting beneath his roof, meaning that he had large quantities of these coins concealed in his house.

A fine Cistophorus of Apamea presenting the sacred *cista* of Dionysos enveloped by serpents is worthy of particular notice. The cistophori are tetradrachms, which bear as their generic type a wreath and berries of ivy, surrounding a chest whence issue serpents, being in reference to those carried in procession by the Bacchantes in their orgies, especially in Asia Minor, where the snake was revered, and considered as an emblem and tutelary god.

All the cistophori which exist are tetradrachms of silver, uniform in weight and fineness, and were struck by some one of the following cities, viz: Apamea in Phrygia, Ephesus in Doria, Laodicea in Phrygia, Pergamos in Mysia, Sardes and Tralles in Ionia.

They were of such exceeding purity and fineness that the Romans would receive no other coins in payment of the tribute moneys exacted from the cities of Asia Minor; for this purpose they were coined in great abundance, and in ancient days were very plentiful, although at the present time they have become of quite rare occurrence.

M. Acilius in his triumph from Corinth, bore in procession 288,000 cistophori, Cn. Manlius Vulso, 250,000; L. Amilius Regillus, after a victory over the Antioch fleet, 131,000; Scipio Asiatica, 331,070. It is probable that these pieces, upon their arrival at Rome, by reason of their superior fineness

* Henin, Numismatique Ancienne, *passim.*

and quality, were at once recoined; a fact which would account for their present scarcity*

Cista mystica existed in the sacred rites of the Panathenæa, of Diana, Eleusinia, Ceres, Theogamia Proserpine, and the Dionysia or orgies of Bacchus.

Upon the tetradrachms of Eleusis, serpents were the symbols surrounding or issuing from the cista, either as representing divine attributes, or the fable of Erichthon. On others, surrounding the chest were various emblems, such as combs, the pudenda muliebre, food, drink or fruits, and it was looked upon as a heinous sacrilege to divulge the meaning of these recondite objects.

A type also exists in which Bacchus, in womanly garb, is figured seated upon the cista mystica, holding in his right hand a thyrsus, below which are two serpents knotted and twined together. Chests, whence serpents are out-issuing, are found on the coins of Anchialis in Thrace, Sardis Nikaea, Pergamos, Perinthos and Teos.

A quinarius of Augustus Cæsar exists, on which is engraved the cista between two serpents, and over which hovers a victory with the inscription ASIA RECEPTA.

A fine tetradrachm of Bœotia exhibits on the obverse the familiar Bœotian shield, and on the reverse, a cippus. The type of the buckler took its origin from the renown acquired by the workmen of this nation from their skill in this manufacture. In Homer we find mention made that the shield of Ajax was made at Hyle in Bœotia. Some authors have imagined it to be a perverted type of the Egyptian scarabæus, while the cippus represents the purifications and lustrations used in the worship of Bacchus. This latter opinion seems to be further borne out by the fact that the head of the Indian Bacchus is also frequently found upon the coins of this country.

A didrachm (*i. e.* a piece of two drachmas) of Tarentum, exhibits Taras, the fabled founder of the city (a son of Neptune), riding upon a dolphin. The coinage of Tarentum is numerous, presenting many different types, is always well executed, and exhibits a high degree of culture and art.

A didrachm of Argos shows on the obverse a running wolf, while the reverse has solely the letter "A" within the rude punch mark characteristic of the ancient period of its coinage.

On Messana we find the type to be a running hare, on the reverse a figure in a chariot, of which the execution while bold is rather rude. Messana is fabled to have been founded about 1600 B. C. under the name of Zancle, an appellation which was changed about 594 B. C. Destroyed by the Carthaginians in 396 B. C., it was subsequently rebuilt, and in 282

*NOTE.—Livius Dec. X. L. VII.

Alex. Xan: Panelius de Cistophoris. Lugdun, 1734.

Rasche Lexicon Rei Numariæ.

B. C., after having been captured by the Mamertines it received the name of Mamertina.

Rhodus presents the radiated head of Apollo, and on the reverse a rose, being a so-called speaking type. Spanheim,* however, considers this flower not to be a rose, but the Punic apple (*Balaustus*), citing Isaac Vossius as his authority. This plant was used for dying vestments, and is still known to the modern Arabs. According to Theophrastus, its flower resembled that of the rose, and Clement, of Alexandria, states that in the Thesmophoric rites women were not allowed to make use of it.

Upon the coins of Massilia (now Marseilles), we find a walking lion of fine workmanship; on Syracuse, the head of Proserpine in an incuse surrounded by dolphins, on the reverse a figure in a chariot. In the coins and medallions of Syracuse, ancient art reached its highest pinnacle of perfection; they are beautiful of design, grand and graceful of execution, bold of relief.

There are coins of Alexander the Great of Macedon, and a fine Tetradrachm of his father, King Philip the Second, bears upon the obverse a powerful head of Zeus, on the reverse, a horseman wearing the hat peculiar to Macedonia, surrounded by the inscription *ΦΙΛΙΠΠΟΥ*. The celebrity of the Macedonian and Thracian horse probably led to its adoption as a national type.

An extremely rare and fine silver coin of Juba the Second, King of Numidia, is noteworthy on account of its historical interest as well for its artistic merits. It bears on the obverse the head of that monarch with curly hair and a conical cap; on the reverse a temple.

A didrachm of Velia, in Lucania, presents a fine head of Apollo, and on the reverse a lion destroying a stag.

Tetradrachms of Antiochus, and one of Lysimachus, of magnificent workmanship and grand design, in the finest possible preservation, must especially claim the attention of the student as examples of Grecian art in its finest stage of development.

These coins are two thousand years old, and are almost as fresh as the day they left the die, while their entire genuineness and authenticity is beyond the faintest cavil or suspicion.

Space will not permit that we should enter into a full description of all the beautiful and artistic objects which this exhibition comprises, and we must content ourselves with a rapid survey of the most salient features of this display.

There are also a number of fine copies of rare Grecian coins, and an especially noticeable selection of forged Roman first bronzes, executed by the celebrated Paduaan forgers, Jean Cavino and Alessandro Bassiano, in the sixteenth century. The work of these artists has long been sought after on account of its exceeding great merits of design and execution, worthy to rank with the best workmen of antiquity. Many of these pieces are pure inventions of the forgers' brains, no originals ever having existed, while

* De usu &c. numorum p. 374, et seq.

others are well engraved counterfeits. These were originally sold only as copies of antiques, but their makers were subsequently induced to dispose of them as genuine.

The boldness of design and power displayed in the treatment of their subjects is of a very high degree of excellence.

The coinage of the ancient Greeks was very rarely (if ever) of a circular form, owing to the imperfection of the processes employed. They did not possess the knowledge of the collar by which in modern times accuracy in striking is ensured, and the result was in many instances that the coin contains only a portion of the device or inscription, the rest having failed to reach the planchet, as there was no means of holding it firmly in place to receive the stroke of the hammer.

The types that occur on the coinage of the ancients are manifold. The bull, the emblem of strength and force, is often found joined to a human head, as on the coins of Gelas, where it signifies human intellect and physical perfection. The bull occurs also in combat with the lion symbolizing the conflict of the fire element (or the sun), and that of water (*i. e.* the bull); this type is often found upon the Persian coinage. The serpent also frequently represents the ocean.

The earliest kings who placed their portraits upon coins, did so under the garb or disguise of gods and heroes; thus Alexander the Great appears as Herakles and Jupiter Ammon; Lysimachus, as the Horned Bacchus, and other examples will readily be found.

Their portraits, professedly as that of human beings, appeared on no coin till after the death of Alexander the Great, and even then the change took place with great caution and circumspection.

The leading characteristic of the coinage of the ancient Greeks, and as such it is to be found even upon their very earliest known specimens, is sublimity.* This arises from the simplicity of thought and object with which these early coins were designed and executed, and is the cause of the calmness and the repose of the Grecian art. Even the most archaic types possess this property, although in the transition stage from the rude to the excellent. Neatness and stiffness constitute archaism in art, and the condition of the early Greek mind has been compared by Humphreys very justly to the quaint productions of the masters of the fifteenth century.

Grecian art attained its highest perfection during the third period to which I have already alluded, viz: From the accession of Philip the Second of Macedon to the final subversion of the Roman liberty under Augustus Cæsar. In the cities of Magna Grecia, it reached a most extraordinary degree of culture, regardless of their not far distant neighbor, the robber city, founded by outlaws, and living by rapine, that city, whose ambition still comprised within petty limits, had not yet broken its bounds to fly its conquering eagles above a prostrate world.

Rome now claims our attention. Its series is composed of gold, silver and bronze. The oldest silver pieces, denarii, are of the value of ten asses

*Humphreys.

(the letter X which so occurs upon them is the exponent of their value), and bear the galeated head of Minerva on one side, on the other the Dioscuri; sometimes on the reverse a biga or quadriga.

Later the names of illustrious families appear on them, whence these have often been termed family coins, as for example, the name of COCLES on those of the Horatian gens; sometimes emblems or types commemorating heroic exploits or punning upon their own names, as upon the coins of Publicius Malleolus we find a hammer, of Valerius Asciculus, a pickaxe; of Aquilius Florus, a flower; of Lucretius Trio, the seven stars (Septemtriones), &c.

Upon certain of these coins we find deities appropriated, thus *Juno Sospita* on the families Cornuficia, Mettia, Pappia, Roscia; *Ceres* on Claudia and Vibia; *Libertas* crowned with laurel and veiled on Sestia; crowned with olive branches on Licinia; crowned with laurel on Junia; veiled on Æmilia and Calpurnia. Sometimes Libertas appears as a female standing, holding in her hand a liberty cap, in her left the rudis, or rod, whose touch manumitted slaves. Upon the early copper coinage of the United States we find the head of liberty accompanied by the cap and rod, being in allusion to this Roman custom.

Among the family coins in the exhibition, there is one of the gens *Cornelia* bearing on the obverse an archaic head of Minerva galeated, and the inscription SULA; one of the gens *Hostilia*, obverse a diademed head of Venus, reverse, a victory walking, holding caduceus and palm branch, inscription SASERN. L. HOSTILIUS. Saserna was the cognomen of this noble family which deduced its descent from King Tullus Hostilius. Some of their denarii bear the head of Pallor or Pavor, to whom that monarch vowed a temple upon the occasion of his battle with the Veiéntes.

A denarius of Julius Cæsar bears an elephant trampling upon a snake which is rearing its head; reverse, the simpulum, adspergillum, apex and securis victimaria, emblems of his pontificate. The elephant is said to refer to his victories over Juba, King of Numidia, and the subjugation of Africa of which it was the symbol. Other authorities consider it as a speaking type, asserting that the word Cæsar, in the Punic tongue, signified an elephant. One author has informed us that these sacred emblems (whose use and meaning is so well known to us) were nothing but the weapons with which the Romans were wont to fight against elephants in time of battle.

Upon a denarius of the gens Scribonia we find on the obverse a female head with the inscription LIBO. BON. EVENT.; reverse a puteal (or well stone) in the form of an altar with the inscription PUTEAL above, SCRIBONIA in the exergue. This is a very interesting coin referring to the puteal in the Comitium built on the spot where the events of the story of King Tarquin and the augur occurred, and where in later days the knife and the whetstone were found buried. Here were oaths taken as an especially sacred place.

Many such puteals abound in Pompeii, in the form of circular altars, richly decorated with sculptures. The one which this coin presents has on each side a lyre suspended with a festoon in the middle and a hammer at bottom. It would seem that L. Scribonius Libo renewed this puteal, whence it obtained his name. It is twice referred to in Horace (Epist. Lib. I. 19. 8., Sat. Lib. II. 6. 34).

In 1812 an altar was found at Veii, in every respect corresponding with this representation, and it is likely that the puteal Libonis served as a model for imitation in other places.

After the decline of Roman liberty the emperors coined gold and silver, but the bronze remained the prerogative of the Senate. Upon the reverse of the imperial denarii occur many interesting types such as Pax, Providentia, Pietas, Fecunditas, Æquitas, Concordia, Tranquillitas, Constantia, Pudicitia, Decursio, Adlocutio, Fides, Spes, Victoria, Fortuna, and a multitude of others. Upon the decease of an emperor, it was the custom to deify him, and to issue coins commemorating the event; they usually bear on the reverse the word CONSECRATIO, and an eagle soaring to heaven, or a chariot drawn by four elephants, or a Phœnix, the head on the obverse being surrounded by rays. When it was a female who received this honor, as in the case of one of the imperial family, the reverse bore a peacock, or a chariot drawn by peacocks, or a carpentum drawn by mules.

The servile adulation which had been their portion in life was not ended even in death.

The very earliest of the Roman coinage was of copper (or bronze), and was issued by Servius Tullius, about the sixth century before Christ. The *As* was the primitive monetary unit of Rome, and although from time to time reduced in weight retained its legal value always unchanged. The coinage of silver, the denarius, quinarius, and the sestertius began about 269 B. C.; gold was first minted about 206 B. C.

One coin alone has preserved to us the monetary implements of the ancients; a denarius of the gens Carisia bears on the reverse the pincers, hammer, anvil and bonnet of Vulcan.

When the first Triumvirs placed their own effigies upon the coins, they gave a great shock to the ancient habits and superstitions of the Roman people by displacing the old traditionary types of gods and goddesses. Pompey and Cæsar were the first to set the example, which was followed by their relatives and their successors in authority, although by some authors it is held that the head of Pompey was not placed upon coins until after his death, and that it was then done by his sons.

Among the imperial Roman series are many fine and rare coins, starting from Julius Cæsar and coming well down to the later days of the Byzantine empire. There are pieces of Augustus, Agrippa, Mark Antony, Antoninus Pius, Ælius Cæsar, Caracalla and Geta, Domitian, Claudius, Caligula, Elagabalus, Gallienius, Herennus Etruscus, Hadrian, Julian the Second, Maximinius, Marcus Aurelius, Philippus, Pertinax, Titus, Trajan, Vespasianus, and many others. They all bear the image of the emperor on the obverse, and on the reverse in many instances commemorate important events. They are in no way remarkable for the art displayed upon their coinage, and maintain their chief interest from their historical associations, while their claims to be regarded as exhibiting a graceful execution are very slight when we compare them with the *chef d'œuvres* of the Grecian artists. The arts never flourished in Rome as they did in Greece, they were never indigenous to the soil that bore a band of rugged heroes.

The coinage of the Roman nation, from its earliest inception down to the capture of Constantinople by the Turks, presents to us a lengthy and uninterrupted chain for two thousand years. Upon the series are preserved to us the portraits of the monarchs, their wives and families, relations and generals; it forms a connecting link between the misty, shadowy realm of the forever past, and the living, breathing, moving present of to-day.

Upon the coinage are found their wars and conquests and expeditions, imperial voyages to distant portions of the empire, valuable historical facts and epochs. We shall take occasion later to more fully advert to these interesting records.

Coins of the Sassanidæ, the rulers of the second Persian empire, from about 226 A. D. to 651 A. D. are curious and interesting. They are thin flat silver coins, bearing on the obverse a bust of the monarch wearing a peculiar head dress, on the reverse a fire altar stands between two figures dressed in the old Persian garb (representing respectively the genii of good and evil), and an inscription in Arian characters is at the side. These coins are of uncouth and barbarous design and workmanship, and represent a period of decadence in art before the Mohammedan conquest had prohibited the representation of the human figure as idolatrous.

The art of coinage, as carried into the East by Alexander the Great, remained in Bactria and India for many centuries, where money was long coined with inscriptions in the Greek languages, the coins of the Arsacidæ in Armenia, and of the Sassanidæ in Persia, bringing the mintages of Central Asia down to a comparatively recent period.

We now come to the coinage of Great Britain, as being a good connecting link between the Roman and the modern eras of coinage. A very heavy and uncouth gold British coin of remote antiquity, perhaps of a period even before the days of Cæsar, marks the beginning. Then in regular order come the rude coinages of the various early monarchs (too familiar to require description here), pennies, groats, &c., &c., broad gold pieces of James I., Charles I., and the Commonwealth of England; a very fine crown of Queen Elizabeth; gold "touch pieces," given by Kings Charles the Second and James the Second, to those unfortunate beings whom, in conformity with the superstitions of the times, they "touched" to cure the King's evil; a fine Gothic pattern crown of Queen Victoria, but never adopted for the national coinage.

Coins of Philip and Mary, bearing both their heads. These were current until a comparatively recent date, and were referred to in Hudibras:

"* * * * * cooing and billing,
Like Philip and Mary upon a shilling."

Scotland is represented by coins of John Baliol and Alexander the Third, and a fine dollar, bearing the name of Queen Mary and her husband, the ill-fated Darnley. Upon the reverse of this coin is a yew tree, popularly supposed to be the one which grew in the court yard of Darnley's residence at Cruikston, from which circumstance this coin is known as the "Cruikston dollar."

There are also a number of coins of the English sovereigns struck for Scotland and Ireland, and various siege pieces of Charles the First, who never in all his extremities resorted to the expedient of a debased coinage.

Germany, rich in silver mines, exhibits a number of fine crowns of different emperors, dukes, bishops, &c., &c. ; and a coin of Vladislaus of Poland (a noble kingdom, for centuries the bulwark of Christendom against the Turk, in the end despoiled and devoured by the very monarchies which its valor had preserved). These pieces range from 1586 to 1689. There are also many silver pieces of the various countries, comprising the Netherlands, such as Gueldres, Zeeland. Campen, &c., &c.

A full line of Spanish and Portuguese coins carries us from the sixteenth century to the present time, among which, is a silver dollar of Philip the Second of Spain, on which among his titles appears that of King of England.

France is represented from Henry the Fourth, including a number of silver ecus of various monarchs. On those of Louis the Fourteenth, we can trace the progress of his years, his coins exhibiting him in various stages from youth to old age. Louis XV. is shown as a very handsome young man. There are also coins of Louis XVI., Napoleon, Louis XVIII., Louis Phillippe, Charles X., the Republic of 1848, Napoleon Third, and the present Republic.

Russia shows specimens of the platinum coinage, which, after a short trial, was abandoned as an unsuccessful experiment, and which is very rare.

The coinage of the Orient is largely represented, including a full set of the rare and curious "bullet money," from Siam, formed by bringing together the ends of oval pieces of silver, and on each piece is stamped a minute mark showing its value. Each "bullet" is perfectly symmetrical and its weight is very accurately and carefully proportioned to that of the other pieces. They are eight in number, and are named Pie, Sungpee, Fung, Salung, Song Salung, Tical (or Bat) Songbat, Sibat.

There are some curiously stamped coins from Cochin China, long and narrow in shape.

Japan presents a full set of gold, silver and copper coinage, both ancient and modern, the liberal gift of Lieutenant Paul, U. S. N., to the Numismatic and Antiquarian Society of Philadelphia, upon his return from the Orient.

There are coins of the great Orkan, and also a complete series of thirty-three Ottoman monarchs, the successors of Mahomet, very rare but barbarous in art and uninteresting, save from historical association.

There are specimens of the coinage of the Caliphs of Bagdad, and of the Moorish rulers of Spain.

There are also some of the "chopped" money, current in China, where the custom exists of mercantile houses placing their "chop" (or guarantee firm name) upon all the silver money that passes through their hands. The effect of this is very soon to render a coin utterly unrecognizable through the multiplicity of "chops" that it had received.

Scandinavia presents nothing remarkable, except the copper *dalers*, issued in the reign of Charles XII., when his insatiate thirst for glory had almost reduced his kingdom to beggary. To obtain the necessary revenues for carrying on his mad career he issued small copper pieces which were to be a legal tender for a dollar. The experiment failed, after working the usual amount of hardships, and its originator, Baron Goertz, paid with his life the penalty of its ill-success.*

In America we find an uncirculated cent of 1793, a beautiful head with flowing hair, an object far more tasteful than the last design with which the authorities of the United States mint have favored us. The very rare silver piece coined by Louis XIV., for circulation in the Franco-American colonies, known as the *Gloriam regni*, exists here in fine condition, as also the Rosa Americana half penny, coined for circulation in British North America, in the reign of King George the First; Georgius Triumpho, Immunis Columbia, Bar Cent, Nova Constellatio, Talbot Allum and Lee (of New York) cent 1794, the Higley copper, coined in Connecticut in 1737, Nova Cæsarea, Vermont, Virginia, Nova Constellatio, Connecticut and Massachusetts coppers, Massachusetts shilling and three pence of 1652 (of which former coin it is narrated that the daughter of the mint master was given her weight as a dowry, she standing in one scale while the money was poured into the other), the sixpence issued in 1783, by I. Chalmers, a jeweller at Annapolis, a very fine Washington cent 1791, large eagle, a number of fine proof-sets and coins of the United States Mint, including the pattern dollar of 1836, the set of pattern cents of 1858, the pattern cents of 1850, 1855 and 1854, the set of pattern half dollars of 1868.

Among the patterns is a *goloid metric* dollar, a composition, the invention of William Wheeler Hubbell, Esq., which was proposed as being especially adapted for the coinage of the standard dollar. It contains gold, silver and copper in fixed proportions, but presents the feeling and appearance of a very light silver coin. Of these patterns there were not more than twenty-five struck and it is of the greatest rarity.

There is the general and customary assortment of the coins usually incident to the American series, a series which contains very little either of beauty or of interest, so that in the present instance where our aim was mainly to exhibit *Art* no attempt has been made towards a display of mere numismatic rarities.

*The names of this series are as follows:

Crown	1715.	Saturn	1718.	Flink och fardig	1719.
Pallas	1716.	Jupiter		Hopel	
Publica fides	1717.	Mars		Goertz's Head.	
		Mercury			
		Phœbus			

The object in hand is to show Art in its origin, growth and progress ; Art as a hand-maid for the illustration of mythology and the elucidation of history ; Art as an interpreter of the classics, where many obscure passages find upon coins their only true solution. Treatise after treatise has been written to show the advantage to be derived from the study of ancient coinages. Agostino, Goltz, Strada, Eckhel, Spanheim, and a myriad of others have contributed their stores of knowledge to the general fund.

Coins throw light upon the history of nations, their forms of government, the political condition of their citizens ; they indicate the classification of their inhabitants ; they serve to fix the successions of monarchs, the events of their reigns, and the dates of eras. They have preserved to us the names of a multitude of civic magistrates and rulers, their offices and functions. They have presented to us the images of sovereigns and great personages of history, the heroes of antiquity, poets, painters, philosophers, and sages, gods, goddesses, demigods, legislators and women of fame. They have added largely to our geographical knowledge of the ancient world, exhibiting rivers and fountains, seas and mountains, rocks and other characteristics of places. Many cities have borne different names at various times and coins alone have authenticated their proper attribution. Coins bear frequently types which relate to the religions of the ancient world, both as representing persons, ideas, creeds, shrines, temples, altars and places of worship, sacrifices, utensils and sacred objects. The holy stone to whose worship Elagabalus was consecrated, Diana of the Ephesians, and many similar devices exist on coins.

Many customs are found on coins, such as *congiaries*, *games*, *allocutions*, &c., and ornaments and forms of dress are also thus preserved to our times.

Architecture has also been enriched by the edifices, bridges, arches, columns, monuments and similar objects which historians have not fully described, as being too familiar a subject or else have totally passed over, not being then in existence.

When we consider the vast extent of the riches and possessions of so many of the potentates and states of antiquity, the enormous quantity of ancient coins which have survived to our times should not surprise us. The antique earth was a world of commerce, as is our modern globe of to-day ; for the requirements of a commerce, which we know was an extensive one, large quantities of circulating medium were necessary, and the great mines of the archaic days furnished immense supplies of the precious metals. The Syracusans, the Athenians, Philip the Second of Macedon, Alexander Magnus, the Ptolemies of Egypt, and lastly the Romans, all issued great quantities of coined money during long centuries ; they were all wealthy and prosperous. In the Royal collection at Paris, probably the finest in the world, there are representative coins of sixty-five thousand different nations, cities and princes ; the whole number of coinage issued, it is supposed, would amount to about one hundred thousand.

The interest which attaches to the earliest day-dawn of civilization upon this planet, to human life in its first development in the far distant past, is heightened by the perusal of these tokens which serve as a connecting link between those who live this day and have their being and those who lived three thousand years ago, who saw these works of art as they issued forth fresh from the coiner's hand; who ate, who drank, who slept, who died while these coins were still in their first infancy. Strange customs and curious ethnological facts, traits and coincidences have been displayed or developed upon coins, the records of the earth verified and brought to light. The world's epitome is here; history, geography, philosophy, religion, all bear their part.

Thrice happy he the gifted mortal who can lift the veil and read the secrets of the dusky night.

Stated Meeting, February 21, 1879.

Present, 8 members.

Vice-President, Eli K. Price, in the Chair.

Photographs for the album were received from Mr. John Ericsson, and Mr. William Ewing Dubois.

Letters of envoy were received from the Rev. F. C. Ager, Secretary A. Swedenborg Printing and Publishing House, New York; from the Board of Commissioners of the Second Geological Survey of Pennsylvania, and from the Meteorological Office of the Royal Society, London.

Letters of acknowledgment were received from the Museum of Comp. Zoölogy, Cambridge, Massachusetts (102); the Historical Society of Pennsylvania (102); the American Chemical Society, No. 11 East Fourteenth Street, New York City (65 to 102 inclusive); from Mr. William Bower Taylor, 457 C. Street, Washington (102); Wisconsin State Historical Society, Madison (102); Royal Geological Society of Ireland (100 and List); West Chester Philosophical Society (65 to 102 inclusive); New Hampshire Historical Society (102); Poughkeepsie Society of Natural History (102); Rhode Island Historical Society (102); Numismatic and Antiquarian Society, Philadelphia (102); New Jersey Historical Society (102); Georgia Historical Society (102); Davenport Academy of Natural Science (101, 102), and from numerous members acknowledging the receipt of their copies of the Proceedings (102).

A letter was received from the Royal Library in Strasbourg asking for further exchanges and donations.

A letter was received from Mr. Austin Winsor, Librarian of Harvard College, one of the Committee of the Massachusetts Historical Society, asking permission to examine and compare the Lee MSS. in the Library with the Lee MSS. in the possession of the Cambridge Library in Gore Hall, and to publish desirable portions of the same.

On motion it was resolved that the Librarian be authorized to forward the Lee MSS. to the Committee, with permission to publish the same, returning the originals in good order to this Society.

Donations for the Library were received from the Zoologischer Anzeiger, Leipsig; the Bordeaux Society of Commercial Geography; Revue Politique, Paris; Mr. Thomas Clark, London; Editors of Nature; Museum of Comparative Zoölogy, Cambridge, Massachusetts; Cornell University; American Chemical Society, and Swedenborg Printing and Publishing Society, New York; Brooklyn Entomological Society; Franklin Institute, and Medical News, Philadelphia; Smithsonian Institution and Light House Board, Washington; Wisconsin Academy; Geological Survey of Pennsylvania; and the Ministerio de Fomento, Mexico; and in addition to the above, an engraving of a medal, found among Franklin's papers, was presented to the Society by Mr. J. Dickinson Sergeant, 420 Walnut Street, Philadelphia.

The death of Prof. Elia Lombardini, of Italy, December 19, 1878, aged 84 years (born October, 1794), was announced by the Secretary.

A communication entitled, "Further Confirmation of Prediction, by Pliny Earle Chase," was read by the Secretary.

A communication from a private letter respecting the great gas well lately struck at Murraysville, in Westmoreland county, Pennsylvania, was read by the Secretary, as follows:

"The newspapers have doubtless informed you of a wonderful *gas well* recently bored in the village of Murraysville, in this county. It is about twelve miles north-west of this place, and is the result of an effort to obtain petroleum. At the depth of 1350 feet the rush of gas was so great that further boring was prevented. The tube now inserted in the well is five and a half inches in diameter, and through this the gas rushes with a roar that is heard distinctly at a distance of two miles.

"A few days ago I formed one of a party to visit it, and I will now try to convey to you an idea of its importance. In the 'derrick room' a horizontal tube has been placed on the top of the main tube, and at right angles with this, four two-inch tubes have been fastened, two of them on the north and two on the south side, each pair about six feet apart, thirty feet in length, and raised three feet above the common level. At night a match is applied to the open end of each tube, and instantly the whole country around is lighted up with a brilliancy that eclipses the moon at the full. At a distance of twenty feet the heat is intense."

Mr. Lesley explained that the boring commenced in the upper half of the Barren Measures, beneath the Pittsburgh coal bed, and penetrated the Carboniferous rocks, to a depth corresponding nearly with the horizon of the Berea Grit, which holds petroleum, in Ohio. This horizon of gas seems to correspond within one or two hundred feet with that of the well-known Leechburg gas well on the south side of the Conemaugh River, some miles north of Murraysville, described in Report of Progress (L) of the Second Geological Survey of Pennsylvania, page 124.

A communication entitled "A contribution to the Geology of the Lower Amazonas; by Orville A. Derby, M. S.," Assistant to the late Prof. Hartt, Geologist of Brazil, was read by the Secretary. (See page 155, above.)

Dr. König exhibited his improved chrometric apparatus; but on account of the small attendance of members, postponed a fuller description to the next meeting.

Pending nomination No. 872 was read and the meeting was adjourned.

Further Confirmations of Prediction. *By Pliny Earle Chase.*

(*Read before the American Philosophical Society, Feb.* 21, 1879.)

Th. von Oppolzer (Comptes Rendus, Jan. 6, 1879), gives elements, deduced from eight supposed planetary sun spots, which represent the fifth of my intra-Mercurial harmonic positions :

	Distance.	Time.
Von Oppolzer	.123	15.8 dys.
Chase, predicted.............	.120	15.1 "

This leaves only one vacancy in the chief interior series, the fourth place being still a "missing link." There is room, however, for an indefinite number of subordinate, or asteroidal harmonies, one of which has been confirmed already, by Gaillot's orbit for Watson's second planet :

	Distance.	Time.
Watson, II..................	.180	27.98 dys.
Chase......................	.183	28.48 "

The predicted harmonic denominator-difference was 4. But the denominator-difference in the principal planetary belt is only 2. The following table shows the agreement between prediction and verification :

Prediction.		Verification.	
$\frac{1}{13}$ of 3.469 =	.267	De la Rue, Stewart and Loewy	.267
$\frac{1}{17}$	.204	Kirkwood	.209
[$\frac{1}{19}$	.183	Watson, II	.180]
$\frac{1}{21}$	.165	" I	.164
$\frac{1}{25}$	.139	....	....
$\frac{1}{29}$	.120	Von Oppolzer	.123

Six remaining terms of the prediction, with a denominator-difference of 144 ($\frac{1}{33}$, $\frac{1}{177}$, $\frac{1}{321}$, $\frac{1}{465}$, $\frac{1}{609}$, $\frac{1}{753}$), represent, as I have already shown,* harmonies of rotation and revolution, thus confirming my hypothesis that rotation is due to the collisions of orbital particles, in the neighborhood of a nucleal focus.

Lescarbault's observation is one of the three for which the exact time is given. Von Oppolzer attaches special importance to those observations, and to the confirmation which they derive from the five other observations which he has compared with them. His orbit, therefore, appears to be that of the *true* Vulcan for which Leverrier looked. If this proves to be the case, other names must be sought for the remaining planets, or for the harmonic sun-spot periods, if any of them do not represent permanent planets.

* Ante, xviii, 35-6.

Stated Meeting, March 7, 1879.

Present, 18 members.

Vice-President, Mr. E. K. Price, in the Chair.

A photograph of Sig. Giovanni Capellini, of Bologna, was received.

A letter declining the appointment to prepare an obituary notice of the late Dr. J. B. Biddle, was received from Mr. H. C. Chapman, dated 2305 Walnut street, February 21, 1879.

A letter acknowledging the receipt of Byington's Choctaw Grammar in MSS., on loan, was received from Major J. W. Powell, dated Washington, Department of the Interior, March 5, 1879.

Letters of thanks, acknowledging the safe reception of two volumes of MSS. Lee Papers, on loan, was received from Mr. Justin Winsor, for the Massachusetts Historical Society, dated Cambridge, Gore Hall, February 27, and March 5, 1879.

Letters acknowledging receipt of Proceedings, were received from the Natural History Society, Frankfurt am M. (100 and List); and the Rantoul Literary Society (102).

Letters of envoy were received from the Central Physical Observatory, St. Petersburg, Jan., 1879; the Natural History Union at Riga, June 15, 1878; the Geological Commission, Berne, Nov. 19, 1878; the Swiss Society, Berne, Sept., 1878; the National Library at Florence; the Accademia dei Lincei, Rome; and the Meteorological Office in London, Feb. 9, 1879.

Donations for the Library were received from the Geological Survey of Victoria, Melbourne; Imperial Society of Naturalists, Moscow; Natural History Union, Riga; Central Bureau of Statistics, Stockholm; Zool. Anzeiger, Leipsig; Verein für Erdkunde, Dresden; Senkenburg Society, Frankfurt a M.; Oberhess. Gesellschaft Giessen; Société Helvétique, Lausanne; M. Henri de Saussure, Geneva; Herr L. Rütimeyer, Zurich; Commission Géologique Fed. Berne; R.

Venetian Institute, Venice; R. Academy of Sciences, Turin; R. Lombardy Institute, Milan; National Library, Florence; R. Geological Committee of Italy, Rome; R. Accademia dei Lincei, Rome; Sig. G. Capellini, Bologna; the late Prof. E. Lombardini, Milan; R. Academy, Brussels; Geological Society, and Revue Politique, Paris; Society of Commercial Geography, Bordeaux; R. Astronomical Society, R. Geographical Society, Society of Arts, Meteorological Office, and Nature, London; Philosophical and Literary Society, Leeds; Prof. Aug. R. Grote; Dr. W. J. Hoffman; American Journal, New Haven; Mr. Mansfield Merriman, New Haven; New Jersey Geological Survey; Germantown Dispensary; Journal of Pharmacy, Medical News, and Robinson's Epitomy of Literature, Philadelphia; Botanical Gazette, Madison Ill.; Wisconsin State Historical Society; and the Kansas State Historical Society, Topeka.

The death of Dr. J. H. McQuillen, at Philadelphia, March 3d, aged 53 years (born Feb. 12, 1826), was announced by Mr. J. Sergeant Price.

On motion, Dr. Kenderdine was appointed to prepare an obituary notice of the deceased.

The death of Mr. E. Spencer Miller, March 6th, aged years, was announced by Mr. Price.

On motion, Mr. Furman Sheppard was appointed to prepare an obituary notice of the deceased.

Dr. König made a communication upon his chromatic method of chemical analysis. Mr. Frazer and Dr. König discussed the subject.

Mr. Cope presented for deposit in the Library a copy of the last number of the Bulletin of the Geological and Geographical Survey of the Territories (Vol. V, No. 1); and in doing so invited the attention of the members present to certain statements which he had published therein, concerning the age and extent of Western strata belonging to the Permian and Tertiary epochs; and mentioned the characters of two species of a new genus of Perissodactyls which he desired to name *Anchisodon quadriplicatus* and *tubifer*.

Mr. Haupt exhibited photographs of the apparatus of the Pneumatic Tramway Engine Company, and read extracts from a report to show the greater economy and efficiency of this method of propulsion by compressed air, over the results obtained by the use of horse-power.

Pending nomination No. 872, and new nominations Nos. 874, 875, 876 and 877 were read, and the meeting was adjourned.

Stated Meeting, March 21, 1879.

Present, 13 members.

Vice-President, Mr. Fraley, in the Chair.

A letter accepting the appointment to prepare an obituary notice of the late Judge John Cadwalader, was received from Mr. Peter McCall, dated March 13th.

Letters of acknowledgment were received from the Prague Observatory (101); the Meteorological Institute, Vienna (101); the Lisbon Academy (100; List); and the American Antiquarian Society, Worcester, Mass. (101).

Letters of envoy were received from Mr. W. B. Rawle, dated Philadelphia, March 7, 1879; and from the U. S. Naval Observatory, Washington, D. C., March 17, 1879.

Donations for the Library were received from the Melbourne Mining Department; Imperial Society of Naturalists, Moscow; Central Bureau of Statistics, Stockholm; R. Prussian Academy; Zool. Anzeiger, Leipsig; Revue Politique, Paris; Society of Commercial Geography, Bordeaux; Victoria Institute, and Nature, London, Literary and Philosophical Society, Quebec; Essex Institute; Mass. Historical Society; Boston Natural History Society; American Antiquarian Society, Worcester; Franklin Institute; Mr. Wm. Brooke Rawle of Philadelphia; U. S. Geol. and Geog. Survey; U. S. Naval Observatory; Dr. A. C. Peale; Mercantile

Library Association, San Francisco; Ministerio de Fomento, and V. Reyes of Mexico; and the R. Academy of History in Madrid.

The death of Mr. Henry J. Williams, at Philadelphia, on the 12th instant, aged 86, was announced by Mr. J. S. Price.

On motion, the Hon. M. Russell Thayer was appointed to prepare an obituary notice of the deceased.

The death of Mr. Jacob B. Knight, at Philadelphia, on the 10th instant, aged 48 years, was announced by Mr. Price.

On motion Dr. Charles B. Dudley, of Altoona, was appointed to prepare an obituary notice of the deceased.

A communicatien for the Magellanic premium, entitled "Epi- and Hypo-cycloidal Linkages," was presented, and was, on motion placed in charge of Prof. J. P. Lesley, for the examination of members, and for reference to the Board of Officers and Council: accompanying this communication is a sealed envelope, inscribed X. Y. Z.

Prof. Sadtler presented a paper entitled, "Analysis of a Calculus found in a deer, by Edgar F. Smith," and another entitled "On a new and delicate chemical test for iron: by Edgar F. Smith."

Mr. Henry Phillips, Jr., read a brief account of the earthquake which occurred at Aachen (Aix la Chapelle) on Monday, the 26th of August, 1868.

Dr. Norris exhibited a microphone, in which the grating sound frequently heard was prevented by the pressure of a small spring upon the carbon rod.

Pending nominations 872, 874, 875, 876, 877, were read.

Prof. Marks exhibited some pieces of coal representing the theoretical limits of the power of coal, measured by foot pounds and horse power.

And the meeting was adjourned.

Analysis of a Calculus found in a Deer. By Edgar F. Smith, Ph.D.

(Read before the American Philosophical Society, March 21, 1879.)

This rather interesting specimen was given me by Mr. Hall, student in the Medical Department of the University. It was found by him in the pelvis of the kidney of a doe, which had been shot by a party hunting in the north-western portion of this State.

As the investigation of such calculi very frequently affords some interesting results, I subjected this specimen to both a qualitative and quantitative examination.

The size of the calculus was equal to that of the egg of a pigeon. It possessed a fawn color and consisted of three layers encircling a rather large nucleus, which presented a granular sandstone-like appearance. The layers were exceedingly thin, and seemed to have grown out from carbonaceous deposits, which were detected in various portions of the calculus.

Upon testing the nucleus qualitatively the presence of silica, ferric oxide, calcium oxide and phosphoric acid was clearly shown. The surrounding layers were found to contain calcium and magnesium oxides, phosphoric acid, sodium, potassium, uric acid and another organic compound. The latter was extracted from the finely divided material by boiling the same for some time with alcohol. The alcoholic filtrate yielded upon evaporation a gelatinous mass, which proved to be the sodium salt of an acid, which formed strong, colorless needles, exhibiting an hexagonal structure. Upon gently warming this crystalline mass with a grain or two of sugar and a drop of concentrated sulphuric acid, a beautiful purple color appeared. It is true, several acids occurring in the bile give the same reaction with sugar and sulphuric acid, but not any of them, that I am aware, possess the crystalline form of the above compound, nor yield a sodium salt similar to that mentioned above. The only acid which in the least corresponds to the previous description is that known as *Lithofellic Acid*, which was discovered a number of years ago* in a variety of the deer family. The want of sufficient material prevented me from making other and more decisive tests to discover the real character of this compound.

As the layers surrounding the nucleus were alike in chemical composition they were finely divided and a qualitative analysis made of the mixture.

Analysis.

43.15 %	P_2O_5.
.91 %	MgO.
2.60 %	Loss on ignition.
2.50 %	CaO.
51.00 %	alkaline oxides.
100.16	

Detection of Iron by means of Salicylic Acid. By Edgar F. Smith, Ph.D.

(*Read before the American Philosophical Society, March* 21, 1879.)

While working upon various substitution products of salicylic acid I had frequent occasion to filter solutions of the latter acid and its derivatives, and during this operation was continually annoyed by the constant appear-

* Annalen d. chem. u. Phar. 39, p. 237.
" " " " 242.
" " " 41, p. 150.

ance of the beautiful purple color, which is produced when salicylic acid is brought in contact with ferric salts in solution. The best quantitative filter paper invariably gave a deep purple coloration, and as the paper was considered pure enough for all analytical purposes, a few tests were finally made with a view of learning approximately the amount of iron which could be detected by means of salicylic acid. As the halogen substitution derivatives of the acid give purple color with ferric salts several of them were also experimented upon with the results recorded below.

A litre of water containing one grain of iron as chloride was employed in the preparation of the iron solutions.

Salicylic Acid and Iron Solution.

(1) The $\frac{1}{1000}$th of a grm of iron—in a drop or two of water—gave a distinct violet color, when mixed with as much salicylic acid as could be taken upon the end of a small knife blade. The acid was usually dissolved in three or four drops of alcohol. In the following tests the same quantity of acid as above was used.

(2) The $\frac{1}{40,000}$th of a grm of iron—treated as in (1) gave distinct purple coloration.

(3) The $\frac{1}{80,000}$th of a grm of iron—same as (2).

(4) The $\frac{1}{200,000}$th " " —decided purple color.

(5) The $\frac{1}{400,000}$th " " —distinct purple color.

(6) The $\frac{1}{3,200,000}$th " " —visible color.

(7) The $\frac{1}{32,000,000}$th " " —very faint coloration.

Metachlorsalicylic Acid (Fuses at 172°C.) *and Iron Solution.*

(1) The $\frac{1}{40,000}$th of a grm of iron—beautiful purple color.

(2) The $\frac{1}{80,000}$th " " —deep purple.

(3) The $\frac{1}{400,000}$th " " —faint purple color.

(4) The $\frac{1}{800,000}$th " " —faint purple color, but more distinct than that produced by ordinary salicylic acid.

(5) The $\frac{1}{1,600,000}$th " " —very faint color.

Dibromsalicylic Acid (Fuses at 218°C.) *and Iron Solution.*

The $\frac{1}{40,000}$th of a grm of iron—remarkably deep purple color.

The $\frac{1}{80,000}$th " " —very deep purple color.

The $\frac{1}{160,000}$th " " —distinct purple color.

The $\frac{1}{1,600,000}$th " " —barely visible color.

Upon adding a drop of a potassium sulphocyanide solution to one containing the $\frac{1}{80,000,000}$th of a grm. of iron a distinct red color was noticed. Farther tests were not made.

I noticed, however, that salicylic acid was a decidedly good reagent for iron in the presence of an excess of copper. In fact it is more delicate than sulphocyanide in such cases.

Laboratory of the University of Pennsylvania, March 21, 1879.

A Brief Account of the Earthquake at Aix la Chapelle (Aachen) on Monday, August 26, 1878. *By Henry Phillips, Jr., A. M.*

(*Read before the American Philosophical Society, March* 21, 1879.)

For several days prior to this occurrence the weather within a circuit of one hundred miles had been excessively rainy and quite cool for the season. Sunday, August the 25th, was chilly and lowering, although the barometer seemed inclined to rise. The next morning (Monday) dawned with rain falling in torrents, which continued at intervals during the remainder of the day and the whole of that night, driving the strangers visiting at Aix to seek refuge within their hotels and lodging houses. At about five minutes before nine o'clock in the morning a heavy shock of an earthquake, recurring in several waves, was experienced, and again, although of fainter intensity, at 9.05, 9.30 and 11.05, in the forenoon of the same day.

The first (viz., that at 8.55) was the most violent, moved in the direction from north north-west to south-south-east, the vibrations continuing in this plane for several seconds. A very heavy rolling, rumbling sound, apparently *not* subterranean, resembling that caused by the simultaneous passage through the streets of cumbersome deeply-loaded wagons, accompanied the disturbance.

In the upper portions of the dwellings the brunt of the shock was most forcibly felt; glassware and crockery were thrown down from their places and shattered on the floor, the window panes were rattled with great force, the bedsteads were swung in the direction of the motion. In the hotel where I was sojourning there was great consternation, and ladies rushed out terrified into the corridors, believing the building was about to fall upon them. I was at that moment ascending the grand stairway of the hotel, when I was suddenly seized, as I imagined, with a dizziness; everything reeled or rolled before me, the steps seemed to come towards and recede from me, and I seated myself, believing that I was suffering from an attack of vertigo. After a few seconds I perceived by the confusion of surrounding people that there was something really amiss. The oscillations became more and more violent, and it seemed as though the whole town was about to be laid in ruins. Many chimneys were demolished, the stone base of a weathercock on the Deaf Mute Asylum was thrown to the ground, a figure of an angel in the Church of the Holy Cross fell, striking terror into the hearts of the early worshipers, who fled in dismay, the officiating priest and his assistants escaping with great difficulty.

The long continuance of the first shock wrought a strong impression upon the inhabitants, who, pallid and trembling, rushed forth into the streets, while others stood with fixed gaze in the open air, as if paralyzed by fear or rooted to the ground. Some in their anguish fell upon their knees in prayer, calling loudly upon the saints in heaven for their intercession and protection. The market women, the letter carriers and all those whose business required them to be out at this early hour in the morning were witnesses of many ridiculous spectacles.

Surmounting the Polytechnic Institution there stands a colossal statue of Minerva, from which the hand and the point of her lance were broken off by the shock, and great rents were made in the bust, knees, head and the folds of its drapery. Two of the smaller turrets of the Treppen-haus portion of Rath Haus were said to be so seriously damaged as to involve their removal.

The barometer marked as follows :

Sunday, August 25, 10 P. M., 27.3.
Monday, August 26, 6 A. M., 27.282.
" " 9 A. M., 27.21.

The first shock is reported to have lasted about ten seconds, those which were later were less violent as well as shorter in their durations. It is a noteworthy fact that the last two earthquakes with which the city of Aachen has been favored have likewise taken place at an early hour of the morning; that of October 22, 1873, at 9.45 A. M., and that of June 24, 1877, at 8.50 A. M.

The disturbance was by no means a local one, but extended as far as the Hague, being experienced with considerable violence at Cologne, Brauweiler, Horrem, Forst, Altenberg, Herzogenrath, Stolberg, Elberfeld, Osnabrück, Barmen, Graflenich, Eschweiler, Düsseldorf, Nivelsteen, Lennep, Mountjoie, Linn, Jüngersdorff, Haum, St. Töuis, Reviges, &c., &c.

On Tuesday, August 27, the weather altered, being cool and showery in the forenoon and clear and bright in the afternoon and evening.

Stated Meeting, April 4, 1879.

Present, 15 members.

Vice-President, Mr. ELI K. PRICE, in the Chair.

A letter accepting the appointment to prepare an obituary notice of the late Henry J. Williams, was received from the Hon. M. Russell Thayer, dated Philadelphia, March 31, 1879.

A letter declining the appointment to prepare an obituary notice of the late Dr. McQuillen, was received from Dr. R. Kenderdine, dated Philadelphia, March 25, 1879.

On motion of Dr. R. E. Rogers, he was excused, and Dr. Agnew was appointed to prepare an obituary notice of the late Rev. Dr. Beadle.

A letter was received from Mr. Henry Bradshaw, Librarian of the University of Cambridge, England, respecting certain numbers of the Proceedings of the American Philosophical Society in that University Library.

On motion, the Librarian was directed to complete a set for the University as far as practicable, and place the Library of the University on the list of correspondents to receive the Proceedings.

A letter of acknowledgment for (102) was received from the Museum of Comparative Zoölogy, Cambridge, Mass.

A letter from M. Léon Bigot, dated 9 and 10, Rue de Manoir Petit Queval pris Rouen, was read, requesting to be made a corresponding member.

Donations to the Library were reported from the Asiatic Society of Japan; Geological Survey of Japan; Swedish Bureau of Statistics; Zool. Anzeiger; Royal Accademia dei Lencei; Geographical Society, Annales des Mines, and Reveu Politique, Paris; Society of Commercial Geography, Bordeaux; M. Ch. Martins, Montpelier; London Nature; Canadian Naturalist; Essex Institute; Boston Natural Historical Society; Harvard College Observatory; New Bedford Free Public Library; American Journal of Science and Arts, and Prof. Norton, New Haven; Academy of Natural Sciences, Numismatic and Antiquarian Society, Mr. S. W. Roberts, Prof. F. Prime, Mr. Jas. J. Barclay, and Robinson's Epitome, Philadelphia; Johns Hopkins University, Baltimore: U. S. Naval Observatory and Department of the Interior, Washington; St. Louis Public School Library; and the Ministerio de Fomento, Mexico.

A donation for the cabinet was received from the Numismatic and Antiquarian Society of Philadelphia, with a letter from its Corresponding Secretary, Mr. Henry Phillips, Jr.

The donation consisted of a bronze medal struck to commemorate the Twenty-first Anniversary of the Society, and the Twelfth Anniversary of the Presidency of the Hon. Eli K. Price. On the obverse, the effigy of Mr. Price; on the reverse, the seal of the Society as described in a pamphlet given to the Library.

The death of Dr. George B. Wood, President of the Society since 1859, at his residence in Philadelphia, on the 30th ult., aged 82 years (on the 13th ult.), was announced by Mr. Fraley, with appropriate remarks, who then moved the following resolutions:

Resolved, That Dr. Alfred Stillé be requested to prepare and publicly deliver an eulogium on the life and character of Dr. George B. Wood, late President of the Society; and that a Committee of five members be appointed to make proper arrangements for the delivery of said eulogium.

Resolved, That as a testimonial of the respect of the Society for the memory of Dr. Wood, and of its regret for his death, the President's Chair be draped in mourning for six months.

Dr. Rogers, in seconding the motion, spoke of his own intimate relations with the deceased, and his two other illustrious contemporaries, Dr. Samuel Jackson, and Dr. Hugh L. Hodge, and eulogized the noble characters of this trio of great men.

Mr. Eli K. Price said that he remembered the two occasions on which were delivered the public eulogium on Dr. Caspar Wistar, fourth President of the Society, by his successor, Chief Justice Tilghman, and the equally eloquent eulogium on the latter pronounced in a solemn public meeting of the Society by Horace Binney, and he considered the present occasion one that deserved the attention of the Society, in an equal degree.

The motion being carried, the Committee of five was appointed as follows: Mr. Fraley, Mr. E. K. Price, Dr. R. E. Rogers, Prof. P. E. Chase, and Dr. Jos. Leidy.

The Secretary read extracts from a private letter from Mr. Leo Lesquereux, dated Columbus, Ohio, March 22, announcing the important discovery of a specimen of *Cordaites* bearing its fruit, a *Cordaicarpus.* The discovery was made in examining the last box of specimens of coal plants from the Darlington slate bed, sent by Mr. Mansfield, of Cannelton, Beaver County, Western Pennsylvania.

The following is an extract from the letter:

"Mr. Mansfield continues his systematic explorations with wonderful persistency, and most valuable results. He sends me at least every month a box of specimens, and in each lot I find some novelties.

"In the last lot just received I find what has been searched for since botanists began to study the coal plants, namely, one of those large nuts generally found scattered, never attached to any support, but this time in distinct connection to a branch of *cordaites*, and just to the species on which it might be supposed to be found on account of the numerous branches of male flowers found upon other fragments. See Plate.........

"I believe that this discovery is important enough to be worth a record published in the Proceedings of the American Philosophical Society.......

"It would be advisable to have the specimen figured for a plate. Both fragments would fill, in representation with some enlarged parts, an octavo plate..........."

The description accompanying the letter, is entitled "On a branch of *Cordaites* bearing fruit. By Leo Lesquereux."

On motion of Mr. Lesley the Secretaries were authorized to order a plate illustration, 8° size, to be published with the paper.

Prof. Chase, pursuant to notice, read a communication on some new estimates of solar and planetary mass and distance, derived from Lockyer's "Basic lines," Peirce's meteoric hypothesis, and the energy of light.

Prof. Frazer, in illustrating the curious way in which some arbitrary geographical lines, like that which separates Maryland and Pennsylvania, prove on examination to be real division lines between districts of different geological character, described the different structural and mineralogical features of the copper veins near Liberty, in Maryland, and those near Monterey, in Pennsylvania. He stated that samples from the former gave only 4 or 5 per cent. of copper, and samples from the latter as much as 28 per cent. He described minutely his own method of sampling these ores for the purpose of obtaining reliable averages.

To illustrate the deceptive aspect of some geological exposures, he described the Chicques rock near Columbia, which had been described as an anticlinal outcrop, whereas it is monoclinal to the southward, against a fault; and added, that he recently proved the fact further by a careful study of the south dips in the bluff on the opposite or western side of the Susquehanna river, against which the stream was undercut for several miles.

In reference to the two uncertain forms discovered in the strata near the southern line of Lancaster, which Mr. Hall suspects to be fossil organisms, he said that it was desirable to have published drawings of them, costing about $35.

On motion the Secretaries were authorized to have such drawings made.

Pending nominations 872, 874, 875, 876, 877; and new nominations 878, 879, 880, 881 and 882, were read.

A letter was received from the President of the Historical Society of Pennsylvania, Mr. John William Wallace, dated 830 Spruce street, April 4, 1879, stating that Mr. Wm. Brooke Rawle and Mr. Charles Riché Hildeburn had been appointed to publish a continuation of the Penn-Logan Correspondence after 1711, and requesting permission to use the MSS. in the Library of the American Philosophical Society for that purpose.

On motion the request was granted under proper restrictions by the Librarian with a view to safety of the MSS.

Mr. Fraley announced that Dr. Wood had devised to the American Philosophical Society $20,000, for the purpose of erecting a fire-proof building, or for rendering the present hall fire-proof; and read a memorial to the Legislature, with the following resolution, which was adopted:

Resolved, That this Society will respectfully petition the Legislature for the release of the collateral tax on the charitable legacies and devises in the will of the late Dr. George B. Wood; and that the officers and members of this Society be requested to sign such petition, and to affix the corporate seal thereto.

After explanations from Dr. Rogers, the Chairman of the Committee on the Wootten process, on motion, that Committee was directed to make a final report on the subject at the next stated meeting of the Society.

And the meeting was adjourned.

On a Branch of Cordaites, bearing Fruit. By Leo Lesquereux. Plate I.

(*Read before the American Philosophical Society, April 4th,* 1879.)

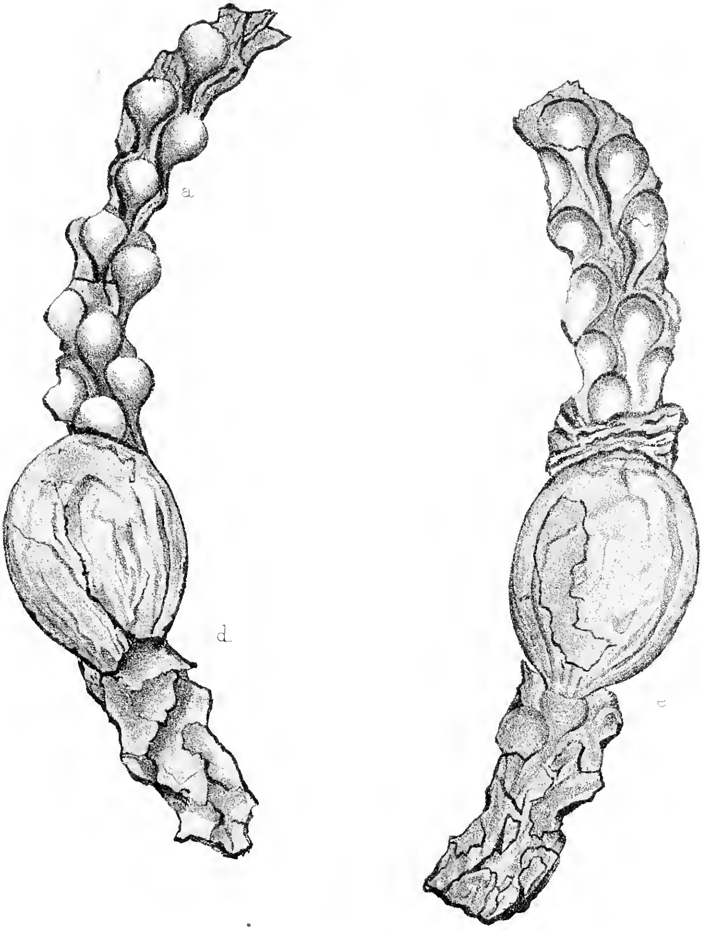
In a former paper, Proc. Am. Phil. Soc. March, 1868, I have given an account of the great work of Grand'Eury, especially considering his researches on the *Cordaites.*

Recent discoveries in the American Coal fields have afforded the means, not only of judging the value and the importance of the facts considered by the French author and of confirming his conclusions, but have also exposed in a new light some peculiar characters of these remarkable plants.

In considering the fruits of *Cordaites* (*Cordaicarpus*), p. 327, of the paper, it is remarked on *Antholites* or flowers of *Cordaites,* that except small nutlets, figured by Newberry, Dawson and Grand'Eury, and others, none of the large fruits commonly found in the Coal Measures have been found attached to stems or branches of *Cordaites,* nor indeed to any other kind of coal plants. Nutlets of *Antholites* are not even as large as peas, while the fruits of *Cordaites,* as Grand'Eury has figured them and as they are also represented, Pl. LXXXIII of the U. S. Coal flora,* vary in diameter from one to two and a half centimeters and therefore are, by their size, without correlation to those fixed upon branches of *Antholites.* Admitting as proved that these large nuts are derived from *Cordaites,* the question has been left by Grand'Eury what it was before for all the phyto-paleontologists from the oldest, who like Sternberg have considered the matter already, to those of our time. What is the relation of these fruits to the plants, their position, the mode of attachment, on stems, on branches, isolated and axillary, or in racemes, etc.? This question could be answered only by the discovery of a distinctly characteristic fragment of a *Cordaites* with the fructifications attached to it. It is to record that discovery, due to the persevering researches of Mr. I. F. Mansfield, who has done so much by systematic explorations in his coal bank of Cannelton, Pa., to promote the interest of the American coal flora, that I write this short notice.

The specimen bearing the vegetable remains is a piece of hard black shale, so appropriately split in the plan of stratification that it exposes both the upper face of the vegetable fragment and the counterpart. It represents a branch of *Cordaites costatus* (species figured U. S. Coal flora, Pl. LXXX, f. 1–3,), twelve centimeters long, bending down or like pending, nearly fifteen millimeters broad, marked in its whole length by prominent, kidney-shaped bolsters, support of pedicels or leaves, placed in spiral order, in the three ranked arrangement, enlarged, inflated in the upper part and abrubtly narrowed into a flexuous linear, lanceolate, long base. The nut or fruit is oval, three centimeters long from the point of attachment to the obtuse top, twenty-three millimeters broad, including its inflated border (three millimeters), broadly obtuse and entire at the top, rounded and narrowed at the base to a point of attachment or very short

* Published by the Second Geological Survey of Pennsylvania, 1879.



[illegible] OSTATUS, LESQ.

BRANCH BEARING FRUIT.

pedicel, five millimeters broad, distinctly joining the rounded subtruncate apex of one of the bolsters. The dividing of the shale in exposing and detaching the upper side of the fruit distinctly shows its mode of attachment by the continuity of the pedicel to the top of one of the bolsters.

The Plate I represents: Fig. 1, the fossilized part of the branch transformed into shining cannel coal. It is flattened to about two millimeters in thickness, the bolsters and their elongated base are in relievo. In the counterpart, fig. 2, the bolsters, concave and marked especially by the projections of the borders, are a little enlarged by compression. The part *e* is broken, as is also the base of the fruit in *d*. But the counterpart, fig. 2, has the impression of the whole fruit with its outside envelope, and the base is seen fixed upon the top of one of the bolsters, or rather of its impression in *e*.

This diagnosis and the figure of this branch of *Cordaites*, explain the position of the fruits as placed in spiral around a narrow branch, in a kind of long strobile. The close position of the bolster, serving as a support, and narrower than the fruits, at least when in maturity, could not allow them to remain upon the stem even until entirely ripe. They were forced out and soon falling off. They do not appear to have been axillary, for the bolsters do not bear any scar indicating the position of a leaf of *Cordaites* under the points of attachment of the fruits. The flowers were monoecious, even perhaps dioecious. A branch of the same species, *C. costatus*, figured Pl. LVIII, fig. 1, 1b, of the U. S. flora, bears racemes of male flowers whose pedicel is too slender for the axis of a strobile. The fertile flowers were in separate racemes, either on different trees or pending from another part of the same tree.

The discussion on the systematic relation of the *Cordaites* finds its place in the U. S. Coal flora. I will merely remark now that the position of these fruits in a kind of agglomeration in loose strobile, is comparable to the fruitifications of Cycadeæ, rather than to those of Conifers.

The Gingko, it is true, has nutlets resembling the. fossil fruits by their shape. They are, however, much smaller, supported by a basilar cupuliform disk, with longer axillary fasciculate pedicels. Separate fruits of Cycadeæ have the size and form of the Cordaicarpes. Compare among many others, *Cycadosperum sulcatum*, in Heer, fl. Helv., IV, Pl. LVI, fig. 18–20 of the Jurassic.

I do not suppose, however, that the *Cordaites* are positively referable to Cycadeæ. They had compound characters, which have been later separated and diversely distributed in other vegetable tribes. They constitute therefore a peculiar separate group with analogies of various kinds. We find the same in the ferns of the coal, of which the multiplied references made to genera of our time, have proved a series of failures especially considering the fructifications. It is the same also with the Lycopodiaceæ as represented by Lepidophlois; with the Sigillariæ, the Calamodendræ, Asterophyllites, Sphenophyllum, Annularia and others.

Columbus, 22d March, 1879.

Solar Records. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, April* 4, 1879.)

I. *Harmonies of Lockyer's "Basic Lines."*

From the third law of motion it follows, as a necessary consequence, that cosmical and molecular bodies act and react upon one another in accordance with laws of perfect elasticity. Hence, by introducing formulas of undulatory motion, results can often be speedily reached which would, otherwise, require the use of long and difficult analytical processes.

In previous communications I have shown :

1. That some of the most striking indications of nodal aggregation in the planetary system, are connected, by the laws which govern the relations between density and altitude in elastic atmospheres, with the nodal indications of the Fraunhofer lines.*

2. That the collisions of subsiding particles, from opposite diametral extremities of a condensing spherical nebula, tend to form shells or rings of nodal aggregation, at $\frac{2}{3}$ of the radial distance from the centre of the nebula.†

3. That centres of linear and of spherical oscillation, exert an important influence, both upon molar and upon molecular arrangements.‡ Professor Stephen Alexander had previously pointed out some instances of the results of spherical oscillation in the solar system.

4. That the nodal resistance of large cosmical bodies tends to form other nodal aggregations, at harmonic intervals, in accordance with the laws of musical rhythm which govern the vibrations of elastic media.§

5. That there are reasons for anticipating, in the fundamental oscillations of terrestrial elementary bodies, symmetrical harmonic evidences of the same laws as govern the harmonic nodes of elastic media and the harmonic grouping of planetary systems.‖

I have also shown, both from independent considerations and as corollaries from the foregoing laws :

6. That in paraboloidal aggregation,¶ there are three wave systems, with tendencies to nodal collisions and orbital aggregations in which the major axes have successive differences of 4 x_0.

*Ante, xvii, 109, *sq.*; 1877 : 294, *sq*; 1878.

† Ib. xvii. 100; 1877.

‡ Ib, x, 103; 1869.: xiii, 140 *sq.*; 1873.

§ xiii., 140, 193, 237; 1873.

‖ Ib., xii., 392 *sq.*; 1872.

¶ Ib., xvi, 507; 1877.

7. That centripetal energy $\left(f \propto \frac{1}{r^2}\right)$ varies as the fourth power of tangential energy in a circular orbit* $\left(v = \sqrt{fr} \propto \sqrt{\frac{1}{r}}\right)$.

Lockyer has published eight† "basic lines," which furnish illustrations of all these laws, or established harmonies.

The mean *vis viva* of the æthereal sphere of which Earth is the centre, tends (law 3) to form a node at .4 of Sun's distance from Earth, or at .6 of the same distance from Sun. Having already seen that the Fraunhofer line A is the exponential correlative of the planet Neptune, we readily find that this node is represented by a wave length of 4215.8 ten millionths of a millimetre. For (Laws 1, 5):

	Neptune.		Earth.		A.		
Log.	6442.985	: log.	214.524×.6	: :	7612	:	4215.8

If we regard this value as a fundamental wave-length for terrestrial chemical elements, we may also (Laws 6, 7), regard $(\frac{1}{4})^4$ of $4215.8 = 16.468$ as a fundamental increment, for such harmonic undulations as may be excited in the elastic æther by inertial resistance.

The "theoretical" column in the following table, is constructed by simple combinations of the fundamental wave length and the fundamental increment.

Theoretical.	"Basic Lines."
$5269.8 + 3^2 \times 16.468 = 5418.0$	5416
$4215.8 + 8^2 \times 16.468 = 5269.8$	5269
	5268
$5170.9 + 2^2 \times 16.468 = 5236.8$	5235
$5022.7 + 3^2 \times 16.468 = 5170.9$	b_3 b_4
$4215.8 + 7^2 \times 16.468 = 5022.7$	5017
$4^4 \times 16.468 = 4215.8$	4215

Lockyer does not give the wave lengths of b_3 and b_4. Gibbs‡ gives 5177 as the wave length of the *b* line. Law 2 is illustrated in the third theoretical line (5236.8), which represents $\frac{2}{3}$ of the interval between 5170.9 and 5269.8. These are both double lines in Lockyer's system. The doubling may, perhaps, be owing to the modification of the other activities by Law 2. Lines 2 and 5 (5269.8 and 5022.7) are directly connected with the fundamental line. All the incremental multipliers are integral squares. The difference between line 2 and line 5 is 15×16.468. The greatest square in 15 is 3^2, and the greatest square in $15-3^2$ is 2^2. These squares are the in-

* Ib., xiii, 245; 1873.

† Proc. Roy. Soc. Jan. 1879.

‡ Am. Jour. Sci. [2] xliii, 4.

cremental coefficients for lines 4 and 3. The difference between lines 1 and 2 is the same as that between lines 4 and 5.

The greatest difference between the theoretical and measured values (5022.7—5017 = 5.7) is only $\frac{1}{40000000}$ of an inch. The closeness of the accordance may be more readily seen by dividing each of the theoretical values by 1.00028.

Reduced Theoretical.	Measured.
5416	5416
5268	5269
5268	5268
5235	5235
5021	5017
4215	4215

In some respects this symmetry seems even more remarkable than those which I found, more than eighteen months ago, in many of the chemical elements. They were, however, directly harmonic, being based on centrifugal relations to the centres of wave systems (Law 5). These are reciprocally harmonic, being based on centripetal relations to the surface of Sun's chromosphere.

Multiples of the fundamental increment often appear in the differences between the wave lengths of elementary spectra. The following instances, in elements for which I have already shown harmonic relations,* will serve as examples. The left hand columns contain exact multiple differences; the right-hand columns, measured wave-lengths :

Mercury.

546.09	546.13
542.80	542.80

Lead.

537.78	537.71
439.07	439.07

Lithium.

479.69	479.48
459.93	459.93

Ruthenium and Iridium.

545.34	545.44
530.52	530.52

Copper.

578.67	578.67
529.27	529.30
522.21	522.24
465.75	465.64

Arsenic.

617.54	617.54
533.55	533.55
611.67	611.67
578.73	578.73

Zinc.

636.99	636.99
610.64	610.64
472.31	472.25

In the copper lines, the first theoretical difference is 30 × 1.6468 ; the second is $\frac{1}{7}$ as much ; the third is the sum of the other two. In arsenic, the second line is $2^2 \times 3^4 \times 1.6468$.

* *Ante* xvii, 297 ; 1878.

II. *Spectral Estimates of Sun's Distance.*

I have further shown :

8. That the harmonic undulations of our atmosphere are such as to furnish a simple method of estimating Sun's distance, by means of barometric fluctuations.*

9. That approximate estimates of Sun's distance, may also be made from the harmonic disturbances of magnetism,† (chemical energy, light, sound, gt, gt^2, simultaneous attraction of Sun, Earth and other planets upon elastic fluids),‡ lunar distance and orbital time.§

10. That there are evidences of paraboloidal nucleation, connecting the Sun, each of the planets, the asteroidal belt, and the star *Alpha Centauri.*‖

11. That planetary rotation is merely retarded orbital revolution, through the collision of particles near paraboloidal or ellipsoidal foci.¶

12. That gt, when t is the time of cosmical or molecular semi-rotation, represents the limiting velocity between complete dissociation and incipient aggregation.**

13. That gt, for the principal planets in the supra-asteroidal and in the infra-asteroidal belt (Jupiter and Earth), is determined†† by Sun's orbital influence ($\sqrt{gr}$); while gt, for the Sun, is the velocity of light.

14. That Jupiter is at the centre of the Neptuno-Uranian nebula ; Earth is at the centre of the belt of greatest density ; Sun is at the nucleal centre of the entire system.‡‡

15. That the frequency of oscillations in the violet rays, and the superficial gravitating energy of the Sun, are indicative of reciprocal action and reaction.§§

16. That successful predictions may be made from simple considerations of the principles which are involved in harmonic undulation.‖‖

All of these laws were found by means of the hypothesis that the undulations of an æthereal medium, when intercepted by inert bodies, tend to produce harmonic undulations (Law 4).

The discovery of the foregoing "basic" harmony, therefore, led me to look with confident expectation for such evidences of undulatory collision, between solar and terrestrial waves, as would furnish satisfactory grounds for new estimates of the Sun's mass and distance.

Beginning with the most far-reaching of all the indications (Law 10), and taking Earth's half radius as the unit and focal abscissa of a primitive

Ante, ix, 287; 1863.
†Ib., ix, 356, 367, 427, 487 ; 1864.
‡ Ib., xi, 103 ; 1869: xii, 392 ; 1872 : xiii, 142; 1873.
§ xiii, 398-400 ; 1872.
‖ Ib., xii, 519; 1872.
¶ Ib. xii, 406; 1872: xiv, 112; 1874.
**Ib. xiv, 111; 1874: xvi, 298, 496; 1876-7.
††Ib. xii, 406; 1872.
‡‡Ib. xvi, 497; 1877.
§§Ib. xiii, 149; 1873.
‖‖ Ib. ix, 288; 1863: xiii, 238; 1873: xviii, 34; 1878.

paraboloid, the focal ordinate would be equal to radius. I then found (Laws 6, 7, 11, 12), that by comparing the *vis viva* of satellite revolution at Earth's surface ($\propto v_0^2 = gr$), with the *vis viva* of rotation at the primitive focal abscissa ($\propto v_1^2 = \frac{1}{4}$ of the square of the velocity of equatorial superficial rotation), we may obtain the equation :

$$\left(\frac{v_0}{v_1}\right)^2 = \frac{r}{y}, \qquad\qquad (1)$$

in which y represents the distance traversed by a ray of light (compare Laws 13, 15), while a body, at the equator, would fall through the "fundamental increment" of the foregoing tabular comparison ($\frac{1}{255}$ of 4215.8 ten millionths of a millimetre). For,

$$v_0 = \sqrt{gr} = \sqrt{\frac{385}{12} \times \frac{3963}{5280}} = 4.907\ m.$$

$$v_1 = \pi \times 3963 \div 86165 = .1445\ m.$$

$$y = r\left(\frac{v_1}{v_0}\right)^2 = 3.436\ m.$$

$$t = \sqrt{.0000000016468 \div 4.8894} = .000018353\ sec.$$

Light traverses Earth's mean radius-vector in 497.825 *sec.* Therefore, according to this estimate, Sun's mean distance is

$$\frac{497.825y}{t} = 93,203,000 \text{ miles} \qquad\qquad (2)$$

A second approximation may be made by remembering that the basic lines are the reciprocals of harmonic lines, and comparing the æthereal volumes, or the reciprocals of the ratio of variability in tidal influence, $\left(\frac{1}{d}\right)^3$, at the points where the disturbing forces are greatest (the surfaces of the disturbing bodies). By the laws of elasticity, the æthereal undulations that are set up at any point, are propagated with uniform velocity. If we take the theoretical fundamental wave length as our fundamental unit, and if we call the mean orbital distance which Earth traverses in the time ($t = .000018353$ *sec.*) of falling through the fundamental increment, the "orbital unit," we find that

$$\frac{\text{Orbital unit}}{\text{Fundamental unit}} = \left(\frac{\text{Sun's radius}}{\text{Earth's radius}}\right)^3 \qquad\qquad (3)$$

For, representing Earth's mean radius-vector by x ;

Orbital unit $= 2\pi x \times .000018353$ *sec.* $\div$ 1 *year.*

Fundamental unit $= \dfrac{4215.8 \times .0000000039371}{63360}\ m.$

Sun's radius $= x \div 214.524$.

Earth's radius $= 3963\ m.$

Substituting these values in equation (3), we get

$$\frac{2\pi x \times .000018353 \times 63360}{365.256 \times 86400 \times 4215.8 \times .0000000039371} = \left(\frac{x}{214.524 \times 3963}\right)^3$$

$\therefore\ x = 92,579,000$ miles $\qquad\qquad$ (4)

It will be readily seen that equations (2) and (4) are entirely independent of each other. The true unknown quantity, or common unit of comparison, in each case, is the velocity of light. The comparison is drawn, in the first instance, between Earth's centripetal and centrifugal forces; in the second, between Sun's orbit-controlling influence upon Earth, and Earth's reaction upon Sun. That reaction must be exerted, either through an elastic medium, or by means of *quasi*-elastic forces. The elimination of the comparative unit, shows that the hypothesis of a luminiferous æther, or "æthereal spirit" as Newton termed it, accounts for inter-stellar, planetary, chemical, electrical, cosmical and molecular action. I do not, however, regard this fact as conclusive of the existence of such a medium, although it seems to lend the hypothesis a higher degree of probability than any previous investigations, and it requires, at least, *quasi*-elastic action.

The difference between the two results is less than one-half of one per cent. It would have been easy to assume values for the constants, which are within the limits of probable errors of observation, and which would have made the accordance exact. The value of Sun's radius ($x \div 214.524$) is deduced from Dr. Fuhg's estimate of Sun's apparent diameter. Three other estimates, which do not make so large an allowance for irradiation, are also included in the following table:

	Apparent Diam.	$x \div$ Sun's r.	x.
Dr. Fuhg.*	32′ 2.″99	214.524	92,579,000
British Naut. Al.	32 3. 64	214.451	92,531,700
American " "	32 4. 00	214.412	92,506,500
Lockyer's Astron.	32 4. 205	214.388	92,491,000

Among the numerous previous mechanical estimates that I have given, the one which accords most nearly with the two present determinations, was the one which was based upon thermo-dynamical considerations derived from the "heating energy of flames,"† and which gave

$$x = 92{,}639{,}500 \text{ miles} \qquad (4_1)$$

The intimate connection between Sun, Jupiter and Earth, which is indicated by Laws‡ 13 and 14, should lead to many other relations, no less interesting than the foregoing.

If we take $\frac{1}{256}$ of the cosmical distance which corresponds to the fundamental wave-length, we find

$$\tfrac{1}{256} \text{ of } .6 \text{ of } 214.524 = .5028 = 1.0056 \times .5 \qquad (5)$$

But .5 is the focal abscissa of the primitive paraboloid, of which Sun's radius is the focal ordinate.

III. *Relations of Mass.*

According to Professor Peirce's meteoric hypothesis, it may be reasonably presumed that each planet receives meteoric increments, or suffers

*Deduced from 6827 measurements; Astron. Nach. 2040, cited in Am. Jour. Sci., x, 159, Aug. 1875.

† *Ante*, xii, 394; Am. Jour. Sci., iii, 292; 1872.

‡ I call all these harmonies "laws," because they exhibit pre-established purposes, though some of them are more special than others.

changes from meteoric influences, in proportion to its mass, so as to maintain a permanency of relative mass among the principal members of our system.

I have already pointed out various harmonic mass relations (Law 3), including the following equation involving figurate powers of the supra-asteroidal masses, as well as of their distances.*

$$\text{Saturn}^{10} = \text{Neptune}^{1} \times \text{Uranus}^{3} \times \text{Jupiter}^{6} \ldots\ldots\ldots\ldots (6)$$

I have also called attention to the fact that these four planets, together with Earth and Sun, represent important centres of nebular or *quasi*-nebular influence, viz :

Neptune, centre of primitive annular condensation.
Earth, centre of belt of greatest density.
Sun, centre of nucleal condensation.
Uranus, centre of primitive "subsidence" collision (Law 2).
Jupiter, centre of Neptuno-Uranian nebula.
Saturn, nebular centre of mean planetary inertia. Saturn is also the centre of paraboloidal subsidence when Neptune was focal and Sun was at the vertex.

The report of Professor Pierce's lecture led me to look for some equation to connect the masses at the two remaining centres (Earth and Sun) with those of the two chief planets, and I soon found that

$$\text{Jupiter}^{3} = \text{Sun} \times \text{Earth} \times \text{Saturn} \ldots\ldots\ldots\ldots (7)$$

This equation gives

$$\left.\begin{array}{lll} \text{Sun's mass} \ldots\ldots & = & 328,600. \\ \text{" parallax} \ldots\ldots & = & 8.''832 \\ \text{" distance} \ldots\ldots & = & 92,549,000 \text{ miles.} \end{array}\right\} \ldots\ldots\ldots (7_2)$$

Combining (6) and (7), we find

$$\text{Saturn}^{9} = \text{Jupiter}^{3} \times \text{Uranus}^{3} \times \text{Sun} \times \text{Earth} \times \text{Neptune} \ldots\ldots\ldots (8)$$

The masses of Neptune and Uranus seem to be so related as to give them equal ratios between their present orbital momentum and the orbital momentum at their respective abscissas in the solar-stellar paraboloid ($\frac{8}{7}$ Neptune and $\frac{7}{8}$ Uranus).

$$\left.\begin{array}{rl} 7 \times \text{Neptune} = & 8 \times \text{Uranus} \\ \therefore \sqrt{\tfrac{7}{8}} \times \text{Neptune} = & \sqrt{\tfrac{8}{7}} \times \text{Uranus} \end{array}\right\} \ldots\ldots\ldots (9)$$

Equation (8) may be stated under the form

$$\left(\frac{\text{Sat.}}{\text{Sun.}} \times \frac{\text{Sat.}}{\text{Ear.}} \times \frac{\text{Sat.}}{\text{Nep.}}\right)\left(\frac{\text{Sat.}}{\text{Jup.}} \times \frac{\text{Sat.}}{\text{Ura.}}\right)^{3} = 1 \ldots\ldots (10)$$

Here the equation of planetary stability groups the centres in two sets, as in equation (7), the first introducing the first powers, the other the cubes, of the relative masses. The same exponential grouping also occurs in (3), but with linear factors instead of mass factors. If we consider that, in a rotating nebula, the time of rotation varies inversely as the square of the

* *Ante*, xiv, 652.

radius, and also inversely as the disturbing mass, the first group leads to the equation

$$\frac{\text{Earth} \times 1 \text{ year} \times (\text{Neptune's r. vec.})^2}{\text{Sun} \times 1 \text{ day} \times (\text{Earth's r. vec.})^2} = 1 \quad \ldots\ldots\ldots\ldots\ldots (11)$$

This equation gives

$$\left.\begin{array}{ll} \text{Sun's mass} \ldots\ldots\ldots & = 330{,}375. \\ \text{" parallax} \ldots\ldots & = 8.''816 \\ \text{" distance} \ldots\ldots & = 92{,}717{,}000 \text{ miles.} \end{array}\right\} \ldots\ldots\ldots\ldots (12)$$

In considering this and other relations of mass to æthereal disturbance, it is well to remember that the simple disturbance varies as the mass; the *vis viva*, or radius of consequent oscillation, as the square of the mass; and the consequent orbital period, as the cube of the mass.

By introducing the vector-radii also into the cubical factor of (10) and designating secular perihelion, mean perihelion, mean aphelion, secular aphelion, respectively, by subscript 1, 2, 3, 4, 5, we find

$$\left.\begin{array}{l} \dfrac{\text{Sat.}_3 \times \text{Sat.}_4}{\text{Jup.}_2 \times \text{Ura.}_3} = 1 \\[2ex] \dfrac{\text{Sat.}_3 \times \text{Sat.}_4}{\text{Jup.}_3 \times \text{Ura.}_2} = 1 \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

The greatest deviation from exactness, in the first of these equations, is less than $\frac{1}{8}$ of one per cent.; in the second, less than $\frac{1}{16}$ of one per cent. The mean deviation, in the square root of the product of the two equations, is only $\frac{1}{36}$ of one per cent.

We see by (5) and (13), as well as by ordinary astronomical investigations, that questions of relative mass are intimately connected with those of orbital eccentricity. One of the most interesting evidences of such connection, in this special line of investigation, is to be found in the position of the mean fulcrum of the system, or centre of gravity of Sun and Jupiter, together with the significance which it lends to equations (5), (6), (8), (13), as well as to the fundamental increment which is the ground of equation (3). The orbital *vis viva* has lengthened the radius-vector of simple equilibrium by $\frac{1}{16}$ of its value. For $5.2028 \times 214.524 = 1116.125$; $\frac{16}{17}$ of $1116.125 = 1050.471$. The limit of synchronous radial and circular oscillations is at $2\,r$. Deducting 2 from 1050.471 we find

$$\frac{\text{Sun's mass}}{\text{Jupiter's mass}} = 1048.471 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

Equations 7, 8 and 9 give the following theoretical values, for Uranus and Neptune, which I compare with Newcomb's:

Sun ÷	Theoretical.	Newcomb.
Uranus....................	22116	22600 ± 100
Neptune....................	19352	19380 to 19700

Newcomb gives two estimates for Neptune, one (19380 ± 70) from satellite, the other (19700) from perturbations of Uranus. The latter agrees precisely with the theoretical ratio (9) between the two planets, while the former is presumably more accurate.

The uncertainty in regard to all the planetary masses, except that of Jupiter, is still so great, that it is impossible to tell how closely they are represented by the equations for the combined central activities (6, 7, 8). The latest investigations of Leverrier and Newcomb, however, show a closeness of approximation which is remarkable, in view of the wide discrepancy in some of the values. Leverrier's mass-denominators, based on the old parallax (8.″57), are: Neptune, 14400; Uranus, 24000; Jupiter, 1050; Saturn, 3512; Earth, 354936. The accordance with the combined equation (8) is within $\frac{5}{8}$ of one per cent. if we deduce Earth from the other masses; within $\frac{1}{14}$ of one per cent. if we deduce Saturn.

If we look to the partial equations, (6, 7), we find that Saturn's mass, as deduced from Neptune, Uranus and Jupiter, (6), is about $\frac{2}{3}$ of one per cent. greater than Leverrier's assumption, and about the same amount less than Bessel's, which was adopted by Newcomb. *The mean of the two results shows an exact accordance*, as follows:

	Deduced.	Assumed.
Leverrier............	3488.3	3512.0
Newcomb............	3525.0	3501.6
Mean..................	3506.6	3506.8

The results of the second partial equation, (7_2), may confidently await the verdict of the observations upon the last transit of Venus. No other estimate can now claim a greater degree of probability. It may be, as Leverrier suggests, that a small portion of the mass may belong to a group of minute asteroids, near Earth's orbit, but there is no present likelihood that any material inaccuracy will ever be found in the equation which connects the two principal intra-asteroidal centres with the two principal extra-asteroidal centres.

E. Wiedemann's experiments upon the illumination of gases by electricity,* have convinced him that the electric discharge may excite a considerable increase of the *vis viva* of oscillation in æthereal envelopes, without increasing the *vis viva* of the enclosed molecules. Peirce's meteoric hypothesis opens an immense field for new physical speculation and investigation. If the æther is material, where shall we draw the boundary between æthereal and meteoric influences? If cosmical masses have been formed by paraboloidal aggregation, may not radiation also be paroboloidal? The solar forces of association and dissociation seem to be almost exactly balanced, and the law of equal action and reaction may, perhaps, free the science of thermodynamics from the opprobrium of its apparent tendencies to universal aggregation, stagnation and death.

* Wied. Ann., vi, p. 301.

Obituary Notice of Robert Frazer. By Persifor Frazer, Jr.

(Read before the American Philosophical Society, February 7, 1879.)

ROBERT FRAZER was born December 29, 1818, at his father's house in Newtown Township, Delaware County. His father, Robert Frazer, was a lawyer of excellent standing and distinguished for his knowledge of land law, who had served several times as a member of the House of Representatives of this State.

The elder Robert, son of General Persifor* and Mary Worrall Frazer, was three times married, as follows:

On May 3, 1798, he married Sarah Ball, who died without issue, June 21, 1800.

On October 15, 1803, he married Elizabeth Fries, daughter of John and Anne Fries, by whom he had six children, three of whom died under the age of one year, and the others were, Anne Fries, Persifor, and John Fries, of whom only the second survives.

On February 11, 1818, he married Alice, widow of Eli Yarnall and daughter of Joseph and Sarah Pennell, by whom he had but one child, the subject of this brief notice.

The boy was named originally Joseph Pennell, but on the death of his father, January 20, 1821, his name was changed to Robert.

From that date he continued to live on his mother's farm, near West Chester, till her death in 1825 or 1826, when he spent some time in Philadelphia and attended Dr. S. Crawford's school.

In 1834–38 he went to school in Pittsfield, Mass., and finally completed his education at Norwich University, a military academy in Vermont, under the direction of Capt. Partridge.

He graduated after having completed courses in Civil Engineering and in the Arts and Sciences.

In 1838 he joined the corps of Engineers which was then engaged in laying out the Reading Railroad, and was in charge of the second division above Reading, remaining there until the completion of the road.

In the autumn of 1846 he went to Europe and remained about a year, and upon his return commenced the study of law in Reading, in the office of Judge Jones.

On being admitted to the bar, he removed to Philadelphia to practice, and not long after this held the office of Prosecuting Attorney for Delaware County for some time.

In 1846 he was married to Miss Jane Biddle Wood (daughter of Samuel and Fanny Collins Wood, and grandniece of Marks John Biddle) who was born February 14, 1820. The marriage was celebrated by the Rev. Edmund Leaf, Rector of Christ's Church, in Pottstown, Montgomery County.

On July 22, 1849, Robert Frazer was born as the first issue of this marriage.

* General of State Militia after the Revolution. Lt.-Col. in the American army during the Revolution.

A daughter, Fanny (now Mrs. Herbert Welsh), was born on October 4, 1852.

Almost at the same time in this year (1852) Robert Frazer was elected Secretary and Treasurer of the Camden & Atlantic Railroad, in the construction of which road he had been previously engaged as consulting engineer.

In November, 1863, he was elected President of the Company, which office he retained till the fall of 1873.

It will ever remain as a monument of his devotion, zeal and efficiency in the management of this road that its stock advanced during his tenure of the chief office from an almost unsaleable commodity to a position of prominent favor for such a road.

Upon his retirement from the Camden & Atlantic Railroad he was called to the presidency of the Wilmington & Reading (afterwards known as the Wilmington and Northern) Railroad, and while holding this position he died suddenly of a stroke of apoplexy, on May 4, 1878, at 15 minutes past 6, P. M.

On the 4th of May, 1878, he was apparently in the best health and in buoyant spirits and attended to all his duties with ease. He was expected at the house of his daughter, Mrs. Welsh, to tea, when a short time before the hour a messenger arrived announcing that he had a severe headache and would not be able to come. Very shortly after this he died.

He was a man who was characterized by many salient traits, among which none was so striking, by reason of its rarity, as his gentleness and sweetness of disposition. No one ever observed him in his relations to other men without envying him the kindly tone, the liberal view and the winning manner with which he either opposed or endorsed the sentiments of others. His normal condition of features was the border of a smile, and his heart was full of sunshine, which his cheery words sprinkled like drops of water on those about him. One is tempted to dwell on a character like this, for the memory of it causes always an agreeable sensation: yet it may be thought that the ties of consanguinity render the writer a too partial witness. But it is not so. All who knew Robert Frazer, knew him as a patient, forbearing, kind and cheerful friend, a model of content, and a well-spring of pleasure to those by whom he was surrounded.

His tastes were those of a cultured man, and his mind had that quality of interest and curiosity which kept him actively seeking information and *au courant* with the affairs of the day. Every new turn of the kaleidoscope of the times which developed some new and beautiful idea, some discovery, or some invention, delighted him whether it was or was not in the direction of his professional work.

He was one of those earnest soldiers of ideas who, whether they serve religion, their country, or science, show alike their sense of the solemn meaning of the march of events. He believed in the *duty* of man to *labor* for and with that evolution of new forms of truth which is but the measure of onward progress, even though the progress be in any case inevitable;

and he believed also unwaveringly in the majesty and goodness, the fitness and worthiness of that which the future was to bring forth.

Many find this state of mind inseparable from a mood of seriousness, if not of asceticism ; Robert Frazer did not. No one realized more fully the serious side of life, but he had also learned (if it was not taught him by instinct) the phariseeism of gloom as an emblem of respect for truth. If ever man served his God with the grateful incense of smiles and joyfulness it was the subject of this sketch.

This interest in the affairs of the world around him led him naturally to cultivate various branches of science, as an amateur, and he preserved the keenest interest in them to his last hour, though his engrossing occupations forbade him to tread the path of original investigation.

Microscopy and Entomology always had great attractions for him, and for several years previous to 1867 he was President of the Entomological Society of this city.

He was elected a member of the Academy of Natural Sciences in 1866, and when his duties allowed was frequently seen within its halls on its nights of meeting.

In 1873, he was elected a member of this Society.

Of his inner life as a member of a family ; of his charm within that circle, shut out from the gaze of the world, I may not speak. But were it permitted to pursue this theme a far juster picture of the man could be presented them in these few poor lines in tribute to his memory. Yet those who knew him in the world can easily imagine how bitter was the loss of this friend, who ever dispensed consolation and cheer, to those whom he most dearly loved, and to whom his whole life was a pattern of self-sacrifice, of manly and healthy virtue, and of the warmest human sympathy.

Stated Meeting, April 18, 1879.

Present, 19 members.

Vice-President, Mr. Fraley, in the chair.

A letter declining the appointment to prepare an obituary notice of Dr. Wood, was received from Dr. Stillé, whose communication was on motion referred to the Committee on the eulogy.

A letter accepting the appointment to prepare an obituary notice of Dr. Beadle, was received from Dr. Agnew, dated April 17.

A letter requesting permission to use the Logan-Penn

MSS. in the Hall of the Historical Society, was received from the President of that Society, Mr. J. W. Wallace.

On motion, the Librarian was authorized to entrust, 1. the Wm. Penn's Letters and Ancient Documents; 2. Logan Papers, Vol. 3; 3. Logan Papers, 399-3, to the care of the Committee of the Historical Society, on written receipt for the same and obligation to return without unnecessary delay.

Letters of acknowledgment were received from the Yale College Library (Trans. XIV, XV), and the Rev. Stephen D. Peet, Unionville, Ohio (Proc. Vols. VIII to XVII complete).

Letters of envoy were received from the Imp. Bot. Garden, St. Petersburg, March 4, 1879, and from Prof. Ira Remsen, of Johns Hopkins University, April 10, with the first number of the American Chemical Journal, asking for exchanges.

On motion, Dr. Remsen's name, as Editor, was ordered to be placed on the List of Correspondents to receive the Proceedings henceforth.

Donations for the Library were received from the Botanical Garden, St. Petersburg; the Russian Geographical Society; Prussian Academy; Zoologischer Anzeiger; Flora Batava; Belgian Academy; Society of Geography, Paris; R. Astronomical Society; Nature; Boston Soc. Nat. History; Brooklyn Entomological Society; Am. Jour. of Otology; Astor Library; N. Y. Chemical and Historical Societies; Franklin Institute; Jour. of Pharmacy; Medical News; Jour. Med. Sciences; Am. Chemical Journal; State Mineralogist of Nevada; and Sig. V. Reyes, Mexico.

The death of Dr. Isaac Hays, at Philadelphia, one of the oldest members and former secretaries of the Society, April 15, aged 83 years, was announced by Mr. Fraley.

On motion, Dr. Brinton was appointed to prepare an obituary notice of the deceased.

Pending nominations 872, 874 to 882 were read, Nos. 872, 874 to 877 were spoken to and balloted for.

The Chairman of the Committee on a Premium for an

Anthracite Dirt Burning Process, Dr. R. E. Rogers, reported progress. (See Minute book.)

There being no other business, after scrutiny of the ballot boxes, by the presiding officer, the following persons were declared duly elected members of this Society :

William H. Greene, M.D., of Philadelphia.

Mr. Arthur Erwin Brown, of Philadelphia, Superintendent of the Zoological Garden.

Carl Seiler, M.D., of Philadelphia.

Dr. Middleton Goldsmith, of Rutland, Vt.

Mr. Richard Wood, of Philadelphia.

And the meeting was adjourned.

Stated Meeting, May 2, 1879.

Present, 13 members.

Vice-President, Mr. Fraley, in the chair.

Letters accepting membership were received from Dr. Carl Seiler, dated Philadelphia, April 22, 1879 ; Dr. Wm. H. Greene, dated Philadelphia, 1812 Green St., April 21 ; Mr. Arthur E. Brown, Zool. Soc., Fairmount Park, April 21, and Dr. M. Goldsmith, dated Rutland, Vt., April 22,

A photograph of Mr. Edward Goodfellow, was received for insertion in the Album.

A letter accepting the appointment to prepare an obituary notice of the late Dr. Isaac Hays was received from Dr. Brinton.

A letter enclosing a communication to be read at the meeting was received from Prof. Daniel Kirkwood, of Bloomington, Monroe Co., Indiana, dated April 19, 1879.

Letters of acknowledgment were received from the Kentucky Historical Society (Proc. No. 102); Buffalo Society of Natural Sciences (102); Kansas State Historical Society

(102); Smithsonian Institution (102); Essex Institute (102); Davenport Academy (102); Providence Franklin Society (102); and the Liverpool Lit. and Philo. Society (Nov. 25, 1878, 100 and 101), and postal cards from many members.

Letters of envoy were received from the Lit. and Philo. Society of Liverpool, and from the Société des Sciences de l'Agriculture de Lille, dated April 1, 1879.

A letter offering an exchange of publications was received from the Director of Studies of the Ecole Polytechnique, dated Paris, April 6, 1879.

Donations for the Library were reported from the Asiatic Society of Japan; the Royal Academy dei L. at Rome; Dr. Prof. F. J. Lauth, of Munich; the Vaudoise Society; Zoologischer Anzeiger; Royal Belgian Academy; Revue Politique; Com. Geog. Society at Bordeaux; R. Astronomical Society; London Nature; Lit. and Phil. Society of Liverpool; Mr. James W. Barclay; Silliman's Journal; Penna. Historical Society; Am. Journal of Pharmacy; Prof. Andrews, of the Geol. Survey of Ohio; and Prof. Joseph LeConte.

A communication was read by the Secretary, entitled, "Meteoric Fireballs seen in the United States during the year ending March 31, 1879, by Prof. Daniel Kirkwood."

Prof. Cope exhibited a life-size drawing of a vertebra of a new species of *Camelosaurus*, for which he proposed the name *C. leptodirus*, and showed in what it differed from the vertebræ of *C. supremus*.

Prof. Marks exhibited a beautiful "Compound Compass," made under his direction by Wm. Young & Sons, for the use of the Geological Survey in drawing tangents and curves of very great radius, or parallels and meridians, and explained how this invention of Peaucellier could be modified for other uses.

Mr. Lesley exhibited a large distemper map of Pennsylvania, painted recently to exhibit to the Legislature the progress of the Survey. Also the first bound copy of Lesquereaux's Coal Flora Atlas of 87 plates, just published by the Board of Commissioners of the Geological Survey.

Prof. Frazer read parts of a correspondence which he had had with Mr. Meehan, respecting the local cause of change of color in autumn foliage.

A letter from Prof. Lauth, of Munich, was read, relating to his recent investigations and proposed publication of a new work on Egyptology.

Pending nominations, Nos. 878 to 882 and new nomination No. 883 were read.

Mr. Fraley, for the Finance Committee, reported that he had collected and paid over to the Treasurer, the quarterly interest on the Michaux Legacy due April 1, amounting to $133.07.

A discussion on the Wooten process then took place, pending which the meeting was adjourned.

On Meteoric Fireballs seen in the United States during the year ending March 31, 1879.* *By Professor Daniel Kirkwood.*

(*Read before the American Philosophical Society, May* 2, 1879.)

The following paper does not claim to present a complete list of the fire-balls which have appeared in our entire country during the last twelve months. It includes, however, all that have been brought to the writer's notice. Of those described only three can be certainly classed as detonating meteors, and in no case has an explosion been followed by a fall of meteoric stones ; at least, no aerolites have been actually discovered.

(1.) 1878, June 3, 2h. 59m., A. M.—This meteor, observed at Chicago, by Prof. E. Colbert, was about equal in apparant magnitude to the moon at four days old. Its course was from near the zenith to a point about 4° above Beta Cassiopeiæ. Near Alpha Cassiopeiæ it exploded into seven or eight fragments.†

(2.) 1878, June 6th, 9h. 25m. (local time).—On the evening of June 6, Mr. Geo. H. E. Trouvelot, at Cambridge, Mass., saw a very large meteor which passed directly over Omicron Ursæ Majoris, and disappeared just below Eta in the same constellation. It was pear-shaped, the greatest and least diameters being in the ratio of 4 to 3, and it left behind it a long bright train. About three or four seconds after its appearance it burst into five

* No. 6 (January 20, 1877) of the fireballs described in my paper read before the A. P. S., March 16, 1877, was found, after the article was in type, to be a newspaper hoax.

† Letter from Prof. E. Colbert, dated June 3, 1878. See also the Sci. Obs. for July, 1878, p. 3.

or six fragments, each of which assumed the same form as the original meteor. "The preceding portion was of a crimson red hue, quite brilliant, and not dissimilar to the Strontian flame. The following portion was of a bluish violet color, which merged into that of the trail. This latter was composed of globules, each succeeding following one being of a more and more subdued violet, and finally not distinguishable from the color of the sky."*

(3.) 1878, August 11, 10h. 10m. (Indianapolis time).—A few minutes after 10 o'clock on Sunday evening, Aug. 11, Rev. John A. Bower, of Bloomington, Indiana, saw a large meteor near the eastern horizon. Mr. B. had just taken a position facing an eastern window. The meteor when first seen was almost exactly east of Bloomington, perhaps two or three degrees south of east, and 10° above the horizon. Its motion was from south to north, and the length of its apparent track was 20° or 25°. The first half of its course was but slightly inclined to the earth's surface; the inclination, however, became sensibly greater towards the point of disappearance, which was N. about 70° E., and very near the horizon. The apparent diameter of the meteor was about one-third that of the moon The motion was extremely rapid; the time of flight not exceeding two seconds. No detonation was heard at Bloomington, nor was the meteor seen to separate into fragments at the time of disappearance.

The observations of Mr. Bower were given me verbally. To verify their accuracy I placed myself in the position which he occupied, and had him point out the meteor's course as he had seen it. The foregoing statement, I am satisfied, must be very nearly correct, except as to the time of flight, which is admitted by the observer to be very uncertain.

The same meteor is supposed to be described in the following telegrams which appeared in the newspapers of the next Tuesday morning:—"Titusville, Crawford Co., Pa., August 12. A beautiful meteoric display was witnessed from here last evening. The meteor made its appearance in the west at 10.30, moving in a northerly direction. It was of a greenish color and shone with great brilliancy, lighting up the entire surrounding country with a light that for the time prevailed over that of the full moon. Its appearance was only momentary, when it burst and divided into three fragments, two of which assumed a reddish color. Calculating from the time the explosion was seen until it was heard, the meteor was about 25 miles distant." "Oil City, Venango Co., Pa., August 12. A meteor of unusual brilliancy passed here last evening a few minutes after 10 o'clock. It was nearly twice the size of a cannon ball. Its course was north."

All accounts agree that the meteor's course was northward. It was seen to the west of Titusville; and as the final explosion occurred about 25 miles from that city we may conclude that the track terminated over Crawford County, Pa. The observations at Bloomington, Indiana, indicate that the body first became visible over West Virginia. The distance directly east from Bloomington to the meridian which bounds Venango County, Pa., on the west, is 348 miles. Hence the meteor's altitude when first

* Science Obs., June, 1878.

seen was about 77 miles. This, it must be admitted, is somewhat uncertain, but we may safely conclude that it was not less than 70 miles nor more than 85. The length of the visible track was between 160 and 175 miles. The estimated time of flight was probably too short; but the great velocity appears to indicate a hyperbolic orbit.

(4.) 1878, September 16, 9h. 0m., P. M.—This meteor was observed by Mr. Benjamin Vail, of Henryville, Clark County, Indiana. It was first seen near Gamma Ursæ Majoris, and it passed over Delta in the same constellation. Its apparent diameter was about one-fourth or one-fifth that of the moon.*

(5.) 1878, November 12, 7h. 0m., P. M. (local time.)—Washington, Indiana. Mr. D. Eckley Hunter, Principal of the High School, of Washington, Daviess County, Indiana, was, with several of his students, watching for shooting stars on the evening of November 12, when precisely as the town clock was striking seven, a large fireball appeared very close to Vega, passed in a sourtherly direction through the milky-way, and disappeared about 20° N. W. of Jupiter. Its motion was very slow; the time of visibility being estimated by Mr. Hunter at 10 seconds. Its apparent diameter was about two-thirds that of the moon. What struck Mr. Hunter as especially remarkable was the sharply defined disk which the meteor presented, up almost to the very moment of its disappearance.†

(6.) 1878. November 14, 3h. 30m., P. M.—In the New York Semi-Weekly *Tribune*, of December 10, 1878, Mr. Thomas Whitaker, of Hillside Farm, Mass., reports the appearance of this brilliant meteor as observed by himself. The sky was very clear at the time, and the meteor was seen in bright sunshine. It was due south from the place of observation.

(7.) 1878, December 30.—A few minutes before 7 o'clock (Indianapolis time) on the evening of December 30, 1878, a large meteor was seen in Indiana, Ohio, and Pennsylvania. So far, however, as known to the writer, the only observations sufficiently prescise to be available in determining the height and direction of its path were made at Anderson, Madison County, Indiana; Washington, Washington County, Pa., and Wooster, Wayne County, Ohio.

Anderson, Indiana, Lat. 40° 5′, Long. 8° 28′ W.—The observations at Anderson were made by Mr. Frederick E. Dickinson, a member of the Senior Class, in Indiana University.‡ Mr. D. was in the street, walking eastward, when the meteor appeared in front of him, a few degrees N. of E., at an altitude of not less than 15° nor more than 17°. As the meteor passed behind a building the point of disappearance could not be determined. The apparent diameter was one-fourth that of the moon, and the time of flight was estimated at two seconds or probably a fraction less.

Washington, Pa., Lat. 40° 10′, Long. 3° 12′ W.—The phenomenon as

* Letter from Mr. Vail.

† Letter from Mr. D. E. Hunter.

‡ The meteor was seen by others in Indiana, but the descriptions given were nothing more than vague guesses in regard to its size and general direction.

seen in Washington, is described in the following letter from the Professor of Mathematics in Washington and Jefferson College :

"WASHINGTON, PA., February 1, 1879.

"PROF. D. KIRKWOOD, *Dear Sir*:—The fact of the appearance of a meteor here some time ago, may be of interest to you I set down the facts as I learned them at the time, and intended to have written you sooner. About 7 P. M., Washington, Pa. time, December 30th, a brilliant meteor was seen here. The account which I have was given me by a young man, Mr. A. M. Gow, Jr., who has given me, I have no doubt, a very fair statement of what was to be seen at that time. He was walking eastward on the south side of the street, so that he was in the shade of the buildings: the moon shining brightly at the time. Suddenly a light shone about him as if an additional lamp had been lighted close behind him. He did not turn immediately to look, but when he did he saw a meteor about the size of the moon as he thought by comparing his impression with the half-full moon immediately afterwards. It was of a slightly greenish color, but just as it disappeared it became reddish. The place in which he saw it, as far as I can judge, was about Alpha Cygni, and the place of its disappearance was about Alpha Lyræ. If so, you see its course was W. N. W., and it was observed through 24° of its path. The meteor had been visible a little time, however, before Mr. Gow turned to look. It was seen by three others here that I know of. Yours Truly,

"D. J. MCADAM."

Observations at Wooster, Lat. 40° 50′ *N., Long.* 4° 56′ *W.*—Professor Samuel J. Kirkwood, of Wooster University, had a good view of the meteor, which he describes as the most brilliant he has ever seen. It was greatly elongated, and the apparent diameter at right angles to its path was half that of the moon. The point of the meteor's first appearance and also the first part of its track were accurately observed through large tree-tops.* Prof. Kirkwood gives the following angles as the result of careful measurement with a surveyor's transit :

"First appearance, east, alt. 50°. Disappearance, S. 13° E. alt. 13°." Prof. K. remarks: "The first appearance is, I am satisfied, quite exact, and entirely reliable. I am not so confident of the observation at disappearance. The meteor exploded when about S. 33° E."†

According to the observations at Wooster and Anderson the meteor became visible at a height of 72 miles over a point in Columbiana County, Ohio, Lat. 40° 50′, Long. 3° 40′ W. The Wooster and Washington observations, seem incompatible; the latter, however, make no claim to strict accuracy.. As the exlosion seen at Wooster was not observed either at Washington or Anderson it is probable that at these greater distances the disappearance was simultaneous with the separation into fragments. Such doubtless has been the case in several other instances. For example, the

* A member of the Junior Class in Wooster University was with Prof. Kirkwood.
† Letter from Prof. S. J. Kirkwood.

fragments of the meteor of August 11, 1878, seen at Titusville, Pa., were invisible at Bloomington, Indiana. If we assume, then, that as seen from Washington the point of explosion was also that of disappearance, we find by a tentative process that the observations are approximately satisfied by supposing the separation to have taken place over Tuscarawas County, Ohio, about N. 80° W. from Washington, Pa., at a distance of 70 miles, and at a height of 17 or 18 miles above the earth's surface. After the explosion the parts remained visible at Wooster until within 12 or 13 miles of the earth. The course was nearly S. W.; the true length of the entire visible track as seen at Wooster was about 85 miles; that of its projection on the earth's surface, about 60 miles. The inclination of the path to the surface of the earth was about 45°. The velocity, though uncertain, was probably greater than that corresponding to an elliptic orbit. No detonation was heard at any point of observation.

(8.) 1879, January 28, 2h. 28m., A. M., local time.—Observations at Princeton, Green Lake County, Wisconsin. Lat. 43° 50′ N., Long. 12° 13′ W.—Rev. William M. Richards, states that between 2 and 3 o'clock* on the morning of January 28, he was awakened by a sudden flash of intense light which he at first supposed to be lightning. It continued, however, for some seconds, and by the time he was thoroughly awake and ready to make observations the light had assumed a reddish tinge, somewhat resembling that of a Roman candle. He next supposed it to be a fire, but immediately found that if so, it must be out of the village. After making other conjectures, to be as quickly dismissed, he finally reach the conclusion that the light was meteoric.

"By that time," he says, "the frightful conflagration had settled down into a low pyramid of lurid light, the base extending 60° along the N. E. horizon, and the vertex having an altitude of 30°. * * * The time of the meteor's flight is very uncertain; perhaps 8 to 10 seconds. The brilliant and white light at first would indicate that the movement was from the West."†

Observations at Traverse City, Michigan, Lat. 44° 43′ *N., Long.* 8° 40′ *W.* The *Grand Traverse Herald,* of January 30, 1879, states that the accounts of this meteor by different observers were, in some respects, very conflicting; those who saw it being too much startled to observe it closely. "What *is* known is that it was an immense ball of fire, that the darkness was made light as noonday, and that a terrible explosion followed its disappearance. A night watchman who saw it explode says it flew into minute pieces like star dust. The one thing that all agree upon is the explosion. This was heard with equal clearness at Mayfield, 13 miles south of Traverse City, and at Williamsburg, 12 miles east. The effect was like that of an earthquake. Houses were jarred, windows shook, and dishes rattled upon the shelves. A swaying motion seemed to be given to the

* Mr. Richards did not notice the *exact* time. The Michigan observations give 2h. 28m.

† Letter from Rev. Mr. Richards. See also the Sci. Am. of March 15, 1879.

buildings as an upheaval and settling back. If the meteor had not been seen it would have been thought an earthquake shock."

In response to a letter of inquiry, Thomas T. Bates, Esq., editor of the *Grand Traverse Herald*, has given me the following additional statement:

"A night watch on our streets, an intelligent, cool-headed man, gives me in substance this: Was on watch; passing from due west to east; saw a great light; turned quickly and saw a ball of fire over my right shoulder; turned to left and watched it until it disappeared; when first seen it appeared about as high as ordinary rain clouds; was on a down grade close to and apparently over the bay; came from S. W. and passed to N. E.; appeared to me larger than full moon; full moon looks to me to be 18 or 20 inches in diameter; meteor appeared to pass me, and move out of sight at about the rate of speed a descending rocket has after its explosion; had a good chance to see it plainly; just after passing me a singular thing occurred; a ring of fire seemed to peel off the meteor itself, and this followed the ball of fire out of sight, but dropped a little behind it. It was perfectly distinct, and appeared to be hollow, for I could see a dark centre. Every thing was as light as day. I looked at my watch as it disappeared; it was just 28 minutes after 2 o'clock. I passed on my beat, and shortly the terrific explosion came. It shook and jarred every thing around. I immediately looked at my watch, and it was 32 minutes after 2.

"This is his report as it was given the next day, and as it was repeated to me a few days ago. I have no idea that the meteor fell into Carp Lake,* or that even a portion of it fell there. Every thing points to the correctness of Mr. Smith's report which I send you.

"Truly yours,

"THOS. T. BATES."

Charlevoix, Charlevoix County, Michigan, Lat. 45° 15′ N., Long 8° 12′ W. Willard A. Smith, Esq., editor of the *Charlevoix Sentinel* states that the meteor was seen by several persons at Charlevoix, where it appeared to be at least four times as large as the full moon; that it burst almost exactly over the village, and that parts of it were seen to fall. The ground was covered with deep snow, which was disturbed in several spots by the meteorites, though strangely enough no fragments were found. The meteor before striking the earth lighted up surrounding objects with an intensity of brightness surpassing that of sunshine, and its explosion resembled the sound of musketry. Its direction was nearly from S. W. to N. E., and the interval was very brief between the explosion and report.†

Cheboygan, Michigan, Lat. 45° 37′ N., Long. 7° 31′ W. Mr. and Mrs. Jacob Walton, of Cheboygan, both saw the meteoric light as it approached from the S. W. It lasted several seconds, and was so bright as to cast a very distinct shadow into the windows from the roof of the porch. From

* It was reported that a hole through the ice on Carp Lake had been discovered the next day, indicating that the aerolite had probably fallen into the lake.

† Condensed from a letter of Mr. Smith to Mr. Bates.

this shadow Mr. Walton estimated the greatest altitude of the meteor at about 45°. The explosion was not heard at Cheboygan.*

The preceding observations indicate that the meteor's course was approximately N. E. by N., and that it first became visible over a point not far from Lat. 44° 25′ N , Long. 9° 0′ W. The distance from Traverse city to the point at which meteoric matter is said to have fallen is about 42 miles. But the interval of four minutes between the observed explosion and the report corresponds to a distance of about 49 miles. This would make the point of explosion 26 miles above the earth's surface. The height at first appearance, if we can rely upon the rather uncertain estimate of Mr. Walton, at Cheboygan, must have been nearly 100 miles. The true length of the visible track was about 124 miles, and the length of its projection on the earth's surface, 66 miles. The time of flight is very uncertain, though the observations indicate a rather slow motion.

(9.) 1879, February 3, 11h. 30m., P. M. Indianapolis time.—This meteor is thus described by a correspondent of the Indianapolis *Daily News* for February 7 :

"Raysville [Henry County], Indiana, February 4, 1879. Last night between 11 and 12 o'clock was seen, by a few citizens of this place, one of the largest and most brilliant meteors ever observed in this section. It was larger than the one seen in December, 1876, but did not last so long, being but a few seconds in view. It apparently rose from the eastern horizon, and advanced rapidly, marking its path by a stream of flame until it had almost reached the zenith, when it exploded with a dull but plainly audible report. The different parts shot earthward in various directions, but the lights of all were extinguished before they had gone very far."

(10.) 1879, February 17, 8h. 0m., P. M., Chicago time.—This meteor was observed by C. A. Kenoston, Professor of Mathematics and Astronomy in Ripon College, Wisconsin. It was first seen in the West at an altitude of about 30°. It moved slowly along the line of the two southern stars in the square of Pegasus and disappeared near the horizon without any audible explosion. It was very bright—increasingly so—and seemed to have a short tail.†

(11.) 1879, February 20, 10h 45m., P. M.—This meteor was seen at Henryville, Clark County, Indiana, by Mr. Benjamin Vail. A brilliant train remained visible nearly a minute after the meteor itself had disappeared.‡

(12.) 1879, March 15, 3h. 53m., A. M.—This meteor was observed by a number of persons at Washington, Daviess County, Indiana. When first seen it was S. 10° W., at an altitude of 25°. It moved westward 20° and then burst into many fragments. The meteor was of a pale bluish color, but when it exploded it lighted up everything almost like daylight.

* Letter from C. S. Ramsay, Esq., to Mr. T. T. Bates.

† Letter from Prof. Kenoston.

‡ Thus briefly referred to in a letter from Mr. Vail. No further description was given.

A luminous cloud of smoke or vapor remained visible several minutes after the explosion. No sound was noticed.*

Remarks.

As already stated, no meteorites are known to have fallen from any of the fireballs in the preceding list; although in more than one case the disappearance was followed by loud detonations, and the explosion of the meteor of February 3 took place near the zenith of the principal point of observation. It is also remarkable that the only two whose velocities could be approximately determined were almost certainly moving in hyperbolic orbits. This last mentioned fact is in harmony with the theory of Professor Von Neissl, who regards aerolitic and denotating meteors as a distinct class of cosmical bodies, differing both from comets and periodic star showers in the original velocities with which they enter the sphere of the Sun's attraction.† But not only have certain comets moved in hyperbolas but the computed velocities of at least a few bolides have undoubtedly indicated elliptic motion. This theory therefore can hardly be accepted without further confirmation.

Are meteoroids moving in hyporbolas to be regarded in general as fragments of disintegrated comets?—The discovery that the meteors of November 14, November 27, April 20, and August 10, are intimately connected with comets moving in the same orbits, has suggested that *all* shooting stars and meteoric fire-balls may have been produced by the gradual dissolution of comets or cometary clusters. It must be remembered, however, that the comets connected with these meteor streams are all periodic, and that the dispersion of their matter is due to an indefinite number of returns to perihelion. In cases of non-periodicity complete dissolution, as the result of a single perihelion passage, would be extremely improbable. We conclude therefore, that the meteor of December 30, 1878, and others with hyperbolic orbits are *not* cometary fragments dissevered by solar influence.

That some fireballs explode noiselessly, while others, apparently no larger, produce loud detonations, is a remarkable fact not hitherto explained. The fact also that explosions very often occur without being followed by the fall of aerolites seems no less mysterious. Professor Newton has suggested that aerolites are probably furnished only by such meteors as penetrate the atmosphere with relatively slow motions; those moving with great velocities being burnt up or dissipated before reaching the earth's surface. Much, however, must evidently depend on the size and constitution of the meteoroids. Small meteors (shooting stars) are entirely consumed in the atmosphere. The composition and structure of meteoric stones are very widely various. "While some are extremely hard, others are of such a nature as to be easily reducible to powder. It is not impossible that when some of the latter class explode in the atmosphere they may be completely pulverized, so that, reaching the earth in minute particles, they are never

* Letter from Prof. D. E. Hunter.

† See the Report on Luminous Meteors by a Committee of the Brit. Assoc. for the Adv. of Sci. for 1877.

discovered." * The fireballs of August 11 and December 30, 1878, as well as that of February 3, 1879, had very rapid motions, and we can perhaps best account for the non-appearance of aerolites on the theory of their complete disintegration.† The meteors, it is obvious, could not have escaped out of the atmosphere. Events of this kind are doubtless of very rare occurrence. We have, it is believed, no authenticated instance in which a fireball has escaped after approaching within 39 miles of the earth's surface.‡ Assuming this as an inferior limit and taking 100 miles as the greatest height at which such bodies become visible, it is easy to show that but one in thirty-four can continue its orbital motion.

Suggestion to Observers.

In the theory of meteors it is a matter of first importance to determine the form of their orbits. If any move in hyperbolas they must have had a proper motion in space before entering the solar system. Now the nature of a meteor's orbit is determined from its observed velocity. Unfortunately, however, the time of flight (on which the velocity depends) is generally a very uncertain element; the estimates of different observers being very discordant. Persons therefore who report such phenomena should train themselves to habits of exactness in measuring the time of visibility.

Stated Meeting, May 16, 1879.

Present, 28 members.

Vice-President, Mr. Fraley, in the Chair.

A letter of envoy was received from Mr. A. Agassiz.

A letter of invitation to the members to attend the last session, May 9th, of the West Chester Philosophical Society was received.

Donations for the Library were received from the editor of the Zoologischer Anzeiger, Leipsig; M. Melsens, Brussels; the Annales des Mines, Paris; Meteorological and Antiquarian Societies, Cobden Club, and Nature, London;

* Met. Astr., p. 65.

† The average height of shooting stars at extinction is about 55 miles; that of aerolitic fireballs and detonating meteors at the time of explosion, about 25 miles.

‡ This was the nearest approach of the great meteor of July 20, 1860. See Prof. Coffin's memoir in the Smithsonian Contributions, vol. XVI.

Science Observer, Boston; Professors Brush and Dana; New Jersey Historical Society; Franklin Institute, Medical News, Numismatic and Antiquarian Society, Philadelphia; and Mr. Horace W. Smith.

The librarian exhibited the six volumes, in elephant folio, bequeathed to the Society by its late President, Dr. George B. Wood, entitled, *Gli Edifizi di Roma e sua campagna*, &c. *By Com. Luigi Canina*, 1848, 1851, 1856.

Vols. I and II describe the Roman walls, gates, forums, basilicas, porticos, illustrated in 151 plates; Vols. III and IV describe the Roman theatres, amphitheatres, circuses, baths, aqueducts, bridges, and imperial Palatine houses, in 159 plates; and Vols. V and VI describe the antiquities of the Campagna with a large detailed map of the same in six sheets, and 139 plates of views.

An obituary notice of the late Dr. Isaac Hays was read by Dr. D. G. Brinton according to appointment April 18, 1879.

The death of Prof. Paolo Volpicelli at Rome, his natal city, at 11 P. M., April 14th, 1879, was announced by family circular.

A communication "On the Geology of the Diamantiferous Region of the Province of Paraná, Brazil, by Orville A. Derby, M. S.," was read by the Secretary. This English version of a Portuguese report prepared for the Brazilian Government was read by permission of the Director of the National Museum.

Mr. Lesley remarked that the paper just read was an important contribution to Geology for several reasons:

1. It showed the topography of the southern part of Brazil in a new light. The province of São Paulo, south of the celebrated diamond province of Minas Geraes, and the province of Paraná, south of São Paulo, were traversed by three ranges of mountains, the Sierra do Mar, or Serra Graciosa, 3000 feet high, with peaks 5000 feet high, along the coast; composed of granite, porphyries and schists, equivalent to our Blue Ridge, South Mountain and Highland range. Back of this the Serra Serrinha (or Little Mountain) over 3000 feet high, composed of highly inclined metamorphic non-crystalline schistose gneisses, red schists, and talcose or hydromica schists, probably of Cambrian and Silurian age, with a covering of pebbles of

itacolumite and other quartzites. And back of this again at the west border of the famous Campos Geraes grass plain, the Serra de Esparança, also about 3000 feet high, composed of Devonian (and carboniferous?) fossiliferous soft red sandstones resting on the shales and sandstones of the great plain, and having a bold escarpment towards the east, like our Allegheny-Cumberland backbone range. The upper part of the escarpment, however, is an outcrop of amygdaloidal and porphyritic trap 350 feet thick, and full of agates, which forms the long back or west slope perhaps all the way to the Paraná river, the border of Bolivia; and this is conjectured by Mr. Derby to be of Trias age.

2. The trend of the formations resembles that of the Atlantic border of the United States, being from west of south to east of north. But while the general geographical order is the same, namely,—Azoic, on the east along the coast, and Devonian on the west,—there are striking differences, first in its great simplicity, and secondly, in the Trias and trap lying west of the Devonian. All three ranges have escarpments towards the east. A very high (2000 feet) plateau fills in the space between the first and second ranges; and another plain sloping gently westward, and 1500 to 2000 feet above the sea, fills in the belt 100 miles wide between the second and third ranges. There is, therefore, a general uptilt of this part of Brazil towards the east; higher and higher rocks coming in as one goes west, and the whole slowly settling into the great central plain of South America, as ours do under the plain of the Mississippi Valley.

3. The drainage system has some striking features of resemblance to that of the United States when we consider the short rivers which flow eastward into the Atlantic, and the long rivers, like the Upper Ohio, Kenawha and Tennessee, which flow through the Allegheny Mountains *down dip*, westward into the Mississippi. For Mr. Derby describes four main rivers: 1. The short Ribeira which alone flows east, through the granite range, into the Atlantic; 2. The long Iguassu on the south, and 3, the long Paranapamena on the north, both of which drain the first high plateau and flow in opposite directions from one another, and then turn and cut westward into the face of and through both escarpments, and through the second plain; and 4, the long Ivahy, between them, which cuts across the second plain and third escarpment westward, also into the Paraná.

4. Mr. Derby shows that the pot holes of the Tibagy (a branch of the Paranapamena) got their diamonds and other crystals not *directly* from any older formation than the Devonian, for the Tibagy drains nothing but Devonian country. But again he shows that the diamonds, &c., must have been set free by the erosion of the Devonian sandstones as pebbles or sand-grains or fossils; for the Devonian sandrocks are not in the least metamorphosed. The diamonds must therefore have been originally derived from much older itacolumite rocks, &c., out of which the Devonian rocks themselves were constructed by erosion and deposition.

Dr. LeConte, at the request of Mr. Dubois of the U. S. Mint, exhibited a very fine specimen of laminated native copper from the Calumet and Hecla mine, Lake Superior, and explained its appearance on the supposition that it had been subjected to a sliding pressure between the two walls of a fissure, thus representing a phase of slickensides.

Prof. Cope presented a paper entitled, "Notes on some landshells of the Pacific slope, by J. G. Cooper, M. D.

Mr. Lesley exhibited a slab of limestone full of Trenton trilobites, given nine years ago to Dr. Isaac Lea by Mr. S. Emlen Sharples, of Bucks County, Pennsylvania, who took it from the walls of a limekill at a quarry near Greenville, on the north edge of the belt of limestone rocks (enclosed in Mesozoic) 3000 feet thick, and dipping northward.

The slab is given by Dr. Lea to the Museum of the Geological Survey, and is valuable in evidence of the presence of the Trenton formation in a range over which discussions have been and are still taking place. It is of especial interest just now in view of the late publications of Prof. J. D. Dana, on the new localities of Trenton fossils around Poughkeepsie, east of the Hudson river.

The minutes of the last meeting of the Board of Officers were read.

Pending nominations Nos. 878 to 883, and new nomination No. 884 were read.

The Treasurer moved the following resolution, which was adopted:

Resolved, That the Treasurer be authorized to execute under the seal of the Society a transfer of the certificate of $5000 of the U. S. six per cent. loan held by them, and called in by the Secretary of the Treasury.

Dr. LeConte's resolutions of May 2, being in order of business, it was, after debate, on motion of Mr. McKean, resolved that the consideration of the resolutions be postponed to the second regular meeting in October next.

On motion, leave was given to Mr. Briggs, and Dr. Barker, and to Mr. Britton to withdraw their reports read at the last meeting.

On motion, an appropriation of $10 was made for subscribing to the life of Dr. William Smith, by H. W. Smith, one volume of which was exhibited, and the other promised in August next.

The meeting was then adjourned.

The Geology of the Diamantiferous Region of the Province of Paraná, Brazil. By Orville A. Derby, M. S. (English Version.)

(*Read by permission of the Director of the Brazilian Museum before the American Philosophical Society, May* 16, 1879.)

A portion of the ancient Capitania of São Paulo, now the province of Paraná, has long been known to be diamantiferous, but as no extensive washings have ever been undertaken, and as the gems thus far found have been of small size, although of good quality and color, only very little attention has been attracted to this region, in comparison with the more fully explored diamond fields of the provinces of Minas Geraes and Bahia. During a recent excursion in Paraná, I was able to make some observations on the geology of the region in question, and on the mode of occurrence of the diamonds.

The province of Paraná lies between São Paulo on the north, and Santa Catharina and Rio Grande do Sul on the south, and extends from the Atlantic to the river Paraná, occupying about six degrees of longitude and three of latitude. Topographically it is divided into two very distinct regions: a mountainous region along the coast, extending about 100 miles inland, and a plateau region, occupying the central and western portions of the province. The first or mountainous region constitutes a distinct geological area, while the plateau portion is divided into two grand geological provinces. Strictly speaking, the whole province, with the exception of a coast belt from ten to twenty miles wide, is a plateau, the coast mountains, constituting a part of the great Serra do Mar system, but known in this province by the beautiful and appropriate name of the Serra Graciosa, rising abruptly from the coast belt, and forming the margin of a plateau, from 800 to 1000 metres in height. In the northeastern part of this great plateau, an interior range of mountains, a continuation of the Paranápiacaba range of São Paulo, rises above the general level, but dies away towards the south. The coast belt, the Serra do Mar, and the eastern portion of the great interior plateau, whether mountainous, as in the north, or nearly level, as in the south, have the same general geological characters, and may properly be united together in what I will designate as the first or mountainous or, geologically speaking, the metamorphic region. The topography of this region, in the more mountainous portions, is bold and abrupt, with picturesque peaks, rising to a height of about 1500 metres above the sea, and 600 to 700 metres above the river valleys and the more level portions. The latter are, in general, moderately undulating prairies, with strips and patches of forest. In the southern portion of the province one such area, of considerable size, extends from the Serra do Mar to the margin of the second region, and reaches northward to beyond the capital, Curityba. Another and much smaller area exists to the west of the second range of mountains, in the north of the province, about the city of Castro. This last is generally included in the second region, under the name of the Campos Geraes, but geologically it has nothing in common with those campos, and belongs to the first region.

The rocks of this region are all metamorphic, the beds being highly inclined, with a general strike E. N. E. Along the coast and in the Serra do Mar granite, porphyritic and schistose gneisses occur, as in the corresponding region of the province of Rio de Janeiro, with an abundance of igneous rocks, including diorite, porphyry and a compact variety with a basaltic structure. In the plains about Curityba epidotic rock occurs abundantly, with schistose gneiss; while farther west the latter is associated with metamorphic, noncrystalline, red schists, which are either talcose or hydromica, and with red, metamorphic porphyry, which is a more metamorphosed portion of the same schists. In the plains about and to the west of Curityba a thick deposit of decomposed material covers the rock and good exposures are rare. The rocks seen *in situ* are those above mentioned, but an abundance of pebbles of itacolumite and other varieties of quartzite attest the existence of other rocks in the vicinity.

Unfortunately I was unable to visit the northern mountainous portion of this region, about the head waters of the river Ribeira, which is by far the most interesting part of the metamorphic belt. In the western margin of this district, which is known by the general name of Assunguy, I found the red schists and porphyries, above mentioned, extensively developed, with beds of white marble and iron ore. From the specimens and information I was able to obtain from this region, it appears to be very rich in marbles, iron ores and auriferous rocks. From about fifteen miles north of Curityba, I saw a greenish serpentine marble, identical with that associated with the same red schists near Sorocaba, province of São Paulo, and from other portions of the Assunguy region, I saw specimens of itacolumite and of the peculiar auriferous, ferruginous quartzite called Jacutinga, so characteristic of the metamorphic region of Minas Geraes. These specimens, and the few observations I was able to make, confirm the opinion I had already formed, that the non-crystalline metamorphic series, composed of quartzites (itacolumite, itabirite, jacutinga, etc.), talcose (hydromica?) schists and marbles,* so characteristic of the interior of the provinces of Bahia and Minas Geraes, extend in a continuous belt to the southward, probably as far as Rio Grande do Sul, presenting everywhere the same essential characters.

I have elsewhere† presented reasons for referring the crystalline meta-

* The crystalline marbles form a very subordinate part of the series, which, for convenience, I call non-crystalline, to distinguish it from the older crystalline series, composed of gneisses, etc.

† Proceedings, American Philosophical Society, page 161 above.
Archivos do Museu Nacional, Rio de Janeiro, Vol. II, 1878.

morphic series to the Archean, and the non-crystalline series to the Lower Silurian or Cambrian, a classification in which I but follow my esteemed friend and teacher, the lamented Prof. Hartt.

Going west from Curityba, at a distance of about thirty miles, an abrupt escarpment, called the Serrinha, or Little Serra, is met with, rising to an elevation of 1040 metres, or about 200 metres above the plateau of Curityba, which it completely dominates. This escarpment extends across the province in a general north-south direction, being, however, somewhat irregular and zig-zag towards the north, where it becomes, in a measure, confounded with the higher lands of the Assunguy region, which surpass it in elevation. In consequence of this it does not separate so completely as in the south the various systems of drainage.

This escarpment is composed, in the lower part, of the inclined metamorphic beds above described, capped by massive horizontal beds of coarse, friable, white sandstone, which rise everywhere to the same level, but vary in thickness from 20 to 100 metres, owing to the irregularities of the surface upon which they were deposited.

The Serrinha forms the eastern margin of the second region, the far famed Campos Geraes. This is a vast grassy plain, extending westward about 100 miles, with a gentle inclination towards the west, where the elevation of the highest portions becomes reduced to from 850 to 900 metres. The surface along the margin is almost perfectly level, but the innumerable streams, fed by thousands of springs and by torrential rains, soon cut themselves deep valleys, descending in the western portion of the region to an elevation of 600 metres, rendering the surface more and more undulating, as one enters the Campos. In a broad zone in the western part, there are, in addition to the irregularities due to denudation, others of greater consequence, caused by numerous immense dykes of diorite.

The character of the rock changes also in going westward, the sandstone becoming finer and tending to give way to beds of shale, which occur interstratified with the sandstone, in such a manner as to show that they belong to the same formation. In general it may be said that, in the west, as a rule, the lower portion of the formation is composed of shales and shaly sandstones, the shales in the extreme west becoming charged with silicious and calcareous concretions, and containing a few subordinate beds of a peculiar, silicious, oölitic limestone. This shaly portion is wholly, or in part, overlaid by soft sandstone, which to the eastward is the predominant formation. The sandstone appears to cover the shales over the entire region, but on this point I cannot form a positive opinion, before making a detailed study of the fossils collected, as it is possible that, in the wooded limestone region, I may have been deceived in regard to the identity of the sandstone that occurs there, with that of the open campos, further east. The rock is everywhere charged with pebbles, and often, in limited regions, changes to a pudding stone or conglomerate. In a ravine near Ponta Grossa, I found such a conglomerate, containing boulders a foot and a half in diameter, of metamorphic rocks, such as gneiss, syenite, quartzite, etc. The most interesting is a boulder of metamorphosed conglomerate, containing rounded pebbles, the size of one's fist, of the rocks above-mentioned, united by a metamorphosed, silicious cement. These boulders undoubtedly indicate the neighborhood of some high point of the original surface of the underlying metamorphic rocks, which, before being buried, formed an island in the sea, in which the deposits of shale and sandstone were being laid down.

In the portions of this region where the sandstone is the prevailing surface rock, the soil is poor and sandy, supporting only grasses and, on the slopes, small patches of forest, in which the Araucarian pine occurs in great abundance. This tree is also extremely abundant on the metamorphic plateau of Curityba. The shaly portions of the region have a somewhat better soil, but are still poor, in the eastern and central parts. Going westward, the soil improves, the beautiful open campos giving place to others with scattered pines and an abundance of shrubs, and these in turn, in the extreme west, where the shale is more varied in character, and where diorite and calcareous rocks are abundant, are replaced by luxuriant forests, showing the superior quality of the soil.

The geological age of this sandstone and shale has never been satisfactorily determined. The first light on the subject was thrown by a few fragmentary fossils, discovered by Mr. Luther Wagoner, Assistant of the Geological Commission, in 1876, and determined by Mr. Rathbun and myself to be Palæozoic, and probably Devonian. A few months ago, I found in the province of São Paulo, in a cherty limestone, identical with that above mentioned, a few obscure Lamellibranchs, belonging to Devonian or Carboniferous types. In my last excursion I visited the localities discovered by Mr. Wagoner, and had the good fortune to find more perfect specimens. From a bed of shale, intercallated in the sandstone, at Ponta Grossa, close by the conglomerate locality above mentioned. I found a species of Ophiuran, a few badly preserved Lamellibranchs, and species of *Lingula, Discina, Spirifera, Rhynchonella, Streptorhynchus and Vitulina*, strongly resembling, and probably identical with, those of the Devonian of the Amazonas. The *Spirifera, Streptorhynchus* and *Vitulina* are particularly well-marked Devonian types, the former being probably identical with *S. duodenaria*. In the cherty limestone at Ivahy, I found a number of species of Lamellibranchs, some of which are identical with those of São Paulo, but I could not, in the field, give them the study required to determine with certainty whether they belong to the Devonian or Carboniferous. Fragments of *Lepidodendron* also occur in the same rocks.

As above remarked, the elevation of this second region diminishes somewhat towards the west, where the heights, including the diorite ridges, rise to 850 or 900 metres, although, owing to the excessive deepening and widening of the numerous valleys, the general level is somewhat lower. From this level rises a second escarpment, known as the Serra de Esperança, to a height of 1040 metres. On the steep slope there is seen, in ascending, a considerable thickness of soft, red sandstone, overlying the shales and sandstone of the second region, and above this a bed, 100 metres or more in thickness, of amygdaloidal and porphyritic trap, apparently a kind of trachyte. The amygdaloid is full of beautiful agates. This second escarpment is the beginning of the third geological region, the topographical features of which are very similar to those of the second or Campos Geraes region,—that is, produced by denudation on horizontal beds. The escarpment extends entirely across the province, in a north-south direction, and into the province of São Paulo, where I have recognized the same rock, in the margin of the plateau, west of the Piracicaba river. South of the river Iguassú, I am informed by Mr. Luis Cleve, a very competent observer, that it bends eastward, under the name of Serra de Espigão, and extends as far as the Serra do Mar. Prof. Hartt had already observed that the Serra do Mar, in Santa Catharina, is capped by phorphyritic trap. It is probable, therefore, that these rocks cover the greater part of the interior of that province, as well as the neighboring portion of Rio Grande do Sul, in which agatiferous trap is common. A portion of the Republic of Uruguay probably belongs to the same formation. To the west the country is unexplored, but from the scanty information I could obtain, it seems probable that the trap formation extends to the river Paraná.

The surface of this region is, in general, a heavily wooded plain, but has several extensive campos, the most important ones being those of Guarapuava, which unite, to the south, with the extensive campos of Rio Grande do Sul. There appears to be a slight inclination towards the Paraná, and the river valleys being deep, present high steep slopes, that have been dignified by geographers, as well as the common people, as mountains. In point of fact, no true mountains exist in the province, outside of the metamorphic area.

No very definite data exists for determining the geological age of this enormous outflow of trap. It is certainly later than the Devonian, and is most probably Mesozoic. In lithological characters both the trap and the red sandstone, which appears to be associated with it, and to be distinct from the underlying Devonian series, resemble in a striking manner the Triassic rocks of eastern North America.

The drainage of the province is determined by the above described topographical features, and is principally toward the Paraná, only one large river, the Ribeira, flowing directly to the Atlantic. This river rises north of Curityba, in the mountainous Assunguy region, and flows northward, into the province of São Paulo, breaking through the Serra do Mar, above the city of Iguape. Some of its tributaries flow down the slope of the Serrinha, and have cut ravines, indenting the margin of the sandstone region, but can hardly be said to drain any part of the Campos Geraes. In the same metamorphic region, between the Serra do Mar and the Serrinha, rises the principal river of the province, the Iguassú, which flows first southward and then westward, traversing the second and third regions, to empty into the Paraná. Passing over several almost unknown rivers, belonging exclusively to the third region, we come to the Ivahy, which rises in the wooded western portion of the second region, flows for some distance northward, skirting the base of the Serra de Esperança, and finally turns westward, entering the third region, and traversing it to the Paraná. In the north, forming a part of the northern boundary of the province, is the large river Paranapanema, which, like the Igaassú, rises in the metamorphic region and traverses the two others, receiving from the province the Itararí, Rio de Cinzas and Tibagy. The latter is, *par excellence*, the river of the Campos Geraes, in which it rises and flows, to within a short distance of its mouth, where it enters the third region. It receives from the north the Pitanguí and Yapo, both of which rise in the metamorphic region, about Castro, and enter the sandstone region by deep cañons.

The diamantiferous region is principally in the valley of the Tibagy. Its tributaries, the Yapo and Pitanguí, also contain the gems, but are supposed to be less rich than the main river, perhaps because of insufficient examination. Fine diamonds are also said to have been found in the Rio de Cinzas. As far as I was able to learn, they have never been found in the Iguassú or Ivahy, although I see no reason why they should not occur, at least in the former river.

The gems occur in the sands of the river, in the numerous pot-holes, and also in gravel banks, known as dry washings, situated in the campos, at a greater or less elevation above the river. Near the village of Tibagy, are two of these dry washings. One is in a depression of the Devonian shale, in the valley of a small stream, and is only a few metres above the level of the river. It may therefore be supposed to have been deposited by the river, or by the stream that now cuts through the deposit. The section presents below a very irregular deposit of pebbles and sand, a few centimetres in thickness, which is the part washed. Above this are three or four metres of coarse, variegated sand, with pebbles scattered irregularly through the bed, which shows very irregular lines of deposition, as if deposited in an eddy. Portions of this bed have been cemented by oxide of iron, forming curious, corrugated sheets, globes, and irregular masses, of extravagant form. On top is about a metre and a half of dark-red, structureless clay. The other washing is on a hill side, near the top, at an elevation of about twenty metres above the bed of a small stream, which flows along the base of the hill, and empties into the river, at an elevation of about 100 metres below the mine. The deposit has evidently been laid down under water, but it can scarcely be attributed to any of the present streams. It also rests on Devonian shale, fragments of which are scattered abundantly through it, and consists of a bed, about three metres thick, of sand and pebbles, in which diamonds are irregularly distributed. Above this are about six metres of structureless, red clay, like that of the first washing.

The pebbles in both these washings are well rounded, and consist mainly of quartz and of quartzose rocks, with pebbles of gneiss, and of various other metamorphic and igneous rocks. The red clay continues nearly to the top of the hill, which is a long ridge, with moderate slopes, and extends for a considerable distance horizontally, but whether it is everywhere underlaid by the diamautiferous gravel or not, I cannot state. Other washings have been opened, some twelve or fifteen miles below Tibagy, and it is probable that there are many other localities in which diamonds may be found.

As I saw no work in progress, I could form no idea of the richness of these mines. The diamonds are said to be rare, and small and poor, in comparison with those found in the river. The workings have been conducted on a very small scale and very carelessly, so that, although the mines are certainly not extremely rich, it is impossible to affirm that they would not repay better, and more systematic management. A small quantity of gold also occurs in these washings, and this metal is quite generally distributed throughout the region.

In the river, the best stones are found in the deposits in the pot-holes, which contain gravel, firmly cemented by ferruginous matter. Rarely pot-holes are found with a very hard, bluish cement, and these are reported to contain the most diamonds, which are of the best quality both as regards size and perfection. Not having seen this cement, I can form no idea of its character. The miners note as a curious fact, that in a group of pot-holes close together, one may have the bluish cement, while all the rest have the ferruginous, the pebbles of the one being quite different from those of the others.

Many of the stones shown me were broken and worn, but a fair proportion were perfect crystals. The largest ones I saw were about the size of a small grain of corn, but were irregular and broken. The most valuable stone found here, of which I could obtain an authentic account, was sold for a conto of reis ($500). The stones are in general of good color and brilliancy.

Coming now to the question of the origin of the diamonds, it seems to me to be very evident that they are washed out of the Devonian sandstone. As already remarked, the Tibagy is almost exclusively a river of the Devonian plain. The lower portion, in the trap region, is not known to be diamantiferous, and if it is, since the stones occur throughout the whole course of the river, before it enters the trap formation, the latter may be eliminated from the problem. There remain then the Devonian rocks and the diorite. Having passed around the head of the river, and crossed it at three different places, I have become satisfied that these are the only rocks that come to the surface, to the eastward of Tibagy, that is to say, in the diamantiferous region. It is of course possible that the river may have cut down, in certain places, to the underlying metamorphic rocks, but of this there is no evidence, and it is not probable that any considerable area of such rocks are exposed, or if so exposed that it could have furnished diamonds to so wide-spread a region. Two considerable tributaries, the Yapo and the Pitanguí, flow from the metamorphic region, and might be supposed to have brought the diamonds from the rocks cut through in that region, but I was unable to obtain any notice of diamonds, found in those rivers, before entering the sandstone district, and the Tibagy is diamantiferous above, as well as below, its confluence with them.

The diorite can scarcely be supposed to have furnished the gems, not alone on account of the nature of the rock, but because in the upper part of the valley, where diamonds are not uncommon, diorite is extremely rare, if it occurs at all, and because the pebbles which always accompany the gems, certainly do not come from the diorite. This last has most probably furnished, by decomposition, the red clay, above the gravel at Tibagy. The only other rocks which, as far as I observed, could have given such a clay, are those about Castro; but it would be difficult to account for its transportation from there to Tibagy, while large dykes of diorite are common near the latter place.

The secondary origin of the gravel is not far to seek. The sandstone is everywhere full of pebbles, and on every slope where this rock is exposed the surface is strewn with gravel, set free by disintegration. The primary origin of the pebbles is equally clear; they, in common with all the material of the Devonian beds, are derived from the metamorphic series. That the diamonds have the same primary origin can hardly be doubted, as they cannot be supposed to have been produced in the sandstone, which does not show the slightest sign of metamorphism or of crystallization of any kind. That the diamond must have originated in some series rich in crystals is evident from the fact, that it is always accompanied by a variety of crystals, called by the miners *informations.* I have not had an opportunity of determining those of Tibagy, which do not differ materially from those already described from Bahia and Minas Geraes.

It may then be regarded as extremely probable, if not absolutely certain, that the diamonds originated in the metamorphic series; that, during the Devonian age, they were washed out and redeposited in the sandstone, from which they have been again extracted, to find their third resting place in the sand banks and pot-holes of the river, and in the gravel deposits of the campos. May we not suppose that the rare patches of gravel, with blue cement, are nests formed in the sandstone and laid bare by the formation of pot-holes?

As to what portion of the extensive metamorphic series constituted the original matrix of the diamond, I could obtain no data in Paraná. The evidence on the subject, which is being slowly accumulated, tends apparently to the confirmation of the old idea, that it belongs to some part of the itacolumite series.

After my studies in Paraná, it seems to me probable that the extensive high sandstone plateaus of Central Brazil, which we have been accustomed to consider of Tertiary age, are in reality much older, and probably Palæozoic. It is yet too early to form a decided opinion respecting them, but if my suspicion regarding their age proves correct, we can explain the course of geological events in Brazil much more satisfactorily than at present.

The lower plateaus, of almost precisely similar topographical and lithological character, along the coast and on the Amazonas, are certainly later than the Cretaceous; but none of those, whose age can be positively determined, rise much above 1000 metres, and the higher plateaus of the interior have been referred to the Tertiary, solely on resemblances in lithological characters which, in Brazil, are peculiarly deceptive and untrustworthy.

Obituary Notice of the late Isaac Hays, M.D. By Daniel G. Brinton, M.D.

(Read before the American Philosophical Society, May 16, 1879.)

The subject of the present memoir, Dr. Isaac Hays, had been at the time of his death, a member of this Society for very nearly fifty years, his name first appearing upon its rolls in 1830. For many years he was also one of its most active members, and in the published volumes of our Proceedings which embrace the period previous to 1850, his name frequently recurs. Most of the subjects which he brought before the Society, related to medical science, and especially those portions of it connected with the physiology of vision and ophthalmic surgery. But he did not confine himself to professional topics. I find, on looking over the earlier numbers of our Proceedings that he took considerable interest in geology, particularly in the remains of the gigantic mammals preserved from the post-tertiary period. About 1840, a number of such remains were collected in Missouri by Dr. Koch, and subsequently exhibited in this city and London. An active discussion arose among palæontologists as to their classification. Besides, the mastodon, the *Elephas primogenius*, and the mammoth, they distinctly proved, so one party maintained, the former existence of another species of mastodontoid animals belonging to the class *Proboscidæ*, to which was given the name *Tetracaulodon*. Dr. Hays sided with this party, and in addition to many verbal statements embodied in the Proceedings, he published in the Transactions a paper on the teeth of the mastodon, evincing in its preparation a most careful study of his theme. That later investigations have disproved his position, detracts but little from its merit; for the abstract correctness of a scientific theory is of less importance than the honesty and ability with which it is advocated. At various periods Dr. Hays served on the Committee of Publication, and the Council, and was Curator.

At the time Dr. Hays was elected to this Society, he was thirty-four years of age. He was born July 5, 1796, in this city, his father residing at that time on Chestnut street below Third. His education had been first at the Grammar school kept in those days by Samuel Wylie, next at the University of Pennsylvania, whence he was graduated, A. M., in 1216; and finally as a medical student in the same institution whence he received the degree of M. D., in 1820. His preceptor was the eminent Dr. Nathaniel Chapman, celebrated not less for his wit than for his professional skill.

In early life Dr. Hays was much interested in natural science, and even before his graduation in medicine, he joined, in 1818, the Academy of Natural Sciences. With its history and success, he was identified for more than half a century. From 1865 to 1869 he was its President, and in many other official capacities actively aided its progress and influence.

His sympathies with the advance of general science led him to unite with others in the organization of the Franklin Institute. He was one of its original members, and for a number of years its Corresponding Secretary.

To his activity much of the success of that prosperous institution can justly be ascribed.

As a physician, Dr. Hays studied and practiced his profession in a spirit of liberal culture and honorable feeling. The special branch which he cultivated was ophthalmology, and for a long time he stood first in that department in this city. He was one of the earliest to detect the pathological condition known as astigmatism, and the case which led to his discovery of it was reported to this Society.

His professional life was not confined to the care of his large practice, but extended to the relations of medical men to each other and to the public. Thus he was a member of the Convention which organized the American Medical Association, and of that which led to the formation of the State Medical Society of Pennsylvania. As Chairman of the Committee of the former body to draw up a Code of Ethics, he was mainly instrumental in collating and reporting the code which has since been universally adopted throughout this country, and in some parts of Europe. He was also Chairman of the Board of Publication, and Treasurer of the Association for several years.

In September, 1835, he was elected a member of the College of Physicians and for a number of years was its Senior Censor. He was also Chairman of its Building Committee, and it was largely through his endeavors that the commodious structure at the corner of Thirteenth and Locust street, was erected for the College.

Dr. Hays literary labors include an edition of Wilson's Ornithology, 1828; Arnott's Elements of Physics, 1848; Hoblyn's Dictionary, 1846; Laurence on Diseases of the Eye, 1847, and some other medical works; but he is best known in this connection as the editor of the American Journal of the Medical Sciences, with which he was actively connected from February 1827, until his death. The ability and judgment he displayed in this task met with full recognition from the profession, both in this country and Europe, and the Journal has for half a century been recognized the world over as unsurpassed by any other medical periodical of its class in this country.

Advancing age led to his retirement from active practice in 1864–5, but he continued his literary and scientific labors, with unimpaired faculties and undiminished interest in the progress of knowledge to the last.

In conclusion, I may add that Dr. Hays married in 1833, and at his death left four children, one of whom is a prominent member of the same profession, and has succeeded to his father's position as editor of the American Journal of the Medical Sciences.

Eleventh Contribution to the Herpetology of Tropical America.

By E. D. Cope.

(*Read before the American Philosophical Society, June 20th,* 1879.)

The materials studied in the preparation of the present paper, are the following:

1. A collection made at Batopilas in Southern Chihuahua, by Edward Wilkinson, Jr.

2. Two collections made at Guanajuato on the Mexican Plateau, by Dr. Alfredo Dugés.

3. A collection from the Isthmus of Tehuantepec, by Francis Sumichrast.

4. A collection made in Costa Rica from Jose Zelodon.

5. Three collections from the Island of Santo Domingo, made by Messrs. Wm. M. Gabb and Charles A. Fraser and Dr. J. J. Brown.

6. A collection from the Island of Dominica, made by Ferdinand Ober.

7. A collection from the Island of Tobago, also from Ferd. Ober.

8. A few specimens from North west Bolivia, from the late Prof. James Orton.

Of these, all excepting Nos. 1 and 8, and a part of No. 2, belong to the Smithsonian Institution, and have been placed in my hands for identification, by Professor Baird, the Secretary.

No. I. Batopilas, Wilkinson.

Batopilas is a mining town of Chihuahua, in a region celebrated for the extent and richness of its silver deposits. It is on the western side of the water shed of the Cordilleras on the upper waters of a tributary of the Rio Fuerte, which forms in the lower part of its course the boundary dividing the States of Sonora and Cinaloa. The surrounding country is mountainous and dry.

This locality is one of especial interest in its relations to the faunal districts of the adjacent parts of Mexico and the United States. The absence of *Batrachia* and Turtles from Mr. Wilkinson's collection shows its similarity to the elevated regions north and south of it.

Lacertilia.

1. *Anolis nebulosus* Wiegm.
2. *Cyclura acanthura* Wiegm.
3. *Uta bicarinata* Dum.
4. *Sceloporus tristichus* Cope. Report U. S. G. G. Survey W. of 100th Mer. G. M. Wheeler, Vol. III, p. 571.
5. *Sceloporus clarkii* Bd. Gird.
6. *Phrynosoma cornutum* Harl.
7. *Phyllodactylus tuberculosus* Wiegm.
8. *Cnemidophorus communis* Cope, Var. II. Proceedings American Philosophical Society, 1877, p. 95.

Ophidia.

9. *Stenostoma humile* B. & G.

10. *Procinura æmula* Cope, gen. et. sp. nov.

Char. gen. Dentition opisthoglyph. Form that of *Elapomorphus*. Two nasal, one loreal, and one preocular plates; internasals and prefrontals distinct. Scales smooth, excepting those of the posterior dorsal and caudal regions, where they are keeled, those of the latter so much so as to be tubercular. Anal plate double.

This genus is near to *Scolecophis* Cope, but the peculiar tubercular carination of the tail distinguishes it. The only known species inhabits a rocky, mountainous region, and I have little doubt that this peculiar character enables the animal to force itself into the earth or beneath stones. The tail is used as a fulcrum in pushing against rough and resistant bodies.

Char. specif. Scales broad rounded, in fifteen longitudinal series, the median rows rather smaller than the lateral, of which three rows are equal. Muzzle projecting beyond the mandible, rounded, the rostral plate visible from above, presenting an obtuse angle posteriorly. Top of head flat. Prefrontals much wider than long, their external canthal border equal to that of the internasals. Frontal wide, sending a long angle backwards. Parietals short, wide; temporals 1–2, the first small, as deep as long. Superior labials seven, all except the first, deeper than long, the third and fourth entering the orbit. Preorbital vertical, narrow, not reaching frontal; postorbitals two, equal and small. Loreal quadrangular. Inferior labials eight, fourth largest; pregeneials three times as long as postgeneials and separated from gastrosteges by six rows of scales. The dorsal carinæ first appear on the twenty-second transverse row of scales anterior to the vent and occupy the median nine series. All the caudal series are keeled, and as they are wider than long, the free apices of the keels projecting, give them a depressed pyramidal form, Gastrosteges 148; urosteges 41.

In the coloration of the body this species is an almost exact repetition of the *Elaps fulvius*. It is surrounded by wide black rings, which are broadly bordered with yellow, and separated by red interspaces of twice their width. The scales of the red spaces have each a central black spot which are more distinct than in *E. fulvius*, on the anterior part of the body above the sides; posteriorly they are weaker. The black annuli pass round the belly, but all are somewhat broken anteriorly. Between them the gastrosteges have black shades. The coloration of the head differs from that of the *E. fulvius* in having merely a large black spot covering the parietal, superciliary and frontal plates, and extending round the eye but not reaching the edge of the lip. Muzzle and chin unspotted.

Total length, M. :364; length of rictus oris, .011; length of tail, .061.

Although this curious and handsome serpent so much resembles the *Elaps fulvius*, it is not yet known that the two species inhabit the same region.

11. *Phimothyra grahamiæ* B. & G., numerous specimens.

12. *Eutænia sirtalis* Linn. variety near the sub-species *ordinata*, having

the dorsal and lateral bands and lateral dark spots, obsolete. General color bright olive.

13. *Eutænia cyrtopsis* Kenn.
14. *Trimorphodon upsilon* Cope.
15. *Elaps euryxanthus* Kenn.

REMARKS.

This collection, though small, is of interest as serving to fix the extension of the Sonoran fauna to a point further south than has been hitherto practicable. The following are the faunal affinities of the fourteen species enumerated above. *Eutænia sirtalis* may be dismissed as common to Mexico and the Nearctic Realm; *Procinura æmula* may also be passed by as peculiar to the locality investigated, so far as yet known. *Stenostoma humile*, is, according to Baird and Girard, an inhabitant of the Pacific district, and is a very rare species. Species found in various parts of Mexico are: *Anolis nebulosus*, *Cyclura acanthura* and *Cnemidophorus communis*; the last occurring also in S. W. Texas. *Trimorphodon upsilon* is a species of West Mexico, having been found at Guadalaxara, Guanajuato, and the present locality; but is not as yet known from the West Coast. Six species are exclusively of the Sonoran district viz: *Sceloporus tristychus; S. clarki, Phimothyra grahamiæ; Eutænia cyrtopsis* and *Elaps euryxanthus*. *Phyllodactylus tuberculosus* belongs to the Sonoran fauna, but occurs also south of Batopilas in Western Mexico. *Phrynosoma cornutum* is also Sonoran, but is Texan besides. The comparison of this list so far as it relates to the Mexican fauna, is with that of the Tableland; only two species of it, occurring in the Tierra Caliente also; these are the generally distributed *Cyclura acanthura* and *Cnemidophorus communis*.

Mr. Wilkinson's collection contained a specimen of *Pelamis bicolor*, which he informs me was taken in the Gulf of California near Guaymas.

In the Proceedings of the Philadelphia Academy for 1868, p. 310, I noted that William Bischoff had sent to the Smithsonian Institution from Mazatlan the species *Agalychnis dacnicolor* Cope, *Leptodira personata* Cope, *Leptodira pacifica* Cope, and a species of *Holbrookia*, which I named *H. bischoffi*, but did not describe. Since then it has been described under the name of *H. elegans* by Bocourt (Mission Scientifique de Mexique 1874, p. 164), which name it must retain. I add to this list *Bufo debilis* Girard, which gives the extreme western limit of its range. It occurs also in West Texas.

II. GUANAJUATO, Duges.

One collection from this locality was sent me by Dr. Duges, and another collection was subsequently received by the Smithsonian Institution. I give the catalogue numbers of the specimens contained in the latter.

BATRACHIA.

1. *Spelerpes belli* Gray.
2. *Bufo punctatus* B. and G.
3. *Bufo intermedius* Günth.
4. *Bufo monksiæ* Cope, sp. nov.

Cranium without any crests, superior borders of orbits not reverted, canthus rostralis sharp, lores perpendicular, muzzle vertically descending to lip. Tympanic disc concealed, parotoid gland a wide oval, and rather large. Fingers moderate, first and second equal, fourth longer. Heel of extended posterior limb reaching posterior border of orbit. Web of toes measuring half the length of the shorter. Skin rough with small harsh tubercles, which are more remote on the back, but are closely appressed on all the inferior surfaces. They are especially acute on the limbs. There are two distinct tarsal tubercles, which are prominent, though small and without cutting edge.

Color above, blackish-brown with a few small ashen spots, and an ashen cross band extending across the eyelids and intervening frontal space. Lores and lips brown spotted; blackish spots on the sides, belly, throat and limbs.

Length of head and body, M. .035; axial length of head to angle of mandible, .010; width of head at angle of mandible, .012; length of hind limb, .042; length of hind foot, .020. No. 9896.

This is one of the few Mexican species without cranial crests, resembling in this respect, the *B. compactilis*;* *B. hæmatiticus*, and *B. politus*. From the first it differs in the absence of the fossorial spur; from the last two in the roughness of the skin, and the degree of palmation of the feet; the acute canthus rostralis distinguishes it from the *B. politus*. I dedicate it to my friend Miss Sarah P. Monks, of Cold Spring, New York, who has paid especial attention to the cold blooded vertebrata of North America.

5. *Spea hammondi* Baird.

Several specimens. This species was also brought from Chihuahua by John Potts, so that its range is shown to be wide. Nos. 9881, 4–5, 9915.

6. *Hyla eximia* Baird. Nos. 9875, 9898.

7. *Hyla arenicolor* Cope. Nos. 9897, 9916.

8. *Malachylodes guttilatus*, gen. et sp. nov.

Char. gen. Mostly like *Syrrhophus* and *Phyllobates*, but with a fronto-parietal fontanelle as in *Liuperus*. Nasal bones wide, in contact on the middle line. Vomerine teeth none. Toes free, no tarsal spurs.

This new genus is of interest as exhibiting the lowest station in the series which is typified by *Hylodes*, excepting that the nasal bones are not so reduced as in the type of *Phyllobates*. The presence of the fontanelle places it nearer to *Hylorhina* than any other of this group, and allies it to the *Liuperine* division; but its xiphisternum is a thin cartilaginous plate, and the terminal phalanges support a transverse piece as in the *Hylodinæ*.

Char. specif. Head flat and rather wide, with an oval muzzle. Canthus rostralis not well marked. Eye not prominent nor large, its diameter equal distance from its anterior border to the nostril. Muzzle not overhanging. The heel reaches the posterior border of the orbit, and the wrist reaches the end of the muzzle. The foot is rather short, and the terminal dilatations are small. Tarsal tubercles insignificant. Skin without folds, smooth, except some small tubercles on the eyelids, and a trace of areolation on the posterior part of the sides and abdomen.

* *B. levifrons* Brocchi; Bullet. Société Philomathique, Paris, 1877, 13 (Extract).

Color above dark mulberry-brown with numerous, very faint small pale spots. On the sides the ground color becomes paler, and the light spots much more distinct. Limbs banded with rufous. Lower surfaces uniform yellowish.

Length of head and body, .022; of head to angle of jaws, .007; width of head at angle, .009; length of hind limb, .030; length of hind foot, .014. No. 9888.

This species has some resemblance to the *Syrrhophus leprus* from Tehuantepec.

9. *Cystignathus microtis*, sp. nov.

Like all the Mexican species of this genus, this one has short series of vomerine teeth behind the posterior nares, and a discoidal fold of the abdominal integument. It differs from the *C. melanonotus* Hallow, in not having a dermal margin of the posterior digits. The dorsal skin does not present any glandular folds such as occur in *C. labialis* and *C. gracilis*. The muzzle is not elongate, and is convex in transverse section, the canthus rostralis being absent. The limbs are very stout, especially the femur, as in *C. melanonotus*, but not elongate, the heel only reaching the posterior border of the orbit. The eye is not large, and the tympanum's diameter is only two-fifths of its length, a characteristic peculiarity of the species.

Color above dark brown, with a blackish pale edged triangle between the eyes, with its apex directed posteriorly. A dark light edged spot below the front of the orbit. Tympanum and a streak behind it, blackish. No light stripe on the upper lip. Belly dirty white gray, marbled anteriorly. Throat dark brown; limbs light brown below.

Length of head and body, .028; length of hind leg, .038; length of hind foot, .020; length of head, .009; width of head behind, .009.

Three specimens. Nos. 9906, 9908–9.

10. *Rana montezumæ* Bd. No. 9891.

11. *Rana halecina* Kahn. *var.* No. 9900.

LACERTILIA.

12. *Sceloporus dugesi* Bocourt. Nos. 9886, 9893, 9904–5.

13. *Sceloporus formosus* Wiegm. *var.* Nos. 9876, 9878.

14. *Sceloporus torquatus* Wiegm. *var.* 9877.

15. *Sceloporus spinosus* Wieg. Eupataro.

16. *Sceloporus grammicus* Wieg. Eupataro.

17. *Holbrookia maculata* B. and G.; sub-species *approximans* Baird. This is the Mexican form of *H. maculata*, and has not been found within the limits of the United States. Nos. 9894, 9903.

18. *Cnemidophorus communis* Cope. Nos. 9879, 9882–7, 9901–2.

OPHIDIA.

CONOPSIS NASUS Gthr.

19. *Ogmius varians* Jan. (*Oxyrhina*) *Ogmius* Cope, Proceed. Amer. Philos. Soc. 1869, p. 162. No. 9913.

20. *Adelophis copei* Duges MS., gen. et sp. nov.

Char. gen. Allied to *Tropidoclonium*. Scales keeled; anal single;

caudal scutella two-rowed. Teeth equal. Cephalic shields normal. Nasals distinct, and separated by a space from the single preocular, which is occupied by the prefrontal, since the loreal is wanting. Head little distinct from body. Rostral plate not produced. The absence of loreal plate is the only character that separates this genus from *Tropidoclonium*.

Char. specif. Total length, 33 centimetres; tail very acute and terminating in a cone; length of tail, M.0.066. Cephalic scales convex; dorsals and supra caudals carinate, those on the flanks smooth. Urosteges divided; a single preanal. A single preocular and two post-oculars; temporals three (1 + 2). Superior labials five, the first in contact with the two nasals and the rostral; the second is in contact with the posterior nasal and fronto-nasal; the third is in contact with the fronto-nasal, the preocular and the eye; the fourth is in contact with the eye and the inferior post-ocular; the fifth and largest is in contact with the inferior post-ocular, the first temporal and the inferior temporal of the second row. There are two nasals; the nostril piercing the posterior border of the anterior one The rostral projects very slightly above the level of the muzzle. No frenal, the fronto-nasals extending on the sides till in contact with the superior labials. The internasals are small, triangular. The frontal or vertical is much longer than wide, and is six-sided. Palpebrals (supra-oculars) are elongated, straight; occipitals large. Five inferior labials on each side, and a small mental. Four elongate inframaxillaries, the extremity of the posterior ones angulated and separated by two small gulars. Three rows of gulars on each side.

I have counted fifteen dorsal rows of scales longitudinally; the rows in contact with the gastosteges the largest and smooth, those on the back and upper side of tail carinated, rhombic and truncated (emarginate) at their extremities. The preanal is undivided.

On the middle of the back there is a yellowish line extending from the occiput to the commencement of the tail, which embraces two rows of scales. On each side of this line a chestnut-brown band of the same width as the former, which is bordered below by a black line; the line is lost in the tail, and behind the eye it forms an elongate black spot. The flanks and belly are light brown; there is a black line on the posterior margin of each of the scales in contact with the gastrosteges; towards the tail they disappear. The upper side of the head is chestnut and the lips are like the flanks in color, very yellow.

Habitat, Guadalajara, Mexico.

21. *Phimothyra bairdi* Jan., 9883.
22. *Lytorhynchus mexicanus* D. & B. *Zamenis* D. & B. Eupataro.
23. *Bascanium tæniatum laterale* Hallow.
24. *Eutænia cyrtopsis* Kenn , 9892.
25. *Eutænia sirtalis* Linn., 9899.
26. *Hypsiglena ochrorhynchus* Cope, 9889.
27. *Trimorphodon upsilon* Cope, 9911–12.
    Elaps fulvius L.

28. *Crotalus polystictus* Cope. *C. triseriatus* Jan. nec. Wagler. *C. ximenesii* Dugés.

Remarks.

Points of interest in geographical distribution, indicated by the collection of Dr. Dugés, are the following: The species of the above list which belong distinctively to the Sonoran district fauna are five, viz: *Bufo punctatus, Hyla arenicolor, Spea hammondi, Eutænia cyrtopsis, Hypsiglena ochrorhynchus.* Besides these genera, the following belong to the Nearctic Realm, and not to the Neotropical: *Rana, Sceloporus, Holbrookia, Phimothyra, Bascanium. Cystignathus* is the only Neotropical genus; while *Malachylodes, Ogmius, Cœnopsis* and *Trimorphodon* are especially Mexican.

I add that Dr. Dugés has sent *Hypopachus variolosus* Cope, from the State of Guadalaxara, a species heretofore only known as Costa Rican.

III. Tehuantepec, Sumichrast.

A list of species from this locality and collector was published in the Proceedings American Philosophical Society for 1869, p. 161. Since that date a number of collections have been sent by Mr. Sumichrast, which add materially to our knowledge of the distribution of the Batrachia and Reptilia of the district of Mexico properly so called. I append Mr. Sumichrast's notes.

Batrachia.

1. *Œdipus rufescens* Cope, 10042 (15). Heretofore only known from Vera Cruz. Found in tufts of *Tillandsia.*

2. *Œdipus carbonarius carbonarius* Cope.

2. *Œdipus carbonarius salvini* Gray.

3. *Siphonops mexicanus* D. & B.

4. *Bufo agua* Daud.

5. *Bufo sternosignatus* Gthr., 10014 (No. 2). Only found in the beginning of the rainy season breeding in pools.

6. *Bufo canaliferus* Cope, 10015, 10022 (No. 3). Found in woods, and not seen in pools at the breeding season.

7. *Bufo coccifer* Cope.

8. *Bufo valliceps* Wiegm., 10013 (No. 1).

9. *Microphryne pustulosa* Cope. 10023–8.

10. *Engystoma ustum* Cope, 10021.

11. *Rhinophrynus dorsalis* D. & B.

12. *Hyla miotympanum* Cope.

13. *Smilisca baudini* D. & B., 10016 (No. 4). Abundant, but only seen in the rainy season, when it comes to pools, lagoons, etc., to breed.

14. *Hylella platycephala*, sp. nov.

This species conforms to the characters of the genus *Hylella*, as I understand them, viz: in the general structure of *Hyla*, including fronto-parietal fontanelle and narrow divergent nasal bones, but wanting vomerine teeth.

The present species is not large and has elongate hind limbs, the heel reaching the middle of the orbit. The sole of the hinder foot is rather short, not exceeding the length of the astragalus more than the fifth of its own length. The digital dilatations are well developed on both extremities; the posterior digits are two thirds webbed, while the anterior are scarcely one-fourth palmate. The species is particularly characterized by the abbreviation and flatness of the head, which is also wide. The canthus rostrales are distinct and very convergent; the muzzle is truncate vertically, but projects a little beyond the mandible. The nostrils are terminal and lateral, and are as far anterior to the eye as the long diameter of the latter. The latter dimension is four times the diameter of the tympanum, and is equal to the interorbital width. The skin of the superior surface is everywhere smooth. The thorax, belly and inferior face of part of femora are areolate.

The color in spirits is light ashen above, rather darker on the head. Canthus rostralis dark shaded. Inferior surfaces light orange. No markings on the sides or concealed faces of the limbs, nor on the superior faces of the limbs.

Length of head and body, .033; length of head to angle of jaws, axially, .007; width of head posteriorly, .011; length of fore limb, .015; of hind limb, .045; of hind foot, .019.

This is the first of the genus detected in the Mexican district. It is larger than the *H. carnea* Cope, of Brazil, has a weaker palmation of the fingers, and more uniform coloration.

From Japana, from an elevation of from 2000 to 3000 feet. It is found in the tufts of epiphytic *Tillandsiæ* and M. Sumichrast thinks it undergoes its metamorphoses there, in rain-water held in the axils of the leaves.

15. *Lithodytes rhodopis* Cope, 10020 (No. 8).

16. *Lithodytes podiciferus* Cope.

17. *Syrrhophus leprus*, sp. nov.

The genus *Syrrhophus* was proposed by me in 1878* to receive frogs allied to *Phyllobates*, but with largely developed nasal bones, which meet on the middle line, as in *Hylodes*, thus covering the ethmoid cartilage. The typical species is the *S. marnochii* of West Texas; a second species is the *S. cystignathoides* Cope,† and the present frog increases the number to three. These species are distinguished as follows:

Posterior limbs short, heel to tympanum; head wide; tympanum half orbit; rufous, brown spotted .... *S. marnochii.*
Posterior limbs longer, heel to front of orbit; head wide, a canthus rostralis; tympanum one-third orbit; brown, pale spotted...... *S. leprus.*
Posterior limbs longer, heel to front of orbit; head narrow, no canthus rostralis; tympanum one-third orbit; brown, dark spotted, *S. cystignathoides.*

In the *S. leprus* the muzzle is broadly acuminate and obtuse, with vertical profile; nares lateral and terminal, and as far from the orbit as the diameter of the latter. Lores vertical. Eye not prominent upwards.

* American Naturalist, p. 253.
† *Phyllobates*, Proceed. Am. Philos. Soc., 1877, p. 89.

Choanæ and ostia pharyngea small and equal; tongue obpyriform and entire. The digital dilatations are small, and the inferior tubercles of the digits are well marked both anteriorly and posteriorly. A large palmar tubercle; solar tubercles weak. The hind foot is rather slender, the solar part equaling the tibia in length. Skin everywhere smooth.

All the superior surfaces, including limbs, a dark mulberry-brown, dotted with moderately large gray spots; below a pale pinkish-brown (in spirits), without markings. Lores and upper lip like the back.

Length of head and body, .024; of head to angle of jaws (axial), .008; width of head at angle of jaws, .009; length of hind limb, .035; of hind foot, .010.

From Santa Efigenia. No. 10040 (No. 14). Found in woods. According to Mr. Sumichrast, the dorsal spots are yellow in life.

18. *Cystignathus melanonotus* Hallow.

19. *Cystignathus perlævis*, sp. nov.

The species of this genus are numerous, and difficult to distinguish. They fall naturally into groups defined by the form of the series of vomerine teeth, and the presence or absence of a discoidal fold of the abdominal integument, and of membranous margins to the posterior digits. The latter character does not suffice for the discrimination of a genus, hence I regard *Tarsopterus* R. & L. as synonymous with *Cystignathus*.

The species of the Mexican district of the Neotropical Realm all have a discoidal abdominal fold, and the vomerine teeth in short transverse series behind the line of the posterior boundary of the choanæ. I know but one species which has dermal digital margins. The species are distinguished as follows. I premise that the presence or absence of spots is not constant among them:

I. Posterior digits with dermal margins.

Dermal glandular folds numerous, generally broken up; legs stout, heel reaching orbit; tympanic membrane .66 of eye; no light stripe on lip . . . . *C. melanonotus.*

II. No digital dermal margins.

No glandular folds; legs slender, heel reaching front of orbit; tympanum .66 of orbit; no light lip stripe . . . . *C. perlævis.*

Glandular folds (?) none; legs very robust; heel reaching orbit; tympanum .4 of orbit; no stripe on lip . . . . *C. microtis.*

Glandular folds present; legs short, reaching orbit; tympanum equal orbit; lip stripe imperfect . . . . *C. gracilis.*

Glandular folds; legs long, reaching front of orbit; tympanum .6 of orbit; a lip stripe . . . . *C. labialis.*

The *C. perlævis* is characterized by its exceedingly smooth and shining skin, which is entirely without the glandular ridges usual in the genus. The head is angular oval in outline with distinct canthus rostrales, which are near together, and much within the labial outline. The muzzle projects a little, and the nares are about one-third the distance from its apex to the orbit. Tongue a longitudinal oval, entire behind; choanæ rather small and equal to the ostia pharyngea. The vomerine series are well separated from each other and extend but little external to the inner border of the nares. Vertical diameter of tympanic disc a little less than the horizontal. Second and fourth fingers equal; the first a little longer. The posterior foot is slender, and the solar portion is as long as the tibia and half of the astragalus. Solar tubercles insignificant.

Dark ashen gray above, sides blackish above, speckled with white and blackish below. An interorbital dark spot; upper lip marbled; posterior face of femora dark, with light specks. Below white, the sides gray marbled. Throat gray, white spotted. Posterior limbs obscurely cross-banded above.

Length of head and body, .038; of head axially to angle of jaws, .014; width at latter point, .0135; length of hind limb, .055; of hind foot. .028.

Taken from a well near Japana. 10041. (No. 16, F. S.)

20. *Cystignathus gracilis* D. B. 10018–9. (No. 6–7.) Found under old logs and stones, near water.

21. *Cystignathus labialis* Cope, Proceeds. Amer. Philos. Soc. 1877, p. 90. The original description of this species was taken from young specimens in which the posterior limbs are not as long as in adults. Numerous specimens from Tehuantepec, which fix the characters and locality. There are also three specimens sent by M. Sumichrast, from Potrero, near Cordova, Vera Cruz.

22. *Ranula affinis* Pet. (No. 5, F. S.) Rather common in pools and rivulets. It grows to a large size, when the dorsal markings become obsolete.

Rana halecina Kalm, *var.* with indistinct dorsal spots.

Some varieties of this species from its extreme southern range, look quite different from the typical form. The dorsal green becomes more vivid, and has sometimes a blue shade on the head. The spots become obscure, and there is a general resemblance to the *Ranula affinis*. It may be distinguished from that frog by the less palmation of the toes, which are without apical callosities, and by the presence of dermal folds between the dorso-laterals, although these are sometimes faint. The most aberrant examples come from Coban, Vera Paz.

Lacertilia.

24. *Epaphelus sumichrasti* Cope.

25. *Mocoa assata* Cope.

26. *Celestus chalybæus* Cope.

27. *Cnemidophorus microlepidopus* Cope, Proceed. Amer. Philos. Soc. 1877, p. 93.

28. *Cnemidophorus unicolor* Cope, l. c. 93.

29. *Cnemidophorus immutabilis* Cope, l. c. 93.

30. *Cnemidophorus lativittis* Cope, l. c. p 94.

31. *Amiva undulata* Wiegmann.

32. *Lepidophyma smithii* Bocourt.

Ophidia.

33. *Stenostoma phænops* Cope, Journal Academy Philadelphia, 1875, p. 128.
34. *Loxocemus bicolor* Cope.
35. *Geagras redimitus* Cope, Journal Academy Phila., 1875, p. 141.
36. *Ficimia olivacea* Gray.
37. *Tantilla rubra* Cope, loc. sup. cit. 144.
38. *Conophis sumichrasti* Cope, loc. cit. 137.
39. *Coniophanes proterops* Cope, l. c. 138.
40. *Coniophanes fissidens* Gthr. l. c. 138.
41. *Spilotes corais melanurus* D. and B.
42. *Bascanium mentovarium* D. and B.
43. *Leptophis diplotropis* Gthr.
44. *Dryophis fulgidus* Daud.
45. *Himantodes cenchoa* L.
46. *Oxyrrhopus clelia* L.

Remarks.

This catalogue represents a part of the Mexican fauna properly so-called. There is not a single non-Neotropical genus excepting *Rana* and *Bascanium*. Of the remaining thirty genera, fifteen are characteristically Neotropical; twelve are peculiarly Mexican, two are cosmopolitan or nearly so, and one (*Celestus*) is West Indian.

IV. Costa Rica, Zeledon.

This collection includes a number of species which I have named in my monograph on the Herpetology of Costa Rica,* with some additional ones. I now give the names of the latter only, enumerating them from the end of my former list.

3. *Œdipus morio* Cope. Inserted in the essay above cited as doubtfully occurring in Costa Rica. From Cartago on the Plateau.

45. *Coleonyx elegans* Gray. Inserted in my list on the authority of Peters. Zeledon's collection contains fine specimens, which he states were found in ant hills on the table land near San José.

131. *Scolecophis zonatus* Hallow.

132. *Coluber triaspis* Cope. The Plateau near San José. The most southern locality for this species and genus.

133. *Porthidium nasutum* Bocourt.

From Limon, on the East Coast. This species is very near the *Bothriopsis proboscideus* Cope, and may not prove to be distinct from it. In the latter there are two nasal plates, the supranasals are longer, more concave on the external edge, and more widely separated than in *P. nasutum*, and the frontal scales are carinate. They are smooth, or nearly so, in Mr. Zeledon's specimen, which also has the rostral plate a little shorter than in the *B. proboscideus*. The specimens of the latter are smaller than the single *P. nasutum*. It is questionable whether a large series will sustain

*Journal Academy Philadelphia, 1875, 93.

these characters. In *P. nasutum* the scuta are, 136–27; in *B. proboscideus*, 132–31.

V. San Domingo, Drs. Brown, Fraser and Gabb.

A few of the species of the collection made by Dr. Brown are from the Island of Gonave, off the West Coast of Santo Domingo; the others are from near Port-au-Prince.

Batrachia.

1. *Trachycephalus marmoratus* D. and B., Fraser and Gabb. Puerto Plata.

2. *Hylodes martinicensis* D. and B., Gabb and Fraser.

Lacertilia.

3. *Celestus rugosus*, sp. nov.

Scales in thirty-six longitudinal rows; each with a strong median keel, and seven or eight weaker ones on each side of it, making fifteen or seventeen in all. The median keels are strong and continuous from the nape, becoming stronger posteriorly, especially on the tail, whose superior and lateral surfaces are thus thrown into gutters. In the specimen the distal part of the tail is lost. The keels form oblique lines over the sides; they are strong on the hinder and weaker on the anterior limbs.

The general form is slender, and the limbs are quite weak; the latter when extended along the side fail to meet by the length of the posterior foot and leg to the knee. The head is flat and rather elongate, and its scuta are normal. There are nine superior labials, of which the eighth is the first one angulated above. Both the loreals are rather higher than long. Five supraorbitals, the posterior separated by two scales from the parietal. Interparietal large as parietal; a large post-interparietal. Five pairs of large infralabials, which are separated from the labials by scales.

Ground color gray; no longitudinal lines, but the nape and back are crossed by seventeen brown cross-bars, which are nearly in contact medially, and taper to disappearance on the upper part of the side. Their dorsal portions are sometimes confluent longitudinally. A series of faint dusted brown spots on the inferior part of the sides. Below, white, with a few scales here and there brown. Limbs brown above.

Length from end of muzzle to vent three and a half inches; from do. to middle of auricular meatus five-eighths of an inch; from do. to axilla one and five-eighths inch.

From Puerto Plata, Santo Domingo. Charles A. Fraser. No. 10260.

This species is quite distinct from those previously known in both squamation and color.

4. *Celestus stenurus* Cope, var. Proceedings Academy, Philadelphia, 1868, p. 126. Puerto Plata. Fraser.

5. *Celestus phoxinus* Cope, Gabb.

6. *Sphærodactylus alopex* Cope, Fraser.

7. *Anolis cœlestinus* Cope, Gabb.

8. *Anolis semilineatus* Cope, Gabb.
9. *Anolis cybotes* Cope, Gabb and Fraser.
10. *Anolis distichus* Cope, Gabb, Fraser. Puerto Plata.
11. *Liocephalus trigeminatus* Cope, Fraser. Puerto Plata.
Eupristis ricordii D. & B., Gabb and Fraser.
Amphisbæna innocens Weinl., Gonave Island, Brown.

Ophidia.

12. *Typhlops lumbricalis* D. B. Puerto Plata. Fraser.
13. *Ungualia hætiana*, sp. nov.

Scales in twenty-seven rows, entirely smooth. Body stout, head not distinct, tapering; eye small, its diameter less than one-third the length of the muzzle in front of it. Internasals longer than wide; internasofrontals and prefrontals much wider than long. Parietals as long as frontal, in contact medially. Superior labials 9–10; only those in front of the orbit higher than long. Oculars 1–3, fourth and fifth labials entering orbit. Gastrosteges 192; urosteges 32.

Color brownish-ashen above, with four rows of alternating round blackish brown spots, of which the median are larger and become confluent at some parts of the body. Another row of dark spots on the inferior part of the side, which are separated by yellowish scales. An additional row of larger spots alternating with these involve the ends of the gastrosteges, and may or may not meet across the middle line of the abdomen.

Total length, .680; of rictus oris, .017; of the tail, .075.

This, the largest species of the genus, much resembles the *U. maculata* of Cuba, etc., but it has a larger number of scales, and also exceeds it materially in the number of gastrosteges. Its smooth scales distinguish it from the *U. melanura* and *U. pardalis*.

From Port-au-Prince and Gonave Island, Dr. Brown. No. 10164. Puerto Plata. Fraser.

14. *Homolochilus striatus* Fisch. Frazer.

15. *Dromicus parvifrons* Cope, Gabb. Puerto Plata. Fraser. A variety was found on Gonave by Dr. Brown. In two specimens the ground color is black, and the belly is white; a light olive color extends on the sides as far as the third row of scales. Belly not spotted as in the usual variety.

16. *Hypsirhynchus ferox* Günther.

Dr. Brown, Port-au-Prince. These specimens agree exactly with Dr. Günther's description, and differ from the *H. scalaris* Cope, in the presence of a loreal plate and the triangular form of the dorsal spots. Although I have united these supposed species, I now incline to believe them distinct.

17. *Jaltris dorsalis* Güthr., Gabb.
18. *Leptophis catesbeyi* D. and B., Gabb. Puerto Plata. Fraser.
19. *Leptophis oxyrhynchus* D. and B., Brown.

Crocodilia.

20. *Crocodilus americanus* Seba, Fraser. Puerto Plata.

VI. Dominica, Ober.

As no study of the herpetology of this island has been made, the following list of five species partially supplies a deficiency in our knowledge.

1. *Mabuia cepedei* Gray.

2. *Xiphosurus oculatus*, sp. nov.

Abdominal scales smooth, those of sides and back minute: two median dorsal rows a little larger, keeled, and elevated on a moderate simple dermal fold which extends to the head. Superciliary scales separated by one or two rows of scales, and widely removed by scales from the small occipital. Muzzle rather long, flat above; ridges not prominent, covered with large scales, and separated by a shallow concavity, which contains in front, four rows of smaller smooth scales. Six or seven loreal rows; three large infralabials, the first smaller than each symphyseal. Supraorbitals surrounded with granules, consisting of three inner scales the largest, five in the inner row smaller, and six in the external row the least, all nearly smooth. Occipital concavity not profound or sharply defined posteriorly. Scales of arm and posterior leg keeled. Caudal spines well developed in the male.

Color above brownish-ash, with numerous white spots which sometimes form vertical lateral bands, and a white band extending from above the axilla to the middle of the side or beyond. Above this band, on the anterior half of the side are two round black spots, each of which has a white spot in the center. A white band from upper lip to side of nape; lip brown spotted, inferior surfaces dirty white, face yellow posteriorly. Tail uniform.

Total length, .185; of head and body, .072; of head to angle of mandible, .021; width at latter point, .008; length of fore limb .032; of hinder limb, .055; of posterior foot, .025.

The animal which I suppose to be the male, generally has one row of scales between the superciliaries, while the female has two, and has no caudal crest. The color differs in being brown, without the lateral white band or black eye-spots. The white spots form vertical series on the sides. It is possible that this is a different species, but it is in general identical with what the female of the *X. oculatus* should be.

This species differs from its nearest ally, the *X. cristatellus*, in having the superciliary plates separated on the middle line, by the shallow occipital depression, the longer muzzle, and in coloration.

Evidently abundant on the island. Nos. 10139-48, 10150-1, 10153.

3. *Aporophis* juliæ* sp. nov.

Resembles the *Opheomorphus meleagris* Shaw (*Liophis merremii* D. and B.), but has the long tail of the genus *Aporophis*, this member entering the total length 3.4 times. Appropriately, the number of the urosteges is considerably in excess of that found in the longest tailed varieties of *O. meleagris*, where, according to Duméril and Bibron, they do not exceed 63. They here number 82, and the gastrosteges are 158.

The scales are in seventeen rows, and are rather wide, and are as in other species of *Aporophis*, poreless; nevertheless there are a few on the

*Cope, Proceed. Amer. Philos. Soc. 1877, p. 18. *Lygophis* olim.

sides posteriorly with a single apical pore. Rostral plate small, not produced; nasals subequal; loreal high as long; preocular not reaching frontal. Two postoculars; temporals 1+2+3; the first and second bounding the parietals large and subequal. Superior labials eight, fourth and fifth entering orbit. Inferior labials ten, six in contact with geneials. Pairs of geneials equal. Frontal with straight sides, longer than wide in front, equal occipital.

Ground color above black, each scale with a round yellow spot near the base, including the first row, and excepting a row on each side of the vertebral row, which is uniform black (with an occasional spot) for the posterior third of the body. A median dorsal black line on tail. Ground color of head above brownish-yellow; a black band through eye, which sends branches along the borders of the labials; a black spot on top of muzzle; a black cross band between eyes, and the greater part of each parietal plate black.

Total length, M. .640; tail, 190.

This handsome species is named for my daughter.

4. *Alsophis sibonius*, sp. nov.

This species does not conform exactly to the diagnosis of the genus *Alsophis*, which I gave in 1862,* since the tail is less than one-third the total length, not much exceeding one-fourth. It thus approaches *Liophis*, and the question of reference to one genus or the other is left to depend on the character of the scale pores. These have the full number common to the species of *Alsophis* and the ground Colubrine snakes generally, while in *Liophis* there is but one on each scale, as in many Coronelline and water snakes.

The physiognomy of the *A. sibonius* is much that of species of the *A. antillensis* type, but the coloration resembles that of the common South American *Sibon annulatum*. The scales are thin and are in nineteen longitudinal series. Gastrosteges 191; anal double; urosteges 118. Total length, .640 M.; tail, .200. Eight superior labials, the third, fourth and fifth entering the orbit, the part of the third contributing being small. The muzzle projects above and is obliquely truncate below; the rostral plate is flat and barely appears on the superior surface of the head. Postnasal higher than prenasal; loreal longer than high, the superior border straight, not angulate. Preocular not much elevated, not reaching the frontal. Postoculars small; temporals 2–2–4. The superior temporal of the first row larger than the others and in contact with the inferior postocular only. The inferior temporal adjoining it does not reach the postoculars, and is, in fact, a dismemberment of the seventh superior labial, which is, in consequence, reduced to a very small size. This arrangement is identical on both sides of the head. Inferior labials ten, six of which are in contact with the geneials; latter subequal. Top of head flat, and orbits not prominent. Lengths of internasals and prefrontals on median suture equal. Frontal longer than wide, the superciliary borders but little

* Proceedings Academy Philadelphia, February.

concave. Occipitals short and wide for the genus; each is bounded posteriorly by a single large temporal plate behind the anterior one on each side, which are only separated on the median line by a small scale.

The ground color in spirits is straw-color. The dorsal region, between the fourth row of scales on each side, is occupied by a series of large rounded brown spots, whose borders are almost in contact on the median line. There are forty-two between the nape and the vent. Occasionally two or more of them are confluent on the middle line. Below and between them the sides are brown shaded, the shade assuming the form of spots anteriorly. Head brown, with a pale spot on each side of the nape; a brown spot with darker borders passes from the muzzle through the eye, and joins the brown dorsal spot on the nape. All the colors become darker posteriorly. Inferior surface unspotted anteriorly; it is sparsely dusted with brown on the posterior half of the body, and the caudal scutella are dusted most densely along the middle line, forming a stripe.

No. 10138 Mus. Smithsonian.

VII. Tobago, Ober.

Amiva surinamensis tobaganus, sub-sp. nov.

A single *Amiva* from Tobago forms a strongly marked race of the common continental species, but whether separable as a species or not I am not yet able to state. It differs from the typical *A. surinamensis* in color, in a disposition to a somewhat greater subdivision of the scuta of the limbs and belly, and in the greater length of the posterior foot. There are twelve rows of abdominal scales at the middle, as is sometimes seen in *A. surinamensis*. The two inner rows of antebrachials extend to the wrist; only one row extends so far in *A. surinamensis*. Both brachial and postbrachial scales, as well as those of the gular fold are rather more numerous than in *A. surinamnesis*. In the latter species the length of the posterior foot equals the distance from the axilla to the middle of the loreal plate; in the form *tobaganus* the foot is as long as from the axilla to the end of the muzzle.

Color olivaceous, with a black lateral band with undulating edges, which are not light bordered, but which are marked by small yellow spots at regular distances. Back with a chain-like series of black annuli on each side, each ring with an obscure yellow spot in its center. Sides black and yellow-spotted; below uniform straw-colored; head uniform brown, lips lighter.

No. 10113; size less than that of the adult *A. surinamensis*.

Anolis alligator D. and B.

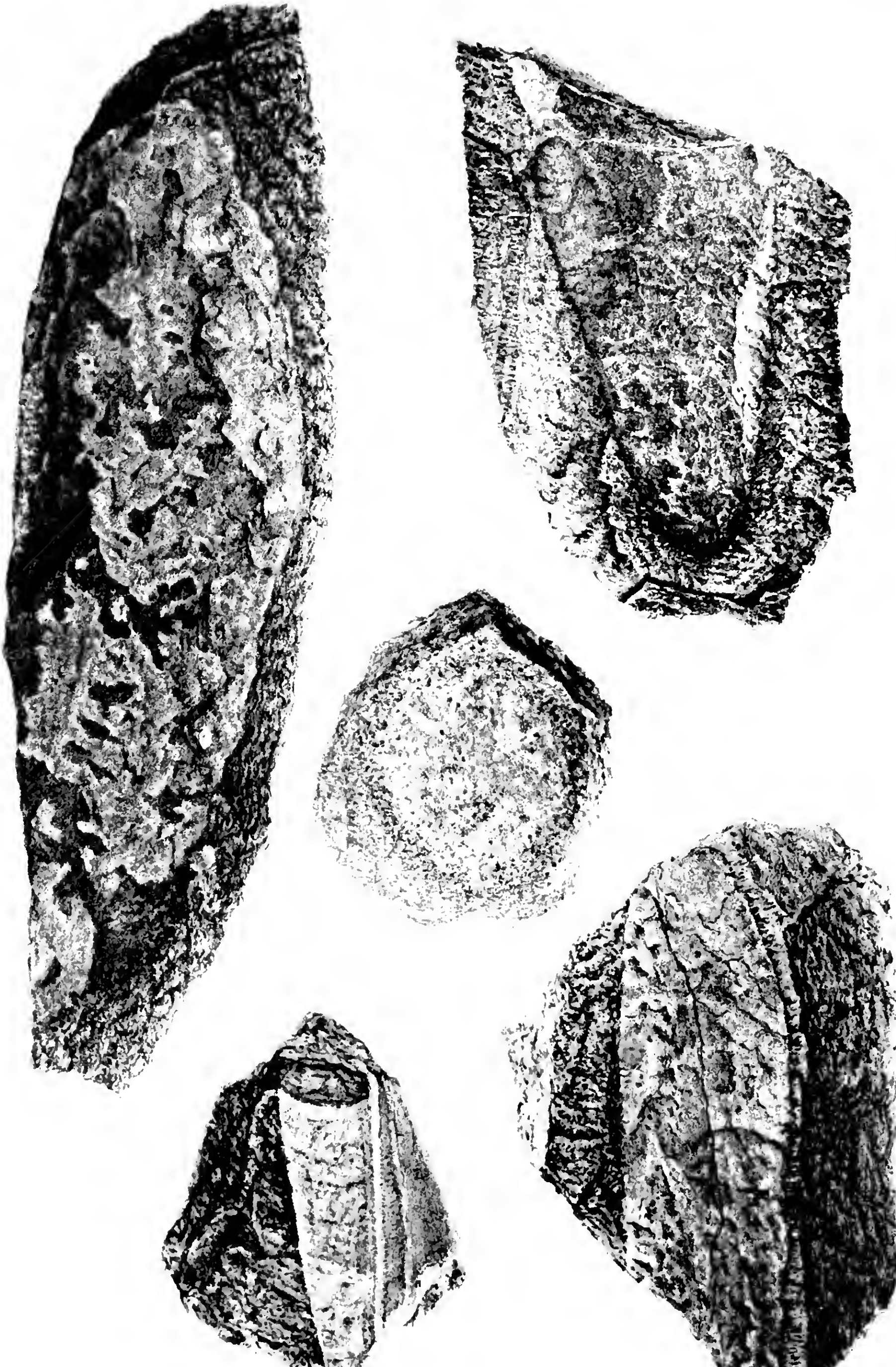
Drymobius boddærtii Seetzen.

Bothrops lanceolatus Merr. (Fer de lance.)

Scales in thirty-one and thirty-three longitudinal rows; colors pale, with the cross bands obscure, as in other West Indian specimens.

Hylodes martinicensis D. and B. No. 10121.

The Island of Tobago is, of the Lesser Antilles, the nearest to Trinidad,



and it might, on this account, be anticipated that its fauna would present a larger representation of continental types than the more northern islands of the series. That this is the case is shown by the present very limited list, which includes two Brazilian species of the genera *Ameiva* and *Drymobius.* None of the species of the Dominica list were found on Tobago by Mr. Ober.

VIII. Northern Bolivia, Orton.

Among the collections sent by Prof. Orton to Philadelphia before his departure for the Beni River, was a collection of reptiles from La Paz, on the eastern slope of the Andes, in Western Bolivia. This city, as is well known, is situated a short distance above the forest line, and enjoys a temperate climate.

In packing, some specimens from Puno, on Lake Titicaca, were mixed with those from La Paz. As reptiles are rare at that elevated locality it is probable that most of the species enumerated were derived from the latter place.

Bufo spinulosus Wiegm.

Oxyrrhopus doliatus D. and B.

Aporophis tæniurus Tsch.

Bothrops microphthalmus Cope, Journal Academy Philadelphia, 1875, p. 182.

Scales in twenty-one longitudinal rows, all carinate excepting the first row, the keels not unusually prominent, and not reaching the apex of the scale. The second labial scute bounds the maxillary fossa in front, but it is partly cut off by suture on both sides.

In the above characters the single specimen of the collection differs from the type. The latter is large, the present individual is small, and the less development of the keels of the scales is perhaps due to immaturity. The scales on the top of the head are larger than in other species of the genus but not so large as in the type. The superciliaries are wide as in it, and there are only seven superior labials. The color of the inferior surface is, anteriorly, mixed black and gray, posteriorly black.

Fossil (?) *Forms in the Quartzose Rocks of the Lower Susquehanna. By Persifor Frazer, Jr. With a plate.*

(Read before the American Philosophical Society, April 4, 1879.)

The forms which accompany and illustrate this paper are found in a hard quartzose greenish rock, difficult to name, which forms part of the left border line of the great river in Cecil County, Maryland, just below the Pennsylvania line.

By a mistake (not the fault of the writer) in the title, the figures are given as from Lancaster county, Pennsylvania. In reality the discoverer of these curious and as yet unexplained phenomena, Dr. C. H. Stubbs, of Fulton

Township, Lancaster Co., found them all in one locality, viz: Frazer's Point, a headland in the river about half a mile below Mason and Dixon's line.

Two of the original specimens have been submitted in turn to Prof. Whitfield, of the New York Museum; Prof. Jas. Hall, State Geologist of New York, and Dr. Joseph Leidy, of this city.

Letters from the first two are found below. Dr. Leidy expressed no definite view.

In the face of the inability of such eminent authorities to determine anything in regard to these objects, I feel reticence to be but the part of sound wisdom. I will only add that these have been very faithfully and accurately delineated of actual size by the artists, Mr. Faber and Mr. Tuthe. (The latter transferred all the drawings to stone, besides making the original sketch of No. 1.) The horizon whence these were taken is believed to have been that immediately under the Potsdam, but in no case can be ascribed to one more recent than the latter formation.

A partial analysis by the undersigned of the very thin film out of which one of these forms, not here represented, was made, here follows. Amount obtained for analysis 0.0562 Gram:

Moisture	2.13
Silica	57.11
Iron Sesquioxide	4.93
Alumina	7.52
Lime	5.93
Magnesia	2.88
Sum	80.50
Undetermined and loss	19.50
Total	100.00

The following are the letters from Prof. Whitfield and Prof. Hall, referred to above:

"AMERICAN MUSEUM OF NATURAL HISTORY,
Central Park, 77th street and 8th Avenue,
NEW YORK, OCT. 9, 1878.

"*Dear Sir:*

* * * * * * *

"The articles sent are *not* fossils, nor are they *organic*—but present every appearance of sandstone pebbles of very fine texture. The annulations on the Orthoceras-like specimen" (Fig. 5) "are lines of fracture, and pass across the rock on each side, showing conclusively their nature."

* * * * * * *

"In future I hope you may have better success than in the present instance.

"I remain yours very truly, R. P. WHITFIELD."

"NEW YORK STATE MUSEUM OF NATURAL HISTORY,
ALBANY.

Fig. 5.

"The enclosed material lies, *apparently*, obliquely to the lines of bedding, and the influence of these lines appears to affect or mark the enclosed piece. It is impossible to say that it is a fossil, nor could a fossil, unless previously silicified, be preserved in a rock so highly metamorphosed.

"I *do not* believe it to have been a pebble. The extremely elongate form and elliptical section would in my opinion preclude that view of the matter.

"Should you ever obtain specimens of which you could spare a thin slice, it would be the best method of determining the nature of the material.

Fig. 4.

"The enclosed material lies apparently in the plane of the bedding or lamination of the enclosing rock. The substance is too thin to give an idea of the full original form, but from its outline I infer that it has been similar to the other specimen" (Fig. 5). "The outline is, in *my opinion*, quite too symmetrical for a pebble, and, while we have no evidence of its organic character, it is not easy to give any satisfactory explanation of its origin.

"The specimens are extremely interesting and others should be sought for. J. HALL."

Since the receipt of the above letters the other specimens have been sent to the writer by Dr. Stubbs.

On Pyrophyllite from Schuylkill County, Pennsylvania. By F. A. Genth.

(*Read before the American Philosophical Society, July* 18, 1879.)

One of the most interesting varieties of pyrophyllite is that from the coal slates of the "North Mahanoy Colliery" (old Silliman Colliery) near Mahanoy City, Schuylkill county, Pa.

It had been mistaken for damourite, until, by chemical analysis, I established its true character.

I am indebted to Mr. Eli S. Reinhold, of Mahanoy City, for specimens and for the following information with reference to its occurrence.

In the bed, known as "Buck Mountain," it is usually found in horizontal seams, parallel with the coal beds, although it occurs at times in irregular seams in other directions. Thus far it has not been found in any of the other beds of the same mine, and only this mine has furnished it, although the bed in which it occurs is worked in other mines. It also is observed as marking or constituting the plant impressions on the coal slates at this locality.

It is found in thin seams of a delicate fibrous structure. At first glance much resembling the serpentine-variety "chrysotile." It seems that this pyrophyllite has been filling up cavities and cracks in the coal slate, and the exceedingly delicate impressions left by the coal plants in the slate are, after their decay, filled up with pyrophyllite material. Then, it is often not thicker than the finest tissue paper, but still shows, when magnified, the fibrous appearance. In larger cracks it seems to have crystallized from above and from below, and the two seams, thus formed, are mostly separated by a thin layer of pyrite in minute crystalline masses, which leave the impressions of their crystals upon the pyrophyllite. Frequently the fibrous pyrophyllite, as well as the pyrite, are coated with a very thin layer, not thicker than the finest tissue paper, of a *scaly* variety of pyrophyllite of an almost silver-white color, and of silky lustre.* The thickest seams of the fibrous pyrophyllite, which I have seen, were 9^{mm} in thickness, separated in the middle by a layer of pyrite.

The purest specimens have a white to yellowish-white color, and a lustre between silky and pearly, the latter especially visible when magnified; the fibrous particles show a somewhat laminated structure. Very soft. Spec. Gr. = 2.804.

Infusible, but strongly exfoliating when heated, leaving a mass of snow-white silky fibres.

Not decomposed by sulphuric nor hydrofluoric acids, nor by a mixture of both.

The analysis made with perfectly pure material gave the composition of pyrophyllite, corresponding to the formula: $Al_2\,Si_4\,O_{11} + H_2O$.

		Found.		Calculated.
Silicic Acid..................	=	66.61	—	66.52
Alumina.....................	=	27.63	—	28.49
Ferric Oxide.................	=	0.16	—	——
Magnesia....................	=	0.10	—	——
Water.......................	=	5.43	—	4.99
		99.93		100.00

This occurrence of pyrophyllite in coal slates and as the petrifying material of coal plants is exceedingly interesting, and I believe it to be the first time that it has thus been observed.

Prof. Gümpel noticed that a mineral resembling pyrophyllite constitutes the mass of many graptolites, but Prof. von Kobell has shown, by analysis of specimens from Nordhalben, near Steben in Upper Franconia, that this substance is *not* pyrophyllite, but a micaceous mineral, containing over 3% of potassium oxide, which he called "gümpelite."

The petrifying material of coal plants in the Tarantaise in Savoy has also been confounded with pyrophyllite, but we are now indebted to Prof. Gümpel for an investigation of this subject.† His analysis gave 6.803% of potassium oxide and 2.208% of sodium oxide. He has also made an analysis of the mineral of the graptolites from Graefenthal, in Thuringia, which gave 5.06% of oxides of potassium and sodium.

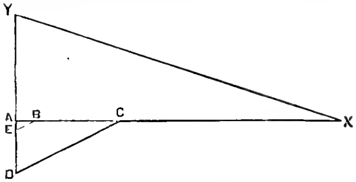
All these analyses show that the substances found as petrifying materials of coal plants in the Tarantaise and of graptolites are *not* pyrophyllite, but varieties, or perhaps mixtures, of micaceous minerals of greater or less purity, belonging to that group, which Prof. Dana puts under the head of *pinite*, and which are so frequently met with in nature as the results of alteration of numerous minerals, such as iolite, nephelite, scapolite, feldspars, staurolite, cyanite, corundum, topaz, &c., &c., which, when pure, would be recognized as damourite, paragonite, &c.

University of Pennsylvania, July 14, 1879.

* I could not get enough of it in a pure state for an analysis, but a partial analysis proved it to be pyrophyllite.

† G. Tschermak, Mineralogische und Petrographische Mittheilungen II, 2, 189.

Approximate Quadrature of the Circle. By Pliny Earle Chase, LL.D. (*Read before the American Philosophical Society, June 20th,* 1879.)



AB = 3 ; AC = 20
AD = 3 AB ; AX = 3 AC
BE parallel to CD
EY = AC
XY = 3.141585 AC

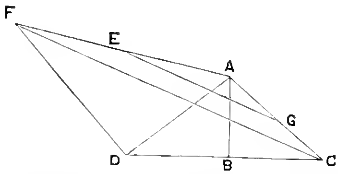
The deviation from perfect accuracy is less than $\frac{1}{4100}$ of one per cent. which would give an error of less than $\frac{1}{6}$ of an inch per mile. For all practical purposes the construction may be regarded as *exact,* for the error would be inappreciable in any mechanical work.

HAVERFORD COLLEGE, June 16th, 1879.

NOTE.—July 16, 1879. My attention has been called to the following more-complicated construction, and closer approximation, in Perkins's Geometry (D. Appleton & Co., 1853).

On an indefinite straight line A N, take A B = B D = D E = 1 ; at E erect a perpendicular E G = 2 A B = 2 E F ; on E N take E H = H K = A G, K L (towards A) = A F, L M (towards N) = D G, M N = D F ; bisect E N at P, E P at R, A B at C ; trisect E R at T. Then C T = 3.1415922.

The author calls this method "very simple," and says, that a better one "can hardly be expected, or even desired." But the approximation of Adrian Metius, $\frac{355}{113}$, is still closer, and the following construction of his ratio is simpler.



On A B = 7 erect the perpendicular B C = 8 ; extend C B to D, making B D = 9 ; on A D erect the perpendicular D F = 15 ; take A E = A C, and draw E G parallel to F C. Then $\frac{AF}{AG} = \frac{355}{113} = 3.1415929$, the true ratio being 3.1415926+.

The error of this construction is less than $\frac{1}{116000}$ of one per cent. Perkins's error is more than $\frac{1}{70000}$ of one per cent. Neither method is so simple, nor so desirable for practical purposes, as the one which I communicated to the Society at its June meeting.

Notes on some Land-shells of the Pacific Slope. By J. G. Cooper, M. D.

(*Read before the American Philosophical Society, May* 16, 1879.)

The recent publication of Vol. V of the "Terrestrial Air-breathing Mollusks of the United States," etc., by W. G. Binney, as a "Bulletin of the Museum of Comparative Zoology at Harvard College," forms a fitting occasion for making some further observations, biographical and taxonomic, on the species found west of the "Great Plains," which form the chief boundary within our limits between the eastern and western groups of species.

It is to be regretted that Mr. Binney has *not* had "time and inclination" to improve on the classifications of Albers and Von Marten, which his own original investigations have made quite inadequate to the subject (Preface, p. iii).

The many improvements made on the system adopted in the "Pulmonata Geophila," of Binney and Bland (Smithsonian Misc. Pub., 194, 1869), are very satisfactory, few of the errors there noted being retained in this work, which is to a great extent a republication of that, with additions from other sources, rendering it more complete as a manual of the subject. The bad results of the habit of blindly following foreign authorities is shown in the higher divisions adopted on p. 81, the first, *Agnatha*, being founded on a *negative* character as to the jaw, while those of the lingual teeth are not different in divisions B and C, and all of them show that these parts are insufficient for classification alone, while they lead to far more confusion of distinct forms than divisions founded only on external characters.

The labored investigations of the microscopists into the internal anatomy has at last led to nearly the same results as a comparison of external forms, as far as they prove a close connection to exist between the two groups of characters, and we may hope that the less difficult system of classification by external resemblances will in time resume its former importance, modified and improved by a knowledge of the *entire* structure of the animals. The fallacy of making family divisions to depend on a few internal characters has been often shown, and is becoming more and more certain with increase of investigation. I do not claim that the *shells* alone should guide in classification, but, with the form of the animal, they should define the higher groups, leaving the details of special organs to determine genera and species.

Genus HELIX.

Again following his authorities Mr. Binney uses "*Helix*" as a comprehensive term, like Pfeiffer including in it every helicoid land-shell, and like the French naturalists making genera by distintegrating it without leaving a single original Helix. No other genus founded by the immortal Linnæus has so hard a fate, and it is to be hoped that at least *one* species will yet be found to be a Helix.

I have before shown that our west-coast banded group has claim at least to be considered first cousin to the type of Helix, and cannot yet see more than sub-generic differences, supposing *lapicida* to be the type. Mr. Binney, however, while admitting that the shell furnishes the most reliable characters for the division (p. 252), makes it subordinate in most genera, and appears to me to give it too little value.

Sub-genus ARIONTA.

I am more convinced by further comparisons of additional specimens that the group of forms of this sub-genus found around San Francisco Bay are merely local races of one species, the *californiensis* of Lea, running into the var. *nemorivaga* Val. (usually called *nickliniana* Lea, which however was so described as to include several), *bridgesi* Newc., passing into next, *ramentosa* Gld. (nearly = *reticulata* Pf.), and the extreme Monterey race *vincta* Val. (= *californiensis* of Binney).

A specimen from Cedar Mountain, east of San Francisco Bay, found by Dr. Yates, has nearly the form of var. *vincta*, being almost as high as wide, but much dwarfed. Occasional specimens occur within the range of each variety connecting it with some of the others. I suspect that the examination of numerous specimens of each would make the differences in internal characters pointed out by Mr. Binney less uniform than he makes them appear, as he admits much variation in these respects in several species thus examined.

The named varieties of the European *A. arbustorum* are even more distinct than in our group inhabiting the region around San Francisco Bay.

In the only admitted species of the Sierra Nevada, *A. tudiculata*, I have before mentioned that many varieties exist, though less localized and marked, only one having yet been named, the var. *cypreophila* Newc., MSS.; distinguished by thinness and umbilicus. This form, of very small size, was also found by Dr. Yates in 1875, at Shasta, Cal., near lat. 41°, the most northern point at which it has recently occurred. Nor does it pass east of the Sierra Nevada, though lately included in the shells of the Great Basin by Ingersoll, from misunderstanding the locality of "Bear River, Cal.," given by Carlton.

It may yet be proved that *A. arrosa* is but a sub-species of *californiensis*, the varieties *arboretorum* Val., and the later varieties *holderi* and *stiversiana* described by me, forming the connecting links. In that case *A. exarata* Pf. must also fall into the series, being connected with *arrosa* by intermediate specimens, though rare and local. But the very rarity of all these links tends to indicate an original difference in the chief forms, now becoming obscured where they meet in their ranges of distribution. (See Amer. Jour. of Conch., IV, 238.)

In a recent article I have shown by maps the peculiar distribution of the species I refer to, *Arionta* being grouped in narrow limits as compared with the others. (Proc. Cal. Acad. Sc., V, 121, 1873.)

Having now disposed of the Ariontas of the San Francisco group, there remain those of Southern California, and the islands, extending onto the peninsula. I have before shown in various articles that these are all connected by intermediate forms, even that retained by Mr. Binney in genus *Euparypha* (*Tryoni*), the difference in this being merely the result of a greater abundance of lime in its food, and therefore in the shell. It is also not improbable that the species called *Euparypha* from southern Europe, etc., are merely *Ariontæ* developed under similar conditions. In our species, however, I see no reason for allowing more than specific differences. Specimens of *H. kellettii*, and of var. *crebristriata* may be selected, and are more common fossil, that have just as much claim to be considered *Euparyphæ* (or of other genera) as *Tryoni*. No *single* character, external or internal, will suffice to distinguish genera in this family or order of animals.

A. redimita W. G. Binn. The author of this name now calls it "probably a variety of *A. ramentosa*," relying upon a resemblance in sculpture. But this file-like surface is characteristic of many forms in the young state, and of these species, the island variety first named *redimita*, shows in its form a much nearer approach to *A. kellettii* than any other, and much the same sculpture. The jaws and linguals are also nearer. A variety of *californiensis*, however, comes very near it in form, and was formerly mistaken for it on this coast.

I have before discussed the close gradations between the other southern species of *Arionta*.

Sub-genus CAMPYLÆA?

Retaining this name provisionally, I merely refer to my previous writings for the distinguishing characters between it and *Arionta*. The remarkable differences in the geographical distribution of the species, shown in the maps referred to, is among the most striking of their characters. It is quite probable that more thorough search in intermediate localities will tend to increase the number of connecting links, but as now known the species are more distinct than in *Arionta*, though a regular gradation in characters corresponding with their distribution has been already referred to.*

* With his characteristic devotion to European precedents, even where plainly wrong, Mr. Binney retains the name *Aglaia* (now as a genus) though long ago shown to be preoccupied twice in Mollusca. Besides it was used first for a South American snail of apparently distinct generic characters from ours. But because Albers long ago placed *H. fidelis* in this group, it is retained, with the subspecies or southern race *infumata*, and because the latter has a form like that of *H. hillebrandi*, Mr. Binney has put this also with them, ignoring the fact that this species bears exactly the same relation to *H. mormonum* as *H. infumata* to *fidelis*, and that intermediate specimens are even more common between the two first. *H. mormonum*, however, is an "*Arionta*" according to Mr. Binney!

Now any one with the shells before him can see a regular gradation from *H. hillebrandi* through *mormonum*, *sequoicola*, *dupetithouarsi*, *traskii*, *carpenteri*, *diabloensis*, *ruficincta*, to *gabbi* and *facta*. If one is an *Aglaia*, all are, the differences between this genus and *Arionta* being in the shells, though Binney's description does not make it at all clear. Having before pointed out the distinctive characters (Amer. Jour. of Conch., V, 201), I merely wish here to amend them by stating that I placed *H. carpenteri* in *Arionta* from misapprehension of its true characters, and that *diabloensis* as well as this, is probably a variety of *traskii*, although the form described by Binney as *diabloensis* appears to be a variety of *ramentosa*, of which he does not figure a type. The types, however, show an approach to *Arionta* as I stated in description.

A link connecting *fidelis* with *mormonum* found at the Dalles, Or., seems to me, however, most properly referred to the former. The most northern locality for *mormonum* now known is at Shasta, Cal., lat. 41° (nearly), alt. 1160 feet, where in the volcanic region Dr. Yates found a very few stunted specimens with but five and a half whorls and the bristle-granulations of the young very strongly developed.

H. dupetithouarsi Desh. The figure copied by Binney from Deshayes, if accurately drawn, is larger than any Monterey specimen I have seen, although Deshayes gives that as the locality. It also has two black bands alternating with three light ones, thus appearing more like the variety of *fidelis* with a light upper surface, while the character "lighter above," also suits that rather than the Monterey shell. As Dupetithouar's expedition visited Oregon, I suspect that Deshayes really figured a *fidelis* as a better example of the species, not having seen Gray's nor Lea's then recent descriptions, just as he overlooked Conrad's of marine species collected by Nuttall in California.

Still as he gives only Monterey as the locality, the name had better remain with that species which the description suits (with the exceptions here noted in color and size).

This confusion may account in some degree for authors confounding with this species others from distant points, and thus giving it an enormous instead of very limited range. Some late authors have also obtained it at second hand from amateur collectors on this coast, who, although getting it directly or indirectly from Monterey, thought it only a finer variety of the banded snails of their own vicinities, and thus gave it as a generally diffused species.

H. fidelis var. *infumata*. Mr. Binney does not refer to the evidences given by me for making this a variety, nor to its ranging 36 miles south of San Pablo Bay.

H. sequoicola Cp. This local race has characters connecting *fidelis*, *mormonum* and *dupetithouarsi* in about the degrees by which it is distant from their ranges. Mr. Binney's description, from a somewhat faded specimen, differs some from that of the types. Only the young shell is bristly up to five whorls, thus longer than in *traskii* and *mormonum*. His figure of *traskii* is from a small, probably stunted variety, as it grows a third larger. That of *diabloensis* is also from an immature specimen, if not a typical *ramentosa*. The colors of the animal of *mormonum* are described by him as different from that seen by me, but as the shells differ much in color, the animals may also in various localities of its long range. (See Proc. Cal. Acad. Sciences, VI, 1875, 18.)

H. rufocincta Newc. I spent several weeks on Santa Barbara Island, and examined it carefully for helices, finding thousands of some species, but none of this, so that I think the large race mentioned by Binney must have been from Catalina Island, where alone I found it, varying much in size. I was wrong also in referring the San Diego shell to this, as it has since been generally considered *carpenteri*. I have before stated the close resemblance in everything but small size of *H. gabbi* to this species, which it seems closer to than to *H. facta* with which Binney unites it.

As confirming the near relation of this group to *Campylæa*, it is notable that Mr. Binney mentions "*Campylæa*" *lapicida* (p. 379), which is so similar to our angled species. If not the type of Helix, the name *Helicigona* Risso, 1826, is, however prior, if the MSS. name, *Chilotrema* Leach, is rejected.

Mesodon Raf.

M. townsendianus Lea. The internal characters of the animal certainly connect this species more nearly with *Mesodon* than *Arionta*, and the shell confirms this connection. Its more developed and reflexed lip, with the lower lip furnished with a "careniform tooth" is typical, while a little resemblance in sculpture is all it shows in common with *Arionta*.

M. (*Odotropis*) *devius* Gould. In that interesting locality, Shasta, California, Dr. Yates also found a dwarf variety of this species only about $\frac{4}{10}$ of an inch wide, and with only five whorls, evidently the Southern stunted race of this Northern species, nearly like Rocky Mountain specimens. Mr. Binney is certainly wrong in calling the bristly and three-toothed *Triod. mullani*, a variety of this species, though examples with faint teeth may look much like dwarfed *devius*. He unites them on p. 338, but on p. 432 shows that the jaws and teeth differ very much. On the same grounds I might call the Shasta specimens *loricata* as they approach it in size and form, or we might make half the Eastern *Triodopses* varieties of *Mesodons*.

"*Triodopsis*" *harfordiana* Binney, not Cooper, p. 309. The shell here described and figured is certainly not my shell, but seems a variety of *T. mullani*, the differences described in jaw and linguals not being so great as in *mullani* and *devius*. My shell differs in the flat spire, unreflexed lip, wider umbilicus, and 6 (not 4) whorls. In his arrangement it would be a *Polygyra* near *P. triodontoides*, and is very unlikely to range in the direction of Idaho.

Mesodon (*Aplodon*) *columbianus* Lea. I am satisfied that the examination of a few more animals of the toothed and imperforate form found in California, which so much resembles a large *germanus*, would prove to Mr. Binney's satisfaction that there is a regular gradation in the number of ribs on the jaws from 8 to 11, as stated recently by myself. Whether the genitalia constantly differ as described in Oregon specimens, requires further comparisons of fresh as well as alcoholic examples.

The list on p. 18, would suggest that both these species extend to San Diego, though really not found as yet south of lat. 36°, if so far.

Glyptostoma Binney and Bland.

The form of jaws alone is allowed to locate this near *Helix*, though most of its characters seem to indicate a nearer affinity to *Patula*.

Patula Held.*

Mr. Binney now unites *P. cooperi* with *P. strigosa*, but on the same grounds should make all the species of the Central Province varieties of

* The great differences in jaws of "*Patulæ*" show that this organ must be considered inferior to external form, &c., in classification.

solitaria. The evidence from intermediate forms, is like that in the case of the *Arionta*, and yet the intermediate specimens are scarcely numerous enough to determine them as mere varieties, while he finds the teeth differ considerably. The fact that *solitaria* occurs as far west as near Vancouver, W. T., and near the localities of *strigosa*, at the Dalles (which is within the Central Province), without mixing, tends to prove distinctness of species in some degree. Future investigation of climatic peculiarities may determine the cause of some local variations.

The *Patula* from Alaska *referred* by me to *P. ruderata* with *a* (?), in the Amer. Jour. of Conch., V, 202, was certainly not *P. pauper* Gould as I at the time stated, and the diagnosis I gave then would distinguish them perfectly, yet Mr. Binney assumes that the Asiatic species is the same; though differences exist between them nearly as great as between *P. idahoensis* and *P. alternata!*

Macrocyclis Beck.

It is not yet determined that the Chilian type of this genus (*M. laxata*) is congeneric with our species, which may yet prove to require the name *Mesomphix* Raf (type *concava* according to Ferussac).

On p. 90, Mr. Binney followed my former statement that *M.? vancouverensis* did not extend S. of lat. 37°, though in Amer. Nat., Jan. 1873, I stated that I found it common near San Diego, and I have seen specimens from Central America, exactly similar (*vellicata* Forbes?).

Zonites Gray, not Montfort. The original type of this genus, *algira*, appears to be very distinct from the thin diaphanous species, belonging to *Hyalina* Fer, though *Omphalina* Raf. (type *cuprea-fuliginosus* Griff., MSS.), may possibly have precedence.

Mr. Binney gives "*Z. nitidus*" as found at Astoria, Oregon (p. 114), and "*Z. cellarius*" as from Astoria, N. Y. If no confusion of localities has occurred, the former is just as likely to have been introduced on ships, as the latter, and not to be really circumpolar.

There appears to be an error, either in the dimensions given or the scale showing size of "*Z. stearnsii*," p. 128. Other probable errors of this kind occur in the book, among them a repetition on p. 360 of 31 millimetres for 21, the actual breadth of the type fig. of *A. redimita*. The want of a uniform scale of enlargement of minute species, is to be regretted.

Ariolimax Mörch.

The figures given from alcoholic specimens have almost no value in comparing the outlines of the species, as they vary much, according to the degree of contraction of the animal, either when dropped in, or afterwards on account of the variable strength of the spirits used to preserve them. This variability also affects the form of internal organs, though in less degree, but probably enough to account for some of the differences described in viscera, though not those in jaws and linguals.

The figures given of *A. hemphilli* and *A. andersoni* show only such differences as can be found in a number of any one species put in alcohol under varying conditions, and are thus undistinguishable from examples of *A. niger*. Of the value of the differences in jaws and teeth, it will require comparison of many from various localities to decide.

The species however, is *A. andersoni* W.G.B. not *Prophysaon andersoni* J. G. Cooper, sp.

Living specimens of these forms differ from *A. niger* only in pale colors, but all the slugs vary so much in this that it is an unreliable character.

Prophysaon W. G. Binney.

The figure given of *P. hemphilli*, represents exactly the alcoholic appearance of my *Arion? andersoni* (p. 236), and the description is conformable, allowing for difference in this respect. Still the internal differences observed, may distinguish the northern form until fully compared with the southern.

In my MSS. description, I remarked on the differences from *Arion*, and suggested the name *Limacarion*, which some friend suppressed in printing, probably thinking it preoccupied. I still have specimens so labelled at the time of writing. At any rate *Prophysaon andersoni* has priority, as a specific name over *P. hemphilli*.

On p. 239, Mr. Binney refers to the *fresh* specimens sent by me to him, but tries to find a discrepancy in my statement that it has a caudal mucous pore. I still think that it has one, but so small as to be imperceptible when contracted by alcohol. This "mucous pore" continues to be a great stumbling block in classification, although it only differs in degree of development in various genera. All of them are covered with mucous glands as in *Limax*, each gland with a pore opening externally, and the caudal gland merely varies in size. No more mucus is produced by *Ariolimax* than by a *Prophysaon* or *limax* of the same size. The large cavity under the mantle as figured by Binney, is rather a notch between it and the end of the foot, than the opening of an enormous gland. In describing *Arion foliolatus*, Dr. Gould calls it a *pit* which tends to prove that form to be an *Ariolimax*.

Besides this character the position of the spiracle in my figure of *A.? andersoni* was sufficient to prove to Mr. Binney that it was not an *Ariolimax*, so that there was no need of making confusion by applying the name of my species to one of that genus.

The number of ribs on the jaw seems variable with age, and as I described the largest specimens, I found more than given by Binney in any of them. In some cases also, two or more ribs appear consolidated into a wide one, and the lateral ribs are rudimentary.

In quoting my locality of Santa Barbara for *A. columbianus* Mr. Binney does not consider that I afterwards separated *A. californicus* from that species, and that the extreme southern specimens are most likely to be the latter, if not a new form.

Surface Geology of South-west Pennsylvania and adjacent portions of West Virginia and Maryland.

By John J. Stevenson, Professor of Geology in the University of the City of New York.

(*Read before the American Philosophical Society, August* 15, 1879.)

Introduction.

I. *Benches along Cheat River and vicinity—Along the Monongahela River—George's Creek—Redstone Creek—Along the National Road—Chestnut Ridge—Youghiogheny River—Westmoreland County, west from Chestnut Ridge—Ligonier Valley—Somerset County—East from the Alleghanies.*

II. *Resumé of the Facts—The Horizontal Benches—The River Terraces—Conclusions.*

The region in which the observations recorded in this paper were made, embraces of Pennsylvania the counties of Fayette, Westmoreland, Washington and Greene, with parts of Alleghany, Beaver and Somerset; of West Virginia, parts of Monongalia, Preston, Mineral and Hardy; and of Maryland, the extreme western portion. But the observations were made chiefly in the four counties of Pennsylvania first named and in Monongalia county of West Virginia.

The Alleghany Mountains of Pennsylvania form the eastern boundary of Somerset county. West from these in the same county are Negro Mountain and the Viaduct Axis, which unite with the Alleghanies near the northern line of Maryland to form Prof. W. B. Rogers' Tygart's Valley anticlinal in West Virginia. This great anticlinal is divided by Tygart's Valley into two monoclinal ridges, known as Cheat Mountain and Rich Mountain.

Laurel Ridge, the next west from Negro Mountain in Pennsylvania, is a bold mountain separating Westmoreland and Fayette counties from Cambria and Somerset; it extends into West Virginia and dies out before reaching the Great Kanawha river. Chestnut Ridge passes through Westmoreland and Fayette counties at twelve or fifteen miles further west, and is separated from Laurel Ridge by the Ligonier Valley, a canoe-shaped synclinal, which disappears southward not far beyond the southern line of Pennsylvania. Chestnut Ridge becomes insignificant soon after entering West Virginia, but in Pennsylvania it is almost as imposing as Laurel Ridge or the Alleghanies. West from Chestnut Ridge, only the Saltsburg anticlinal is strong enough to affect the topography. It forms Brush Ridge in Westmoreland and Fayette counties, but disappears very near the line of West Virginia.

The drainage west from the Alleghanies belongs to the Ohio river system and the smaller streams are tributary to the Conemaugh, the Youghiogheny, the Cheat, or the Monongahela. The first of these large streams flows into the Alleghany, while the second and third are tributaries to the Monongahela, which unites with the Alleghany at Pittsburgh to form the Ohio.

The Alleghanies of Virginia are reached in Maryland. They are not the same with those of Pennsylvania, but belong to the series of anticlinals next east. In this region, the Potomac river, rising near the Alleghanies of Pennsylvania, breaks through the Alleghanies of Virginia and flows past Cumberland on its way to the Atlantic Ocean.

Within the whole area examined, no traces of glacial drift occur, except along the banks of the Ohio river, where such material appears on the terraces, having been brought down by the Beaver and Alleghany rivers from the northern counties.

Some notes respecting the river terraces of the Ohio and Monongahela rivers were given in my report on the Greene and Washington district of Pennsylvania (1875). The observations begun in 1875 were continued during 1876 and 1877, and the surface geology was studied as closely as was possible without interfering with the economic investigations, which were the main object of the survey. Some of the observations are recorded in my report on the Ligonier Valley of Fayette and Westmoreland counties (1877). Barometric measurements were made wherever a terrace or bench could be recognized, but, in very many cases, these observations proved to be worthless as no spirit-leveled line was within reach to be used as a base. The measurements given in this paper were verified by direct reference to leveled lines and by repetitions.

I.

Benches along Cheat River and its Vicinity.

Cheat and Monongahela rivers unite in Pennsylvania at about two miles north from the line of West Virginia. Their channel-ways diverge rapidly, so that the former stream issues from Chestnut ridge at little more than three or four miles south from the State line, while the latter breaks through the same ridge at fully thirty miles further south. The course of Cheat is rudely north-west, and that of the Monongahela rudely north and south.

Stewartstown Benches. In the peninsula between these rivers and west from Chestnut Ridge, a line of high knobs begins at about a mile west of south from the mouth of Cheat and continues in an irregularly south direction to Dorsey's knob beyond Morgantown in West Virginia. These hills are nearly alike in height and reach to about 600 feet above the rivers at their junction. They are rudely conical and their sides are terraced. On one of these hills is the village of Stewartstown, at nearly three miles from Cheat river. In descending from this place to either river, the following series of benches was seen :

Tenth Bench	........525 ft. above river,	1295 ft. above tide.
Ninth "	........465 " "	1235 " "
Eighth "	........425 " "	1195 " "
Seventh "	........360 " "	1130 " "
Sixth "	........330 " "	1100 " "
Fifth "	........280 " "	1050 " "
Fourth "	........210 " "	980 " "
Third "	........180 " "	950 " "
Second "	.... 80 " "	850 " "
First "	.... 20 " "	790 " "

Ice's Ferry. Descending from the State line to Ice's ferry, on Cheat river, at nearly nine miles above its mouth, one sees the first, second, third, sixth, seventh and eighth benches of the series just given, but the fourth and fifth have been so disguised by erosion that they cannot be recognized. Above the third, there are no transported fragments, and the higher benches to the sixth are covered by an irregular deposit of sand with more or less clay. But no clay was observed on the eighth bench. Ascending the opposite side of the river and following the road toward Morgantown, one finds rolled and polished stones, mostly of small size, occurring in great numbers up to the level of the third bench, where they suddenly disappear. The ninth bench is reached on this road at about three miles from the river near the church and school house. The mile-ground, a level stretch about a mile long and nearly the same distance from Morgantown, is on the eighth bench.

Standing here and casting the glass around the horizon, one finds this bench marked by flat-topped hills far beyond Decker's creek, which enters the Monongahela at Morgantown, while the same bench is distinctly continuous along the face of Chestnut Ridge southward to certainly beyond the gorge of Booth's creek, which enters the Monongahela river at somewhat more than 12 miles south from the State line. As ascertained from the records of wells bored or digged on the mile-ground, the deposit consists of coarse sand, sometimes containing a little blue clay, in all from 4 to 22 feet thick.

The seventh bench of the Stewartstown series is reached further along the road, where the valley of Decker's creek is first reached, and it is continuous thence around the hills to the Monongahela side. The third bench is well marked at Morgantown and, opposite that village, decayed shells of *unio* have been ploughed up at that level.

Line Ferry. Here, at three miles from the mouth of the river, the seventh, eighth and ninth benches of the Stewartstown series are distinct on the West Virginia side, but the lower ones have been removed or they have been disguised by erosion so as to be unrecognizable.

In descending from the north towards this ferry, one has difficulty in recognizing any of the benches, as the hill is abrupt and covered with forest; but rolled stones appear suddenly and in great numbers at 210 feet above the river bed, and increase thence in size as well as in number to the surface of the stream; while on the opposite side, transported fragments are numerous up to the level of the fifth bench. On both sides the higher benches are covered with sand, showing no polished fragments, but containing many small pieces of rock belonging to the immediate vicinity, which have been little affected by weathering and evidently have not been subjected to the action of running water.

Benches along the Monongahela River.

Between the State Line and George's Creek. Coming from the south to Point Marion, where the Cheat and Monongahela rivers unite, one finds all the Stewartstown benches distinct except the third, which has been destroyed by erosion on the east side of the Monongahela, though it is still shown on the west side. The higher benches are almost equally distinct on both sides of the river. Polished fragments occur in great numbers up to the line of the fourth bench and, even at that elevation, many of them are of enormous size.

Crossing the Ferry at Point Marion and taking the hill-road to New Geneva, at the mouth of George's creek, one reaches the third bench at half a mile from the river. It is covered by coarse sand mingled with clay, which has boulders freely distributed throughout its whole mass. Such fragments are numerous up to 280 feet from the water's edge, the line of the fifth bench. The eighth bench is reached at somewhat more than a mile from Cheat river, and at the first cross-road it bears a deposit of sand whose thickness has not been determined. A flat-topped hill near this place marks the level of the ninth bench.

The fifth bench is of interest here. It is reached on this road very soon beyond the divide separating George's creek from Cheat river. There it bears a valuable fire clay with pockets of excellent glass sand. The irregularity of the deposit is shown by sections obtained in two neighboring pits. The one shows:

1. Sand, clay, etc.	11 feet.
2. Sand, white, very clean	3 "
3. Clay, ferruginous, sandy	1 foot.
4. Clay, black, very good	1 "
5. Clay, white, good, but containing ferruginous streaks	7 feet.
6. Clay, ferruginous, seen	10 "
Total	33 feet.

The other section is:

1. Sand, clay, etc.	8 to 10 feet.
2. Clay	3 to 10 "
3. Ferruginous conglomerate	0 ft. 1 inch.
4. Glass sand	6 feet.
5. Sand, inferior	unknown.

Respecting the thickness of the ferruginous clay, No. 6 of the first section, nothing is known further than that at 10 feet from the top the tools used in boring became hopelessly fast. An attempt was made to bore through the sand, No. 5, of the second section, but the tools could not be pushed beyond 15 feet.

At a little distance beyond the pits, the third bench of the Stewartstown series is reached, but the fourth bench has been masked by erosion so that the wash from the thick deposit on the fifth covers the place of the fourth and becomes continuous with the deposit on the third. Throughout the deposits on both benches, transported fragments are found in vast numbers. A well digged on the third bench is 23 feet deep and does not reach the bottom of the sandy deposit. At a little way beyond, the bottom of the sand is reached and the thickness to the rocky shelf is shown to be 35 feet.

The black clay of the first section, commonly known as the "swamp clay," was reached in a boring here at 25 feet from the surface. In it, amid the numerous fragments of half-rotted wood, the cupule of an acorn was found along with what seemed to be berries of the black haw. The latter were thoroughly carbonized and crumbled rapidly on drying; but the acorn cup was still tough, and it was kept for some time as a curiosity. The wood in this clay is tough enough to snap in breaking and it has the peculiar tint characterizing the half-rotted wood so frequently seen in peat bogs.

A point of the third bench projects towards George's creek at a little north from the road. *Unio* shells, much decayed, are common here and are barely covered by the soil.

A rise in the road at half a mile nearer to New Geneva brings it again to the level of the fifth bench. There a small deposit of glass-sand was found, but it was soon worked out. It rested on an irregular deposit of clay and sand.

This fifth bench is continuous along the river hills from the State line to the mouth of George's creek, except where cut away by streams, but sometimes it is so defaced by erosion as to be recognized only with difficulty. It is handsomely preserved at Greensboro', on the west side of the river opposite New Geneva, where it shows vast numbers of rolled stones. Mingled clay and sand occur above it to 300 feet above water-level.

Between George's Creek and Redstone Creek. Below Greensboro' on the river hill, benches occur at 20, 180, 265 and 310 feet above low water. At the mouth of Whitely creek, in Greene county, the third bench of the Stewartstown series, at 180 feet, is very distinct up the creek to the village of Mapletown, and polished fragments are numerous all the way. At the mouth of Muddy creek, in the same county, the fifth bench, covered with rolled and polished stones, is handsomely shown, and along the creek it is quite perfect as far as Carmichaels, where the detrital coating is as thick as it is along the river.

On Pumpkin run, in the same county, this bench is shown with the same features. The measurement given in the Greene and Washington report* is erroneous and the bench is confounded there with one which was not seen in the Stewartstown series, but which seems to be intermediate between the fifth and the sixth, and to be persistent along several of the streams in Greene county at 30 feet above the fifth bench. At the mouth of Ten-mile creek the first, third and fifth of the Stewartstown series are shown, together with the supplemental one just mentioned; while at Frederick, in Washington county, or rather, at two miles back from the river, and near Frederick, is a still higher one, which is clearly the same with the eighth of the Stewartstown series, though the erroneous measurement given in the Greene and Washington county report would make it intermediate between that and the seventh.

* During part of the season of 1875 I used a barometer which proved to be quite bad. In this way came the erroneous measurements referred to.

Between Redstone Creek and Pittsburgh. The benches are handsomely shown on both sides of the river below the mouth of Redstone creek, which enters the river at Brownsville, 50 miles above Pittsburgh. At Belvernon, near the northern line of Fayette county, the deposit on the third bench has been opened to procure glass-sand ; and at present two excavations are worked on the opposite side of the river. At the upper one of these the following detailed section was obtained :

1. Alternations of fireclay, gravel and coarse sand, with fragments of varying size ; the whole containing much carbonaceous matter in streaks, mostly broken coal ; very ferruginous toward the base .... 12 to 16 ft.
2. Sand, fine and angular, excellent for manufacture of fine window and mirror glass ; containing thin, irregular layers of blue plastic clay, with occasional layers of conglomerate cemented by oxide of iron ; contains also numerous rounded fragments of rock, some of them very large ; the pebbles are of limestone, sandstone, and carboniferous conglomerate.... 16 to 22 ft.
3. Coarse sand and gravel, with many small rounded fragments ; much carbonaceous matter, coal, and imperfect lignite ; occasionally yields large fragments of trees. This is often a ferruginous conglomerate........ 2 ft.
4. Ferruginous sand, frequently conglomerate ; contains some transported fragments of considerable size .... 2 to 4 ft.
5. Blue plastic clay .... 0 to 4 ft.
6. Blue laminated shale of the lower barren series.

The plastic clay, No. 5, is evidently derived from the underlying shale on which the deposit rests. The section shown in the other excavation is :

1. Clay, containing rounded fragments, lumps of coal, etc...... 10 ft.
2. Dark sand used for moulding........ 7 ft.
3. White sand, used in making glass .... 7 ft.
4. Sandy and clayey material, containing rounded fragments and lumps of iron ore .... 1 ft.
5. Dark sand .... 4 ft.

As these excavations are barely half a mile apart, they show the extreme irregularity of the deposit, which is from 40 to 45 feet thick at the upper excavation, while at the lower one it rarely exceeds 35 feet.

At Monongahela city, the third and fifth of the Stewartstown benches are at 190 and 320 feet above low water mark ; above these are the sixth and eighth at 1110 and 1190 feet above tide. Between the third and fifth there is an ill-defined bench at 290 feet above low water, which is distinct further down the stream, for a terrace, holding that place, is reported from Peter's creek and Thompson's run. The third bench, also, is well defined down the river, being that along which the Pennsylvania Railroad runs from just below Braddocksfield almost to Pittsburgh.

The lowest bench at Monongahela city is at 40 feet above the river or at 750 feet above tide. The Baltimore and Ohio Railroad runs along this bench for a considerable part of the way below the mouth of the Youghiogheny river. It is the bench along the river front at Pittsburgh.

Benches along George's Creek. The third and fifth benches of the Stewartstown series are persistent along this creek, but constantly rise up-stream so that at the village of Smithfield the fifth is 304 and the third 200 feet above the river at the mouth of the creek. The rise is quite regular and in this distance the lower one has gained five feet on the upper one.

The eighth bench is shown on the south side of the creek near the village of Morris Cross-roads, forming the crests of several flat-topped hills on the divide between George's creek and Grassy run, the latter a tributary to Cheat river. Its absolute level is unchanged, being 1195 feet above mean tide. The sixth bench is found near Grassy run, and the second is there at 80 feet above the run, or 125 feet above Cheat river at its mouth.

Crossing the divide between Grassy run and Rubbler's run, also tributary to Cheat river, several benches were seen, but their relations could not be made out owing to lack of time. On Mitchell's hill, projecting from Chestnut Ridge almost immediately behind the old Springhill furnace, the eighth bench stands out from the mountain for almost 400 yards. This bench is continuous thence southward to the line of West Virginia, where, as the divide between Rubbler's run and Cheat river, it extends for a long distance eastward and westward. Its elevation was determined on this divide and differs from that near Stewartstown by barely five feet.

Returning to George's creek and taking the road from Smithfield to Uniontown, which follows the west side of the valley, one finds the third, fifth and sixth benches constantly persistent along the side of Brush ridge, which, as already mentioned, is the elevated land marking the course of the Saltsburg anticlinal. East from the road are some minor benches whose relations were not made out.

Beyond the creek, on the flank of the mountain, fragments of the eighth bench are occasionally shown, and the same bench is reached on the road at the summit of the divide between George's and Redstone creeks at one mile from Uniontown.

Meanwhile, in ascending the creek, the fifth bench has shown a constant increase in altitude, so that as the divide is approached, that bench takes place of the sixth and finally is merged into the seventh. According to the barometer, the eighth bench is somewhat higher here than at the mouth of Cheat river, being 1206 feet instead of 1195, but the measurement was not verified. No opportunity was afforded for following out the minor benches in this valley, but their steady rise from the river to the village of Smithfield justifies the belief that they rise with the stream until, at last, the "bottom" becomes merged into the highest bench at the head of the stream.

Benches on Redstone Creek. No little difficulty was experienced in the attempt to trace out the benches along Redstone creek, which enters the Monongahela at Brownsville, 50 miles above Pittsburgh. From the river to Upper Middletown, 3 miles below Uniontown, the creek is hemmed in by high hills and the valley is so narrow in many places that the benches are necessarily very indistinct. It is sufficiently clear, however, that the bench, on which Uniontown is built, is the same with the third of the Stewartstown series as exposed at Brownsville. The transported fragments were seen on Redstone at five or six miles from the river, where the bench is fairly well defined. Further up, the same bench is imperfectly shown at Upper Middletown.

Along the road leading from Uniontown to Connellsville, the eighth bench is reached very soon after leaving the National road, and it is exposed again near Lemont furnace at four miles from Uniontown, where the sixth bench is handsomely preserved at 90 feet below it. The latter bench shows changes in level as insignificant as those of the former.

The eighth bench is persistent throughout the whole of the Redstone valley east from Brush Ridge, but it becomes a little obscure near the summit dividing the waters of Redstone from those of Dunbar creek. There a higher bench was seen, which belongs between the ninth and tenth of the Stewartstown column.

On the old Pittsburgh road leading north from Uniontown, the eighth bench is well shown, and, at the first summit, the tenth bench is reached. This seems to be the most extensive plain along the east side of Brush Ridge.

Benches along the National Road.

Between Uniontown and the Monongahela River. The National road between Uniontown in Fayette county and Washington in Washington county seems to have been laid out with the view of crossing the summit of every high hill between the two boroughs. It affords excellent opportunity for the study of the higher benches with the least possible expenditure of labor.

The eighth bench is soon reached west from Uniontown, and a persistent floor representing the seventh bench is shown at 50 feet below it. The tenth bench is seen at three miles west from Uniontown; and a rude survey of the surrounding country, made with the level, shows that bench to be very widely persistent and to be the important plain of Brush Ridge.

The ninth bench is reached on the hill holding the eastern outcrop of the *Pittsburgh coal bed* at five miles west from Uniontown. At that place one comes to the benches of Dunlop's creek, and the ninth bench is seen to be constantly distinct along that stream during its passage through the arch of the Saltsburg axis.

On the hill beyond the old hotel at nearly nine miles west from Uniontown, a higher bench is reached, which is shown in several hills in the vicinity, all of them flat-topped. These truncated cones mark an eleventh bench, whose altitude is 60 feet greater than that of the tenth, or 1350 feet above mean tide.

The tenth bench is reached again at a little way further west, and thence for a considerable distance the road runs on the ninth which is handsomely defined.

Thence to within a mile of Brownsville, the country is so disfigured by erosion that nothing can be determined ; but at that distance from Brownsville one comes within sight of the Monongahela river and the road soon falls to the eighth bench, which has an absolute altitude of 1185 feet. if the engineers' station at West Brownsville was correctly identified. This is ten feet less than at the mouth of Cheat river and 5 feet less than on the Connellsville road near Uniontown. The other benches below this are sufficiently distinct along the river above Brownsville.

Between the Monongahela River and Washington. On the west side of the river, the eighth bench is reached within a mile and it is the important one north and south as far as the eye can reach, until one comes to a station, known as Kreppsville, say three miles west from the river as measured along the road. But there, at a short distance north from the road, a higher bench is seen at 1225 feet, which seems to be the ninth of the series and is persistent northward. The road reaches this bench at a little way further west and follows it to near the village of Centreville, where, while crossing a stream, it comes down to the eighth bench. At Centreville, it returns to the ninth, while both north and south from the village a higher bench is seen in fragments, with an elevation of 1245 feet. Still further north, the tenth bench is shown in the crowns of several flat-topped hills, which have an elevation of 1285 feet.

Between Centreville and a mile and a half east from the village of Beallsville, the road runs alternately on the 1225 and the 1245 feet bench, but at the latter place it falls to the eighth as it crosses the valley of a stream emptying into the Monongahela river. It quickly rises again to 1225 and then to 1245 feet, both distinct benches, and within a short distance it comes up to the tenth. The last is the great bench north and south, and apparently it is the most important bench thus far on this side of the river.

West from Beallsville is a high hill, which seems to mark the dividing line between the benches of the Monongahela Valley and those belonging to the valley of Chartiers creek and the Ohio river at the west, though it is broken by Pike run at a little way north from the National road. On this hill, one rises to 1420 and 1445 feet above tide, two splendid benches, and the summit of the hill is little less than 1500 feet.

Descending the west side of this hill, one comes to the 1420 feet bench and goes below it ; but in ascending the first summit east from Hillsborough, he crosses benches at 1420, 1445 and 1475 feet, all of them perfectly distinct, the first two quite as much so as on the east side of the Beallsville Ridge. Descending from this, one soon comes to the tenth bench at 1295 feet, but in ascending to Hillsborough he again crosses benches at 1420, 1445 and 1475 feet and reaches 1505 feet at the hill-top, the three benches being very distinct. Hillsborough is at 12 miles east from Washington.

At eleven miles east from Washington, the road crosses the 1445 feet bench ; at ten miles, the bench at 1380 feet ; and at 9½ miles, the tenth at 1295 feet. At nine miles, one reaches the head of Pike run, and in the whole region north from the National road, the tenth bench is the most widespread, the one which gives character to the country. At 8 miles and a half from Washington, the general elevation of the country increases and the road rises, so that from that point to the four-mile post the road oscillates between the 1420 and the 1445 feet bench. But near that post it falls to 1375 or 1380 feet and comes upon a fine terrace, which is of considerable extent north and south from the pike.

Between the second and third mile-posts, the road crosses an island of the 1420 feet bench and at the second post it is again at 1375 feet. This is the principal bench of the Chartiers Valley, being well shown on both sides. The lower benches came out in their order from this horizon down to the railroad depot at Washington, which is near the place of the sixth bench.

The observations from the river to Washington were made altogether with the barometer, but under very favorable circumstances, for on repetition the measurements showed insignificant variations; and in both cases the total change in the barometer during the passage was barely five one-thousandths of an inch; the altitudes of the stations terminating the line having been well determined by railroad levels.

Benches on West Side of Chestnut Ridge South from the Youghiogheny River.

This slope shows for the most part a very regular face in the Redstone region. Near the West Virginia line and beyond that southward as far as the observations were carried, the rocks of the Lower Barren and Lower Productive Coal Series have so far escaped erosion, that the benches below the eighth are easily recognized. Northward from the middle of George's township, in Fayette county, to the divide between Redstone and Dunbar creeks, the lower rocks of the Coal Measures have been in great part removed, and the massive Pottsville (Seral) conglomerate, resisting erosion, has remained to give the mountain its present slope. The benches do not exist where this rock forms the face of the ridge and traces of them are very rare. It is noteworthy that the outcrop of this conglomerate, though at a considerable distance from the plane of the axis, is not much below the average elevation of the summit of the ridge.

On the summit, at the National road, the surface is covered by a fine reddish sand, almost free from clay, which is well shown at the Summit hotel. The well on the opposite side of the road was digged in this sand to the depth of 40 feet, and the people in the vicinity were surprised by the occurrence of river snails and mussels, many of them being quite fresh looking. This point is about 2400 feet above tide. A well marked bench was seen on the Seaton road, 180 feet higher, which extends along that road for nearly two miles south from the National road and is covered with loose sand derived from the disintegration of the Pocono (Vespertine) sandstone. A level bench covered by loose sand can be followed for several miles along the crest of this ridge.

Some of the low gaps, which extend to but a short distance below the summit are beautifully terraced. The benches in Wymp's gap, exposed by removal of the timber, are distinct to one standing even on the opposite side of George's Creek Valley. The gorges made by the larger streams are usually so narrow and have so abrupt walls that no benches remain, and it is doubtful if benches could have existed in any but very few of them. For this reason no benches below the eighth have been fully recognized along the greater part of this face, south from the Youghiogheny river.

Benches along the Youghiogheny River.

The river "bottom" at M'Keesport is at 765 feet above tide. Thence it is continuous to Connellsville, at the mouth of the Chestnut Ridge gap, where it is 894 feet above tide.

At Perryopolis, just south from the river, a fine bench is shown covered by sand, which contains many enormous bowlders, all of which have been brought down from the mountain gaps.

Possum run enters the river almost opposite Connellsville. On the road leading along this run from that borough to Brownsville, a bench, reached at the first summit, barely 200 feet above the river, is the highest limit of transported fragments. All of the bowlders are of huge size and many of them weigh not less than a ton. They have polished surfaces and are so numerous that the farmers use them in building fences. This bench is the same with that seen at Perryopolis.

This bench is persistent along the river above Connellsville, but it can be followed only with difficulty as slides in the gaps have masked it at several localities. It is very nearly 200 feet above the river at Connellsville, but thence it rises less rapidly than the river bed, so that at Ohiopyle Falls it is not quite 140 feet above the stream. While flowing on this bench as its bed, the river ran directly across the neck of the peninsula at Ohiopyle Falls, and the gorge through which the stream now flows has been eroded since the bed fell below that bench.

At Confluence, immediately above the east end of the gap through Laurel Ridge, the river "bottom," which is only 765 feet at M'Keesport, is 1346 feet above tide or 581 feet higher than the same bench at the mouth of the river. A very fine bench was seen southwest from Confluence at 1820 feet above tide. The persistent bench to which reference has been made, is still seen along the river, but is much nearer the stream than it is at Ohiopyle. Riding up Castleman's river, which unites here with the Youghiogheny, one soon rises above this bench or rather finds the river bottom merged into it.

Benches in Westmoreland County West from Chestnut Ridge.

Few available measurements were obtained in this part of Westmoreland county. The survey was made during the autumn of 1876, a season strangely marked by violent fluctuations of the barometer ; but no measurements have been accepted as trustworthy except such as were verified by direct comparison with a spirit-leveled line as a base.

Though the observations thus available are very few, yet they suffice to show that the system of benches in this county is the same with that found in Fayette and Washington.

The eighth bench of the Stewartstown series is shown half a mile west from Jacksonville, near the county line on the Pittsburgh and Bedford road, at 1190 feet above tide; a still higher one at Jacksonville with an elevation of 1230 feet, is evidently the ninth of that series. These benches are well shown both north and south from the pike, forming the crowns of many hills, while the tenth is distinct north from the Pennsylvania Railroad. Following the pike one finds the twelfth bench at three miles and a half west from Greensburg, with an elevation of 1380 feet, precisely the same as on the National road many miles southwest; and at two miles west from Greensburg the ninth (?) is shown with an elevation of 1242 feet. Benches were seen north from Greensburg at 1185, 1270, and 1300 feet on the road to New Salem, evidently representing the eight and tenth with the intermediate bench seen in Fayette county between the ninth and tenth.

The highest point at the village of New Salem is on the eleventh bench, which is of wide extent in that part of the country. The benches are finely shown west from New Salem along Turtle Creek and its tributaries, but unfortunately, all of the measurements made in that vicinity proved altogether worthless, owing to flagrant variations in the barometer.

Measurements made on the Bedford pike near Latrobe, as it descends to Loyalhanna creek, showed the fifth, sixth, eighth and ninth benches at 1050, 1105, 1185 and 1240 feet above tide. The fifth is here the "bottom" of the Loyalhanna. The highest plain seen near the pike is about 1450 feet above tide.

Benches in the Ligonier Valley.

On the National Road. There was no means of verifying the measurements made here. The base used is the altitude of Chestnut Ridge summit as determined by the original survey at 2400 feet above tide. This determination agrees closely with that shown by the barometer, the railroad level at Uniontown being taken as the base; but as gross errors were made by the engineers in running the line for the road, and as there is no well-fixed point nearer than Uniontown, the altitudes of the benches cannot be regarded as fairly determined. At the same time it may be best to record the levels obtained, because they show that the surface of Ligonier Valley is marked by horizontal benches precisely similar to those seen on the west side of Chestnut Ridge. The following series was made out between the summit and the village of Farmington, midway between Chestnut and Laurel Ridges: 2155, 2060, 1965, 1880 feet above tide. The crowns of the hills in this part of the valley are almost absolutely level and the escarpments of the benches are very steep. The forms stand out more fairly than they do west from Chestnut Ridge.

South from the National road, Laurel Ridge loses its mountain character and, as it were, breaks down into a broad level country, known as the "Glades," which stretches over into West Virginia and Maryland. Though thus breaking down, the ridge loses little of its height, and the "Glades" are not far from 2200 feet above tide. In general character this plain is precisely like the benches.

A fine series of benches was seen near Indian creek at Springfield in Fayette county, but no way existed whereby the exact altitude could be determined, and no measurements were made.

Near the Loyalhanna. Between Ligonier and the village of Stahlstown in Westmoreland county, on the divide between Four-mile run and the Loyalhanna, the following benches were found: 1690, 1570, 1520, 1480, 1390 and 1245 feet above tide. These measurements were verified by reference to the levels of the Ligonier and Latrobe Railroad at Ligonier. The last three are remarkably near three seen on the National road not far from Hillsborough, and the last two undoubtedly represent the ninth (?) and twelfth of the series.

Benches in Somerset County.

The elevation of Meyersdale on the Pittsburgh and Connellsville Railroad has been well established at 2063 feet above tide. Within sight of that village are three fully defined benches at 2123, 2288 and 2323 feet above tide, as determined by barometer from Meyersdale.

The first bench is the floor of the country away from the Castleman's river; is shown on the hill between Elk Lick creek and the Castleman's; is the first bench on the road to Berlin north from the River, where it is beautifully distinct; and is again reached on the summit beyond the crossing of Blue Lick by that road. At each of these places the bench is seen to be persistent over a wide area.

The second bench is at the hill-top on the property of the Cumberland and Elk Lick coal company, and its place southward from that locality is shown by flat-topped hills. The same bench was seen on the road to Berlin.

The third bench was seen on the road to Berlin at the Pine Hill church as well as at Berlin, where its existence is proved by the flat-topped hills. All of the benches are distinct at Berlin, and the second and third are well preserved along the west face of the Alleghanies.

East from the Alleghanies.

The observations here are not in detail. For the most part they were taken hastily along Wills creek and in the vicinity of Cumberland. Enough, however, was ascertained to show that a series of benches similar to that already described, exists along the east side of the Alleghanies in Maryland.

Fine river terraces were seen along the Potomac and on Wills creek, which enters the Potomac river at Cumberland. The chief terrace of the Potomac is easily traced from Cumberland to Piedmont, and has even more rapid rise than along the Youghiogheny or the Castleman's river. The detrital fragments become very coarse in the mountain region, just as they do on the Youghiogheny and Castleman's, and the deposit bears some resemblance to glacial debris. The huge fragments have been transported but a short distance, and slides from the mountains are mingled with detritus moved by the stream; so that, upon the whole, the deposit has little likeness to the material covering the terraces on the lower Monongahela or Youghiogheny, where the larger blocks have been rounded during their long journey, while many of the smaller ones have been reduced to fine sand or clay.

II.

Resume of the Facts and their Relations.

Looking now at the observations recorded in the foregoing part of this paper, we see that although very fragmentary, they show the existence of two sets of benches, in one of which, the higher, the individuals have an almost unvarying level, whereas in the other or lower set, the members have no definite altitude with respect to tide, but vary much, as do the beds of the streams along which they are found. Arranged in tabular form, we have, first the benches of the higher series:

1.	Chestnut Ridge, Seaton road.......	above tide,	2580	feet.
2.	Chestnut " National road......	"	2400	"
3.	Top bench in Somerset county......	"	2323	"
4.	Middle bench of "	"	2288	"
5.	Bottom " "	"	2123	"
6.	Bench near Confluence	"	1820	"
7.	Sixth bench near Loyalhanna......	"	1690	"
8.	Fifth bench " "	"	1570	"
9.	Fourth " " "	"	1520	"
10.	Third " " " also at Hillsborough and Beallsville.....	"	1475	"
11.	National road, Washington county..	"	1445	"
12.	" " " .	"	1420	"
13.	Second Loyalhanna bench, also National road near Beallsville and Hillsborough..................	"	1380	"
14.	National road east from Brownsville	"	1350	"
15.	Tenth bench of Stewartstown series,	"	1290	"
16.	Intermediate bench, Dunbar cr., Possum cr., Greensburg..........	"	1270	"
17.	Ninth bench of Stewartstown series First Loyalhanna bench...above tide,		1225 to 1240	"
18.	Eighth bench of Stewartstown series,	above tide,	1195	"
19.	Seventh " " "	"	1130	"
20.	Sixth " " "	"	1100	"

The elevation of low water at Pittsburgh, as used by the City Surveyor's office, is 699 feet above mean tide.

Comparison of the levels given in this table with those given in the preceding notes shows some discrepancies. The altitudes used in the tables approach the means, or nearly so, of the measurements At the same time, no bench, aside from No. 17, shows any material variation, and in that two are confounded. That two distinct benches belong here will be seen at once by examination of the notes on the National road and on Westmoreland county west from Chestnut Ridge. But it would be unwise to correct the error in this table, as the numbers there given have been published elsewhere,* and any change in the order might prove inconvenient.

The benches seen in the southern part of the Ligonier Valley are omitted, because their elevation cannot be regarded as satisfactorily determined.

The variations in level exhibited by individual benches of this series are so slight that they may be due either to petty variations of the barometer or to errors in reading it, or to the fact that, in every case, the highest point on the bench was sought, so as to determine the top of the detrital deposit. As that deposit, though very thin, has suffered more or less from erosion, one could not, even with perfect instruments, obtain a series of measurements which would tally accurately. The extreme of variation, even in No. 17 where two benches are confounded, is scarcely 18 feet ; so that one is fairly justified in regarding the benches as practically horizontal and parallel.

The deposit on these benches sometimes contains a little clay, but sand greatly predominates. No rolled or polished fragments of stone occur ; and such fragments as are present belong altogether to rocks found in the immediate vicinity. Nothing shows that running water had ever passed over these plains, so that if the water were in motion, its effects must have been confined within a limited space.

The benches of the lower series have no fixed level, but are precisely analogous to the bottoms of the streams which flow below them. In tabular form this series may be given as follows :

1. Fifth bench of Stewartstown series....	above tide	1050	feet.
2. Fourth bench of same....	"	980	"
3. Third bench of same.................	"	950	"
4. Second bench of same................	"	850	"
5. First bench of same..................	"	790	"

The elevations given in this list are those observed at the mouth of Cheat river, and are used only to show the intervals between the benches at a locality where the series is well exhibited.

It has been said that no absolute altitudes can be assigned to members of this series ; the lowest bench is 790 feet above tide at the mouth of Cheat river, but at Pittsburgh it is only 765 feet ; the third bench is 950 at the mouth of Cheat, but 920 at the mouth of Turtle creek in Allegheny county. More marked variations occur on George's creek, the Youghiogheny and many other streams.

* *American Journal of Science* for May, 1878; and Part II of Report on the Fayette and Westmoreland District of Pennsylvania (1877).

As mentioned in my first report on the geology of southwestern Pennsylvania (that for 1875), these lower benches are merely shelves cut out of the rock, on which are spread thin deposits of irregularly or even wholly unstratified débris. At some localities, the lower part shows little aside from clay, while the upper part is made up almost wholly of sand, but ordinarily one of these occurs in pots within the other.

Transported fragments, rounded or polished, appear with this series. Those in the Monongahela benches have been brought from the south and east, for no rocks are represented except such as occur in the mountains crossed by the Youghiogheny and Monongahela or their tributaries ; and no material belonging to the northern drift was found anywhere south from the junction of the Ohio and Monongahela rivers. The detrital covering seems to be greatest on the third and fifth benches, where it is of no small economical importance, the third yielding the glass-sand of Belvernon, and the fifth, the glass-sand of Perryopolis and the fire-clay of New Geneva.

The upper limit of rolled stones shows some perplexing variations, which can be accounted for only by supposing that the higher benches of the series have been worn away from one side of the stream, or that, during the formation of two successive terraces, the channel-way held close to one side. On Cheat river, near Ice's ferry, at nine miles from the Monongahela, the upper limit on the south side is the third bench ; near the Line ferry, further down on the same river, no fragments occur on the north side above the fourth, though they are numerous on the south side up to the fifth ; the fourth terrace is the upper limit on the south side at Point Marion, whereas fragments are abundant up to the fifth on the north side. No fragments have been found anywhere above the fifth bench.

After passing the third bench, the Monongahela river seems to have suffered changes in its channel-way. Below Belvernon, there is distinct evidence that it now flows along a line very different from that followed when its bed was on the third bench. The change was more serious near Pittsburgh. The river had a direct course from Braddocksfield to the Allegheny and that line is now followed by the Pennsylvania Railroad. The present channel-way of the river is very tortuous. A similar change is shown at Ohiopyle Falls on the Youghiogheny, where the old channel on the fifth bench crossed the neck of a peninsula, while the new channel-way makes a long and close bend around the peninsula.

The conditions, then, are these : The area in which observations were made covers more than 10,000 square miles ; embraces that part of Pennsylvania lying south from the Ohio and Conemaugh rivers and west from the Alleghanies ; includes part of Maryland and West Virginia, lying on both sides of the Alleghanies of Virginia ; and has the channel-ways of four great rivers, the Monongahela, Cheat, Youghiogheny and Potomac, lying partly within it. Along all these streams are terraces, covered by detritus, which contains many transported fragments polished by running water ;

these terraces fall down stream, though not so rapidly as do the present stream beds.

But a second series of benches or terraces appears throughout this whole region and seems to be characteristic of a very much wider area than that in which observations were made. The members of this upper series differ in many respects from those of the lower series; their coating of débris contains little clay and no polished fragments; they are almost absolutely horizontal and parallel; they do not merge into the lower series, though as the higher benches often form divides between the streams, the lower or stream terraces always end up in one of them. These horizontal benches begin within the area west from the Alleghanies at 1100 feet above tide; they line the faces of the mountains, they curve round the conical hills and often they are indicated only by the leveled crowns of the higher knobs.

Let us look at these series separately, beginning with higher one.

The Horizontal Benches.

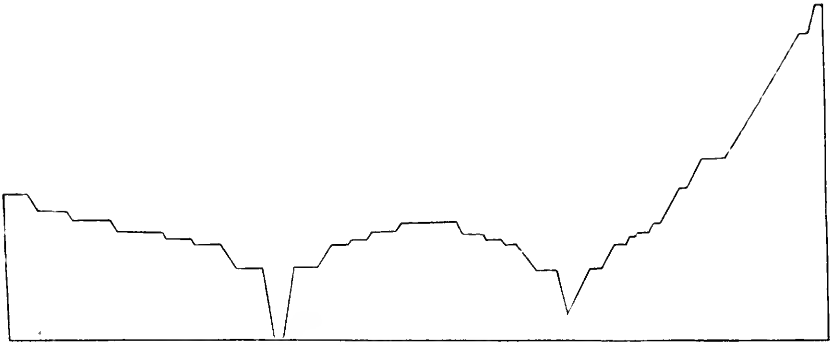
Standing on the highest point crossed by the National road between Chestnut Ridge and the Monongahela river, one finds himself on an island of bench 14, or 1350 feet above mean tide.* Below him an almost continuous plain of the fifteenth bench stretches for a long distance north and south and is broken only by gaps through which the larger streams cross Brush Ridge. He sees also that this plain is the divide between two valleys, one at the east between Brush and Chestnut Ridges, and the other at the west, through which the Monongahela river flows. The latter is uninterrupted, but the former is crossed by strips of the fifteenth bench as well as by lower benches of the series, which breaks its continuity and convert it into a succession of basins. On each side the surface from the summit of Brush Ridge falls off in regular steps.

If now the observer turn his attention to the region lying west from the Monongahela river he will see that the fifteenth bench is a broad continuous plain beyond that river; but that still further back toward the west, the fourteenth, on an island of which he is standing, forms a similar plain, while still further west, the thirteenth, with an altitude of 1380 feet, stretches northward and southward, and is broken only by narrow valleys, in which the larger streams flow.

Should the observer's position be changed to Hillsborough, on the National road nearly midway between the Monongahela river and the borough of Washington, where the elevation is about 1500 feet above tide, he will see that this thirteenth bench is of great extent north and south, while back of it the country rises to a still higher level, again and again, until it reaches to 1445 feet above tide. This last bench is the ridge, which practically separates the benches of the Monongahela from those of the Chartiers Valley further west, though near the National road that ridge is broken by Pike run, along which all the lower benches of the series are shown. From the river westward to Hillsborough, or rather to the ridge passing nearly three

* The numbers are those on the last table.

miles from that place, the surface rises in a succession of steps which are beautifully marked. From the hill-top at Beallsville, three miles east from Hillsborough, the descent of these to the river is well seen. There is here, then, a repetition of the conditions shown east from the Monongahela. The diagram rudely represents the succession.



Profile of benches from Chestnut Ridge to Hillsborough.

In the valley between Brush Ridge and Chestnut Ridge, benches lower than the fifteenth fringe the several drainage areas, while the sixteenth and eighteenth form subordinate divides.

Two general questions present themselves here, the one relating to the time when the valleys were scooped out, the other to the age and origin of these benches by which the sides of the valleys are marked.

Erosion of the Valleys. The present drainage system was outlined at a very early date, in part no doubt before the elevation of any of the great axes; the Conemaugh river taking its rise on the western slope of the Alleghany Mountains of Pennsylvania, breaks through both Laurel and Chestnut Ridges, as well as the Blairsville, Saltsburg and Waynesburg axes, which are west from Chestnut Ridge; Loyalhanna, Jacob's and Dunbar creeks cut through Chestnut Ridge; the Youghiogheny has worn its way across all the main axes west from the Alleghanies of Pennsylvania; Cheat river heads against the Alleghanies of Virginia, and its deep channel-way passes by deep gaps through the Alleghanies of Pennsylvania and all other axes at the west, until it enters that of the Monongahela midway in the Saltsburg arch; while the main fork of the Monongahela river splits the Tygart's Valley axis in West Virginia, flowing for miles in a broad anticlinal valley, and after breaking through the west slope of that axis, runs rudely northwest and north, until, having cut through every axis to the Brady's Bend, it joins the Alleghany river at Pittsburgh.

It seems altogether probable that this system developed itself gradually as the land increased toward the central part of the basin, and that the great streams flowed very near their present lines before any marked elevation of the axes had taken place.

One is not fairly justified by the facts in supposing that the system was established after the axes had been elevated enough to affect the topography. Several canoe-shaped synclinals lie between the Alleghanies of Pennsylvania and Laurel Ridge; a similar synclinal exists between Laurel and Chestnut Ridges and another between Chestnut and Brush Ridges. A drainage system, like that now existing, could hardly have originated in parallel synclinal troughs separated by distinct ridges such as these mountains are. A series of lakes might have been formed, but that they would have been in communication so as to give a uniform drainage system, tending wholly westward and breaking through the axes, seems not altogether probable; for Laurel and Chestnut Ridges are little, if at all inferior to the Alleghanies of Pennsylvania, either in altitude or in the inclination of the strata.

It is equally difficult to believe that the streams now flow along lines of original weakness, crossing the several axes, or that their present courses through the mountains mark lines of transverse fracture. A transverse fracture would necessarily be parallel to the direction of the disturbing force, and it could arise only in case the rock on one side of a line has greater power of resistance than it has on the other. Associated with the transverse fracture there would be a greater or less faulting of the axis. So that there would be no difficulty in deciding the presence or absence of such a fracture; for even were the direct evidence masked by river erosion, the side throw would be distinct. But there are no evidences of such side-throws near the gaps or anywhere else in these mountains, and all the conditions go to show that any supposition of their existence is altogether improbable. For, as I have shown elsewhere,* though the axes are thrown off successively toward the southeast, yet there are no breaks. The two parts of a shifted axis overlap, one becoming gentle toward the north and the other toward the south, until each is over-ridden by the other.

In addition, such a hypothesis necessarily assumes not only that these fractures must have existed in all of the mountain axes, but also that much more extensive erosion had taken place in the region west from Chestnut Ridge than any of the more eastern troughs, in order that by deepening the fractures in the several mountain ranges, the waters could be drawn off into the next trough west.

While neither the hypothesis nor its attendant assumption goes beyond the range of possibility, each oversteps very far the bounds of probability. Erosion must have been going on all the time east from Laurel Ridge, while the valleys were deepening on the west side of Chestnut Ridge; and a system of drainage must have existed in one region just as well as in the other; unless, indeed, the region east from Laurel Ridge was arid, which is wholly improbable. If these systems were not one from a very early date, it is difficult to conceive how they could become one at any later date; at all events it would be impossible by any natural deepening of gaps or removal of divides to divert the drainage from one side of an axis to the

* Reports on Fayette and Westmoreland Dist. of Penn.

other in a region like this, even were the ridge no greater than Brush Ridge, which marks the course of the Saltsburg anticlinal.

The accuracy of this statement will be apparent at once to one standing on the National road at the summit of Chestnut Ridge, where on the west he sees deep gorges made by Redstone creek, while on the east side he may look down into the almost equally deep gorges made by Cheney's run. The water from the former flows to the Monongahela by way of a close gap through Brush Ridge; while that from the latter, flowing against the dip of the rocks, which rise southward towards the point of the Ligonier canoe, passes by way of Sandy creek to the Cheat river. Each stream has a rapid fall, so that no possible cutting down of the divide by natural operations would suffice to divert the drainage from one side to the other.

Altogether the more probable hypothesis, therefore, is that the main streams flowed along or near their present lines before the axes, which they cross, had been elevated so as to affect the topography; and that the gaps were eroded during the slow elevation of the folds. This process has been well described by Mr. Gilbert in his *Memoir on the Geology of the Henry Mountains*, and Maj. Powell has given instances where it is clearly impossible that the disturbance could have ante-dated the erosion. Some of these are analogous to the ones under consideration.

The great length of time which has elapsed since this erosion began is shown not only by the general wasting of the surface between the axes, but also by the structure of the gaps; for in these, above the highest river terrace, the walls slope with comparative gentleness, and in many places they are deeply trenched by streams flowing directly along the axial line; whereas below the line of the highest river terrace, the walls are abrupt. The same conditions exist in minor gorges made by such streams as George's creek, Redstone creek, Jacob's creek and Sewickley creek through the axis of Brush Ridge, for there also the lower part of the gorges has abrupt walls, while the upper part is wide, with walls sloping gently toward the streams. It will be understood, of course, that there are occasional exceptions to this general statement of the conditions.

That the erosion of the valleys ante-dated the formation of the horizontal benches is shown by the distribution of the benches themselves. These appear in many localities only as the crowns of flat-topped hills; the fifteenth is an extensive plain along Brush ridge, but between that and Chestnut Ridge it occurs only in the crowns of hills or as the summit of narrow strips stretching from one ridge to the other. Some benches are seen only along the mountain slopes, while others line both sides of narrow valleys reaching far from the rivers into the interior of the counties. All of the terraces below the twelfth are shown along Pike run in Washington county, though that stream breaks through the ridge which shows the highest benches seen west from Chestnut Ridge. For this reason, one riding from the Monongahela to Washington along the National road frequently descends from higher benches to lower ones and finds them all equally distinct. The lower benches can be seen along the valleys for a considerable distance from the National road towards the river, and when followed out they are found to be continuous with those previously crossed on the road.

Age and Origin of the Horizontal Benches. The surfaces of these benches are still level, and in many places the escarpments are so nearly perfect that one has difficulty in believing that the flat topped hills are not ancient fortifications. The detrital covering is well preserved, though it consists only of loose sand with occasionally a little clay.

Some may suppose, that, in measure at least, these benches are creatures of the imagination and that they are merely such as must occur in a region where the rocks are of unequal hardness and are horizontally stratified. But such a supposition would be wholly erroneous. The rocks are not horizontally stratified and the benches bear no relation whatever to the dip of the rocks. Thus in Springhill township of Fayette county, on the west slope of Chestnut Ridge, the rocks dip at from 4 to 6 degrees toward the north-west, but the fifteenth bench is as level there as it is on the side of Brush Ridge, eight miles away, where the dip is but one degree, or at Uniontown, ten miles away, where the dip is three degrees, or at any other locality within the whole region. That no relation exists between the stratification and the benches is a fact which cannot be stated too positively.

It has been suggested that these benches may be regarded as marking base levels of erosion, such as have been described by Maj. Powell. In defining the term, that author uses the following language: "We may consider the level of the ocean sea to be a grand base-level, below which the dry lands cannot be eroded; but we have for local and temporary purposes, other base-levels of erosion, which are the levels of the principal streams which carry away the products of erosion."

As Major Powell states, the term "level" is used with some freedom in reference to stream-beds, and the term base-plane might have been more apt. Major Powell notes the fact, that, for all practical purposes, a stream ceases to deepen its channel-way long before the bed has reached the level of the lower end of the stream. If I understand the doctrine aright, it is, that after the corrasive energy of the stream has reached its minimum, it is less rapid in its effect than the wasting away of the adjoining surface; so that eventually the whole region will be worn down to a slightly inclined plane, having about the same altitude with the base-line of erosion or the bed of the stream.

It is with some hesitation that I venture to disagree with those who would explain the phenomena on this hypothesis, for they have had opportunity for very extended study of surface geology; but the explanation is insufficient here, and is open to serious objections, some of which are almost insuperable.

The wide-spread horizontality of the benches seems to conflict with any such explanation. One can conceive that all the streams feeding the Alleghany and Monongahela could reach the limit of corrasion at the same altitude above tide, and that, after that limit had been reached, the tributaries of those streams could continue to eat away the surface until at length a broad and almost horizontal bottom might be formed on each stream, all having the same elevation. But such a condition is inherently improbable. Aside trom that, it would not suffice to explain the phenomena, for the benches would not be horizontal, they would be river terraces, with a gentle slope down stream.

If the plains of south-east Pennsylvania and the adjoining region have resulted from any such process as that described by Major Powell they must be very ancient; for although the rainfall has always been very great in this region, yet that very excess of rainfall has been the means of preventing too rapid erosion by encouraging the growth of vegetation. In like manner, if the plains had originated as suggested, they would necessarily ante-date the tremendous erosion by which the valleys below have been scooped out; for often they are shown only by the leveled tops of slender hills; they must be fragments of once continuous plains, which have been broken up by the erosion producing the valleys as they now exist. It is needful then to thrust back their origin to a time when the drainage was in its infancy.

In this case the origin might seem to be readily explained. It may be said that when the drainage was in its infancy the fall of the streams was insignificant; that if the drainage existed before the mountains rose, and the corrasive power of the streams was equal to or somewhat greater than the rate at which the axes were elevated, there would be no difficulty in understanding the formation of the benches; for since the flow was gentle the limit of corrasion would soon be reached and erosion would soon produce the benches, so that at each elevation of the land a new bench would be formed.

But all this appears to be in discord with the facts. The benches could not have been formed during the elevation of the axes, for the rocks were not lifted vertically; the elevation was effected by a lateral thrust which wrinkled the rocks. It would have wrinkled in like manner, any stratum resting upon them, and the horizontality of the benches would have been destroyed.

The phenomena, too, are too recent; the deposits are too well preserved. If horizontal plains, such as these, had existed so long ago, those plains would not have been in existence to-day. It is incredible that in a region with great rainfall, perfectly horizontal plains should remain unbroken, while valleys, hundreds of feet deep, were being digged out below them. As already stated, the deposits on these benches consist only of loose sand with occasionally a little clay. If the benches were of ancient origin this covering would be absent; the flat crowns of the hills would be rounded, especially where the rock was a soft shale as on Chestnut Ridge and in the Ligonier Valley, where, however, the horizontality is complete and the benches particularly well preserved.

But the character of the deposit on these benches shows that it could not have accumulated under such conditions as must have existed had the plains resulted from lateral corrasions by streams with but slight fall. Under such circumstances, as has well been shown by Maj. Powell, the debris torn away by tributary streams would be distributed over the widened flood-plain of the main stream and would not be washed away by that stream. Such a deposit would contain many transported fragments, fragments, indeed, of rocks belonging not far away, but showing distinct traces of water-wear, for their motion would be slow and their exposure long-continued, owing to the slight fall of the transporting streams. No small period would elapse from the time of tearing them from the rock to that of depositing them on the flood-plain; and during all this period they would be subjected to the action of water.

This condition is well shown on the great plains stretching eastward from the Rocky Mountains for hundreds of miles and finally merging into the prairies of the Missouri-Mississippi Valley. These plains are covered with a deposit which originated certainly according to Maj. Powell's doctrine. The character of the deposit is shown in the channel-ways of all the streams. On top is an irregular layer of fine silt, which rests on a mixed mass of fine silt, gravel and large water-worn fragments; while, above all, over the whole surface, water-worn fragments are freely strewn. The higher benches toward the mountains as well as those on hills far out in the plains show a similar covering. The coarser beds of gravel are often cemented by carbonate of lime into firm conglomerates. But this is not the character of the deposit on the horizontal benches of the region under consideration. As has been said so often in this paper, the deposits on these benches contain no water-worn, transported fragments; the only fragments found belong clearly enough to the underlying rocks, and show no signs of having been subjected to the action of running water.

The doctrine of base-levels of erosion, though adequately and beautifully explaining the conditions existing in the arid regions of the far-west, fails to account for these horizontal benches in the Alleghany region, one of great rainfall. These plains are too widespread, too nearly horizontal and parallel, too recent and too nearly free from traces of running water, to be regarded as marking base lines of erosion referable to stream beds.

It is impossible to account for the phenomena on the hypothesis of a great flood's sweeping down over the whole region, for the action of such a flood would be too violent to produce effects such as have been described in this paper.

The benches bear much resemblance to beach lines, marking successive stages of emergence from a body of water; but they are not due to base-level erosion in the full sense of that term in this connection. The areas of the benches are so insignificant in many places that they could not have been leveled by water falling on and flowing off the surface. Such a process would require a vast length of time, altogether too vast in view of the freshness of the detrital covering on the highest benches. More than this if the time were long enough to admit of leveling the insignificant areas by ordinary erosion, it was not too short to admit of leveling the larger areas and of removing the mountains during the successive stages. But no such leveling exists; on the contrary the mountains and hills still exist, and the numerous benches are found on their sides.

Had the phonomena been observed only on the west side of the Alleghanies, there might have been room for supposing that the benches resulted from the draining away of some great lake; but this hypothesis would be useless, since one would have difficulty in finding a sufficient barrier at the south or west for the retention of the water. For in those directions the surface falls away so rapidly that in the whole of south-west Pennsylvania and West Virginia, west from the mountains, it rarely rises to even 1500 feet above mean tide. But there are distinct benches at 2400 feet above tide. A temporary barrier, 1000 feet high, is beyond the reach of even the most indolent credulity.

The conditions suggest that these benches were formed by ocean wear between tides. Their horizontality and their excessively comminuted deposits go far toward supporting this supposition. The features closely resemble ancient sea beaches in other parts of the country. Such a supposition involves a submergence to a distance of more than 2500 feet above the present line of mean tide; and the submergence would have to be somewhat greater to account for the even crests of the Alleghanies and other ridges west from the Blue Ridge. Horizontality of crest characterizes all those ridges as far south, at least, as the New river of West Virginia, for there they look, not like mountains as generally understood, but rather like a succession of gigantic waves which have not approached near enough the shore to show signs of breaking.

To some, perhaps, the absence of marine fossils may be regarded as a vital objection to this hypothesis. But not so. The detrital covering is loose, not compact, and the occurrence of fossils would be cause for surprise. Their absence is not.

Immense deposits occur in the Rocky Mountain region which are unquestionably of marine origin, yet over great areas they contain no traces of fossils. The enormous red sandstone seen along the east face of the Rocky Mountains in Colorado, is to all appearance devoid of fossils. Similar conditions exist in the sandstones of the Upper Cretaceous or Lignitic series in by far the greater part of Colorado and New Mexico. They frequently contain fucoids and remains of other plants, but animal remains are absent from the loose rocks. But here and there calcareous or ferruginous materials have rendered the rocks compact, and in such cases animal remains do occur.

Of like character is an instance mentioned to me by Prof. Geikie. A Lower Carboniferous sandstone in Scotland is celebrated as a repository of fossil trees; but though searched diligently at many localities during a whole generation, it failed to yield even a single relic of animal life until

November of 1877, when a Mytiloid shell, which is associated with *Orthoceras* and other forms of marine life elsewhere in the district, was found inside the cast of a *Lepidodendron*, where it had been preserved by the superior hardness of the material in which it was imbedded.

If fossils were ever present in the detritus covering these benches, they have been dissolved out by ordinary water or by water carrying carbonic acid in solution. As the coating is merely incoherent sand, all animal remains would be leached out of it in a comparatively short time, while fragments of wood, which occasionally occur, would be unaffected. Instances of this kind are common enough, so that they need not be referred to in detail.

An objection to the marine origin of these benches may be found in the existence of fresh water forms on the summit of Chestnut Ridge. That such forms do occur there seems to be altogether probable from the testimony of several persons, but I have been wholly unable to discover the localities, although I have made diligent search. The shells obtained at the summit of that ridge near the National road could not have been numerous, for close examination of the sand on several occasions yielded not even a fragment.

If remains of fresh-water mollusks do occur on the crest, they mark places once occupied by ponds such as those now to be seen at a little way north from the National road and very near the summit. The presence of the great Lower Carboniferous limestone is exceedingly favorable to the growth of mollusks. This explanation is the more acceptable because according to the statements made, the specimens are too well preserved to admit of the supposition that they had been entombed for any considerable length of time. They still retain the epidermis. Such being the case their presence has no bearing whatever on the age or origin of these benches.

If these benches are old beach lines, as seems by no means improbable, they show that, at some period since the glacial time, the sea has covered the greater part of the continent, certainly submerging the present summit line of the Alleghanies in Pennsylvania. This would confirm the surmise offered by Dr. Hitchcock in his "Illustrations of Surface Geology," when discussing the sea-beaches found along the streams of New England.

The lowest of these benches is at 1100 feet above tide. This statement holds good only for the extreme north-western part of the area examined In the Ligonier Valley the lowest horizontal bench is at a greater altitude, so, also, in southern Somerset county. Of necessity the horizontal benches ceased when the drainage was re established, that is when the line of submergence sank below the stream beds previously existing. When the water sank below 1100 feet, it fell below that level in this region and the lower series of terraces began to form; but further west and south-west where the elevation of the country is less than within the area described, horizontal benches should be found at altitudes less than 1100 feet above tide, possibly down to within a very little way above the tide-level.

The River Terraces.

The river terraces fall down stream and are covered by irregularly bedded sand, clay or gravel, containing transported fragments which have been rounded by the action of running water. When followed up the streams these terraces show differences among themselves in degree of slope, so that each is merged successively into the next higher, until that, which at the mouth of the stream is the river "bottom," becomes the only terrace and is lost at last in one of the lower horizontal benches.

For the most part the terraces occur at the same elevation on both sides of the stream, being divided by the channel-way just as the present "bottom" is divided. Sometimes a single terrace and occasionally the whole series of terraces is wanting on one side of the stream. In such a case it is clear enough that erosion was confined to one side so as to remove all traces of the terrace or to prevent the formation of the terraces, just as is seen in the present channel-way, the "bottom" being present often on only one side while stratified rocks reach to the water's edge on the opposite side.

As stated in my report on the Greene and Washington district of Pennsylvania (1875), these terraces are merely shelves in the rock, on which a thin coat of detritus rests. Mr. G. K. Gilbert, in his Memoir on the Geology of the Henry Mountains, describes the occurrence of similar terraces in those mountains.*

These terraces then do not fall in the same category with those described by Dr. Hitchcock in his "Illustrations of Surface Geology," for those had been eroded from valleys previously filled by gravels. No evidence has been found suggesting that any valleys of that sort exist in the region under consideration, while there is good reason for believing that the valleys lined by the river terraces, described in this paper, were not in existence to be filled with gravels.

The terraces below Pittsburgh on the Ohio river are covered by a deposit consisting largely of northern drift brought down by the Alleghany and Beaver rivers. No such material is found along the Monongahela and other rivers south from the Ohio, as they flow altogether beyond the southern limits of the drift. But their age is as clearly shown as is that of the terraces on the Ohio. The fifth terrace, at New Geneva, on the Monongahela, has a layer known as the "Swamp Clay," which contains much half-rotted wood. With the wood are berries like those of the black haw and in the same clay a well-preserved acorn cupule was found. In the same vicinity, as well as near Morgantown in West Virginia, the third terrace shows many *Unio* shells in an advanced stage of decay, while at Belvernon, on the Monongahela, much wood is found on this terrace. That the third terrace is older than the second and that this is older than the river

*This work has not been published at the time of writing, but Mr. Gilbert has very kindly given me a set of plate files for use during the preparation of this paper. It contains an elaborate discussion of the whole subject of land sculpture, embracing the results obtained by Mr. Gilbert during his long study of the Colorado Plateau.

"bottom," is sufficiently proved by the condition of the *Unio* shells on the several terraces. For those on the first are fresher than those on the second, and those on the second are fresher than those on the third; while the species on all are apparently the same with those now existing in the river.

Since the deposits on the first, second, third and fifth terraces are distinctly of recent origin, there would seem to be good reason for supposing that the valleys below the highest of the terraces are also of recent origin. It has been suggested, however, that the terraces resulted only from reworking of the sides of valleys which had been digged out previously. But this suggestion seems to be hardly in accord with the facts.

It must be remembered that the streams flow on a rock bottom, so that the beds are now at the lowest point ever reached by them; that there is no evidence thus far, going to show that any gravel deposits ever existed along the Monongahela, so as to make its valley like that of the Ohio at Wheeling or Steubenville; that the deposits on the terrace shelves are not remains of valley gravels, but simply accumulations of material brought down by the streams and distributed as the matter has been distributed on the present "bottom." Rocky banks are shown at the mouths of tributary streams. Had the valley been filled by gravels, it is incredible that even the most comprehensive erosion could have failed to leave some trace of their existence.

The structure of the valleys below the highest terrace is very different from that observed above it; for in the upper portion the sides are gently sloping, whereas below the highest terrace they become steep almost at once. Above the line of that terrace, the valleys of the smaller streams are broad swales, with smooth sides, while below that line the streams usually flow in gorges. The abruptness of this transition from gentle to abrupt walls shows that erosion had been long at work on the upper part of the valleys and that it began in the lower part at a comparatively recent period; in other words, that the lower portion was eroded after the upper portion had acquired its present form.

The river terraces are relics of river beds, such are the present "bottom;" and the valleys below the line of the highest river terrace have been eroded since the drainage system was re-established by withdrawal of the submerging flood to below the line of the former stream beds.

Conclusions.

The general conclusions which seem to flow readily from the facts recorded are:

First. That the erosion, to which is due the general configuration of the surface above the line of th highest river terrace, began even before the elevation of the anticlinal axes and continued until the region was submerged in post-glacial time.

Second. That the horizontal benches are due to the re-working of pre existing valleys, and that they mark stages of rest during the emergence of the continent from the submerging flood.

Third. That the river terraces and the valleys, which they line, were formed after the drainage system had been re established by withdrawal of the water to a level below that at which the streams had previously flowed.

It will be seen that the last conclusion leads to one of wider application. So long time had elapsed between the beginning of this drainage and the coming of the great flood, that deepening of the water-ways had become not more rapid than the general wasting of the adjacent country; for we find comparatively gentle slopes down to the line of the highest river terrace. But after the drainage had been re-established, the rate of flow must have been more rapid than before, so as to increase the corrasive power of the streams to far beyond what it had been, for in the newer parts of the valleys the sides are abrupt. There must, therefore, have been a change of altitude with respect to tide-level, to lead to this increased rate of flow and the consequent increased speed with which the channel-ways were deepened.

It would appear then, that, after the submergence following the glacial period, the continent rose to a greater height than it had before the submergence, or that the ocean was drawn off to a lower level than before; the result in either case being the same—to depress the mouths of the great rivers, to increase the fall of the streams, and therefore to cause the deepening of the channel-ways.

The Philosophy of the Biblical Account of Creation.

By Aug. R. Grote, A. M.

(*Read before the American Philosophical Society, September* 19, 1879.)

Mr. Grote introduced his subject with a list of works which he had consulted, by the following authors: Keil, Kuenen, Colenso. Bleek, Sharpe, Haverick, Geiger, Goldziher, Geo. Smith, Delitzsch, Cory, H. C. Rawlinson, Geo. Rawlinson, Von Herder, Arnold. Spiegel, Simrock, Max Müller, and Prof. Adolf Duschak.

He then gave in brief the historical distribution of the Shemitic languages and their literary remains; following this with the Hebrew text (in English letters) of the first two chapters of Genesis, and in opposite columns his own translation, with that of the authorized English version in parenthesis, thus:

20. Vayyomer Elohim Yishr'tzu hammayim sheretz nefesh chayyah v'of y'ofef alha aretz, al p'nay rakeeah hashamayim.*

20. And Elohim (God) said: Let the waters abound with (bring forth abundantly) creeping (the moving) creature living (that hath life) and fowl shall fly (that may fly) above the earth in the face (in the open) of the expanse (firmament) of heaven.

*Syntactically the word "v'of" (and fowl) besides being the subject of "y'ofef" (shall fly) may be the object of "Yishr'tzu" (abound with). The common English version gives it exclusively as the object, and supposes a relative pronoun understood.

And to this verse he drew special attention, subsequently, as showing that in the Elohistic Genesis the fowls were described as created out of the waters; whereas in the Jehovistic Genesis (2 : 19) it is said:

Vayyitzer Yahveh Elohim min ha-Adamah kol chayyath hassadaih v'aith kol of kashshamayim vayyabhai el ha-adam, &c.	And out of the ground Yahveh Elohim (the Lord God) formed every beast of the field and every fowl of the heaven (air) and brought (them) before the man (unto Adam), &c.

The "literary criticism" with which the author follows these chapters discusses the evident distinctness of the two narratives.

"They differ in almost every particular, in the arrangement, in the facts, in the name of the Deity, in their object, and lastly, in the language used. The different arrangements of the two accounts need hardly be pointed out.

"In the first account we have an orderly progression, a subdivision of the whole drama into acts. After each act, occupying a day, the curtain drops; the work must have been done in the night, as the day begins with the evening, although we are somewhat puzzled to understand how the author could have imagined 'evening and morning' before the creation of the sun.

"The second account, on the other hand, beginning Ch. II, 4, has no division of time at all, nor is there an orderly subdivision of events; all events are only told with reference to one central fact, the creation of man. A comparison of the facts narrated in each shows the following differences:

"The first account begins with Chaos, as in the Greek Cosmogony, the first differentiation being between light and darkness on the first day. The second day brings about the division between heaven and earth. On the third, land appears.

"The second account opens with the earth as a dry arid plain without vegetation and animal life.

"In the first account the earth is made to produce the herbs bearing seed and the trees bearing fruit with seed, independently of rain and human interference.

"In the second account the herb of the field does not grow until it has rained and man has tilled the ground, though we are not told whence he obtained the seed to plant, nor how the uncultivated plants originated. Man, however, appears *first* on the ground, while in the first account he is the *last* object of creation. In this act itself a variety of divergencies may be noted.

"In the first account man is made in the image of Elohim, in the second no mention is made of his "god-likeness," on the contrary we find that it was quite against the will of the Deity that he should become so. And after he had become so by the advice of the serpent and the curiosity of Eve, he is driven from the Garden of Eden for, says Yahveh Elohim (Ch. III, 22), 'Behold the man has become like one of us to know good and evil,'' exactly as the serpent had foretold in the same chapter (verse 5) : "for Elohim knows that on the day of your eating therefrom, your eyes will be opened and you will be like Elohim knowing good and evil.

"In Chap. II, 27, man is created, male and female.

"In the second account woman appears only after a surgical operation.

"In the first account the birds appear on the fifth day, the wild beast and *domesticated* cattle at the beginning of the sixth day, after which follows the creation of man, male and female.

"In the second account Adam is first made alone, in a manner to which we find no reference in the first account. Then the 'beast of the field and the fowls of the Heaven' are made by Yahveh Elohim from the ground before woman is created. Mark also, that first beasts and then fowls are made by Yahveh Elohim himself, out of the ground, in the same way as Man ; but in the first account the fowls are produced, at command on the fifth day, out of *the water*, and beast and cattle are brought forth by the earth on the sixth day.

"The first account knows nothing of the Garden of Eden, of the four rivers, of forbidden fruit, of the naming process and of matrimony.

"The second does not mention the creation of heavenly bodies, of the fishes and 'whales,' and of creeping things. It knows nothing of 'festive seasons' and of the Sabbath.

"In the first account Man is given unlimited control over the whole earth and all animal creation; in the second he is simply the gardener of Eden."

He next discusses the difference between Elohim and Yahveh Elohim as names for the Creator, and infers that the first account was penned by an Ephraimite, and the second by a Levite, who omitted mention of the Sabbath because the Levitic tendency was to refer all festivals to the Exodus, the Sabbath included (see Deut. 5: 15); whereas the Elohistic Sabbath was an adaptation from the planetary (Saturn) worship of pre-Levitic times. "The Hebrews were undoubtedly Zabeans in the early stages of their development; in evidence of which we have the word *Shabbah*, to swear, from *Shebbah*, seven ; *i. e.*, swearing meant to call the seven stars or gods to witness. We find Amos (5: 26) reproaching them with worship of *Keeyun*, Saturn."

"The Yahvistic account has a different object in view. When it was committed to writing the priestly dominion must have been already very pronounced." "We hear Yahveh declare (6: 5) that the wickedness of man was great on the earth, and the instinct of the imaginations of his heart was only evil day by day." "Cain and Abel bring sacrifices" (4: 3,4). "In the history of Noah we find the distinction of clean and unclean beasts."

"From the geographical notices (v. 10, 14) we may learn that the trade with India, opened by Solomon (1015, 975 B. C.), must have settled down to staple articles."...... "Considerable time elapsed from the first partnership of Solomon with Hiram, before India became well known and its gold proverbial." "The Euphrates was the chief river......since the main troubles of the Israelites originated thence."

The author then gave a chapter on the "Testimony of Archæology," describing the Assyrian tablets of the Genesis, Deluge, &c., and laid special stress on the occurrence of the deity *Il* in the Chaldean Pantheon, "standing at its head, the fountain and origin of deity, equivalent to the Hebrew *El, Eloah,* with its plural *Elohim,* and of the Arabic *Allah.*"

"The word used in the Hebrew text of Genesis, and translated God, is Elohim, a plural, but the verbs and pronouns agreeing with it are all in the singular, excepting in the account of the sixth day. The twenty-sixth verse of the first chapter of Genesis reads, 'And Elohim said: Let us make man in our image, after our likeness.' The twenty-seventh verse again returns to the singular by beginning, 'So Elohim created the man in his own image, in the image of Elohim created he him.' We see then the noun signifying the Deity is plural, but conceived as a unit in its creative power.

"And now let us look at the first verse of the account of the fourth day and the fifth Chaldean tablet quoted above in full. 'It was delightful all that was fixed by the Great Gods (*Illinu,* Hebrew *Elohim*) stars their appearance in figures of animals *He arranged.*' Exactly as in the Hebrew text, the noun is in the plural and the pronoun and verb in the singular, and this is kept up throughout the whole account. Thus, under the test of the linguistic crucible, this difference also gives way and the identity of the Hebrew and Chaldean accounts, not only in their incidents, but even in their fundamental mythological notions must be accepted as proven."

He then discussed the probable date of the Chaldean originals of the Assyrian tablet stories, and "the conclusions....reached may be thus briefly stated: The legends having existed for a long time as oral traditions, were committed to writing before the union of the kingdoms or before 2234 B. C., when Abraham, according to Biblical chronology, was not yet born. The earliest date assigned to the composition of the Biblical records is the time of Moses; this date is positively established through hieroglyphical inscriptions to be that of the king Menephthah, the Pharaoh of the Exodus, who followed his father Rameses II. on the throne in the year 1245 B. C. According to this the Chaldean account of Genesis would be nearly 1000 years older than the composition of the Biblical legends."

After giving "parallel myths" from other races and nations, the author concluded his paper with "The testimony of facts."

"At the outset it will be seen to be foreign to our purpose to introduce here any evidence in proof of the reality of the process of Evolution. But the existing evidence that things have been brought to their present condition by a slow process of succession, in which the more simple forms preceded the more complex, is unanimously conceded by all who have investigated any branch of natural science, and effectually contradicts the sudden and separate origin of things deducible from the account in Genesis. With this, it will be sufficient if we point out in a brief way the facts discovered by science which contradict the account of creation in Genesis, whether we accept the sequence of plants and animals revealed by a study of fossils and living kinds, as indicating a genetic connection, or as being insufficient grounds for such a conception.

"From internal evidence, Genesis is not homogeneous in its composition, as we have already seen. An originally detached portion having a different immediate source, terminates with the third verse of the second chapter, and it is quite evident that in dividing the text into chapters a mistake has been committed in this instance; the second chapter should begin, if an arbitrary division into chapters is intended to help the comprehension of the text, at its fourth verse. That these two accounts contradict each other is plain. The first account affirms that when God created man, 'male and female created he them.' The second account as positively declares that man was created in the person of Adam as one sex and solitary. Finding that such a creation was incomplete and useless, the Deity made woman not out of the ground or dust, but of a bone of man himself. At one time one can readily conceive that such a belief could be seriously entertained when we read the accounts given by existing savages of their own origin. But it never for one moment occurs to us to credit such conceptions. The idealists have been busy with this account of the origin of woman. It is taken as symbolical of the marriage state, of the dependence of woman upon man, 'bone of his bone, flesh of his flesh.' But to the uncultured races *their* fairy-stories are real, they believe them as Roman Catholics believe modern miracles and Protestants ancient miracles. Among the people who originated this fairy-tale of the origin of the first pair, the story passed for circumstantial fact. It satisfied their natural enquiry as to the origin of things, and it arose out of their mental status. But to ask us, who have gone beyond their mental condition, to still accept it as true, is unreasonable, and it is quite impossible that we should comply with such a request.

"In the second account the events of creation are given in a different order from the first, and this account is throughout more circumstantial. The Garden of Eden is described, and this has been lately identified with the mythological center of the ancient Chaldean Pantheon. Before both accounts were cast in their present fossil condition in the Hebrew Bible, they probably had a connection, as we have seen in a preceding chapter, and had undergone a development in which both had lost something of their original form, the first account more, the last less.

"The first account in the first chapter of Genesis may be now compared with the facts ascertained by science. We must believe that the text should be understood literally when it speaks of 'day' and 'night,' because with this reading it agrees with the context. From the alternation of light and darkness sprang 'day' and 'night,' and 'the evening and morning were one day.' To take these *days* as *indefinite periods* is a proof of want of exact thought, it is an effort to reconcile an exploded statement with the new facts, rather than cut loose at once from demonstrated error. The Hebrew word *Yom* not only means a day of twenty-four hours, but it expressly means *day* in this connection.

"But even granted that we take the less natural meaning of the word 'day' as the proper rendering, and that by this word 'day' any conceivable measurement of time is intended, it is only on the fourth of these days that the Sun appears. Astronomy, if it shows anything, proves that the satellites of a central orb, as separate masses of matter, must have been projected from it and at one time formed a part of such a body. The relation between the earth and the sun, as we gather it from astronomical sources, is a different one from that intended by the account in Genesis. We cannot conceive that the sun or the moon were created for the benefit of the earth or its inhabitants. Night and day are not necessities in the sense that we could not have become accustomed to some other division of times, for darkness and light, as indeed the Eskimo now are. Our organs of vision have plainly adapted themselves to the light which evidently existed before eyes were developed. And as to the succession we find that the earth is the child of the sun and the parent of the moon. But, that such a succession was comprehended by the writer of Genesis cannot be maintained. He undoubtedly believed that the sun and the moon were created for the benefit of the earth, which he did not know was round and a satellite, but imagined as flat and the center of the system. Light is also conceived of as independent of the sun. Plants bearing 'seed and fruit after their kind,' are regarded as being created before the sun, whose rays, the physiological botanist now shows, alone give them health and vigor. Again, whole groups of animals of whose remains mountains are made, such as corals and rhizopods, are omitted from the account. Such an omission, if it tallied with the restricted knowledge of the times in which such an account was believed, proves conclusively that the account was not extraneous, or in any way above the level of ancient civilization. And undoubtedly it does so tally, and the most powerful argument against Genesis, for those accessible to reason, lies in the fact that it contains no information superior to a very low grade of observation in natural history. Later on, in the magnified and equally inprobable story of Noah's ark, we find no mention of the rescue of the plants or how they stood the flood. At that time it was simply not known that plants breathed like animals and would drown as well as they.

"The records of the rocks tell us unmistakably that plants and animals have flourished through untold ages side by side, new forms succeeding old ones. But in Genesis, the creation of trees and shrubs took place in a period perfectly distinct from animals. The paleontologist must, then, reject the account of Genesis as perfectly incredible. Again the distinction between the 'beast of the earth after his kind and cattle after their kind,' shows a belief that domestic animals were created in a state of domestication. The Hebrew word *b'hemah* means cattle, *i. e.*, domesticated animals, in contradistinction to wild animals. The other term *chayah* means wild beasts, in contradistinction to tame animals. The use of both terms shows that both kinds were believed to have been created 'after their kind,' and as distinct species. There is nothing contradictory in the conclusion that the statement was at one time believed in, because savage man still believes in parallel assertions, and this particular belief was generally current in Europe before naturalists had shown its contrary to be true, and that all domestic animals were originally wild and by man's selection have been changed from their original physical condition. A vegetable diet is also assigned at first to beasts and man, but the physiologist knows that carnivorous animals have always existed and that the instincts of animals are true to their teeth.

"The story of Genesis takes no account of the different races of mankind nor of prehistoric man. Its chronology is recent and special. All attempts to consider it as merely omitting to mention these facts, which it could as well have given, must be rejected as defective reasoning. If it could go so far as to note the creation of cultivated races of beasts, such as cattle, it should not have failed to note the more important races of mankind. The character of the fauna of the country in which the myth originated is stamped on the face of the recital. All attempts to consider it as the true Genesis of the white, or Semitic and Aryan races, and therefore as reliable to this extent, must likewise fail. The history of the descent of man is not yet written, but, so far as we have the facts, they make for the view that the negro is a geographical variety, thrown off from an ancient stock of mankind, and therefore not an older stem through which mankind has passed to become white.

"Finally, at no time can it be true to say that 'thus the heavens and earth were finished and all the hosts of them." Change in all nature is the well attested truth, and this change has never relaxed its endless procession.

"Unessential as much of the scientific criticism directed against the ethical portions of the Scripture is seen to be, such criticism must be appropriate when directed against a portion which deals almost exclusively with statements of facts.

The Gods of the two accounts in Genesis expressed by nouns plural in form mark a reminiscence of a preceding plurality of deities and are plainly not coincident with our modern conception of the Deity. The notions of the Bible writers about God are not the same as the notions of the Israelites during the times of which the Bible writers treat. And our notions about God are not the same as those of the Bible writers. There has been on the one hand a growth in the direction of a recognition of an universal God, who at one time was tribal and national; and on the other hand there has been a progress in the direction of a recognition of one God, the final cause of Nature, who has absorbed the minor deities into himself.

This last change runs parallel with our progress in science and philosophy. We have gradually come to the knowledge that the laws which govern Nature are related and correlated and it is now no longer necessary to have a separate God for each phenomenon. But our Gods were those of the Aryan nations, Greek and Roman, Indian and Scandinavian, and these nations were behind the Semitic in the expression of monotheism. In fact we came by our present and popular monotheism suddenly through Judaism in its form of Christianity; while the monotheism of the Hebrews was not fully expressed until the eighth century before Christ. Moses, as has been abundantly shown, was not a monotheist. In the ten commandments, which in their ideas are certainly his, we find the expression, "Ye shall have no other Gods before me (Yahveh)." This carries the force of an acknowledgment that *after* Yahveh, and as of inferior rank and power, other Gods might be worshiped. The monotheism of the Israelites is more especially a development on the side of morality. Yahveh is the High and Holy One; a broken and contrite heart He will not despise! By giving Yahveh the character of supremacy the first steps towards a pure monotheism were slowly established; and the straight line of the best conduct being recognized, it was easier to reach monotheism by this route than by an intellectual acquaintance with the forces of Nature, upon which the Indo-European mind, before its contact with Judaism, principally concentrated its powers. But in the mythology of Aryan nations a progress towards monotheism can be shown; only the Aryan idea is more abstract and intellectual, the Semitic concrete and moral. As soon, therefore, as Judaism was offered as the true religion for Aryan nations, it was only accepted in its dilution of Trinitarianism. It is now the province of science to demonstrate from the intellectual side the truth of the monotheistic philosophy. But, undoubtedly, the prime error of the orthodox Biblical expounders, as also the error of the Bible writers themselves, is the measuring of past epochs by present conditions.

"In the Biblical story of creation we have to do with a myth, which had undergone many changes before Genesis was written. Since that time and when the latter could no longer change, many differing conceptions of the origin of things have found their orthodoxy in a play upon the meaning of the words and a distortion of their original intent. A lax wording, a shorter and more general statement, a monotheistic conception, gives an elasticity to the story of Genesis and a certain adaptiveness to later discoveries; but in its treatment of the heavens and the heavenly bodies, in the little bit of the earth on which its miracles are performed, it is still akin to the notions of the Homeric ages with regard to the Universe."

The Cosmogony of Laplace. By Daniel Kirkwood, LL.D., Bloomington, Indiana.

(*Read before the American Philosophical Society, Sept. 19th, 1879.*)

Laplace's celebrated nebular hypothesis was first distinctly stated in his *Système du Monde*.* The reasoning by which it is there sustained is general, and it does not appear that the author made any effort to test his theory by analysis. The law of the conservation of energy was then undiscovered, and hence data, which now seem available for a critical examination, were entirely wanting. Let us consider the hypothesis in some of its obvious aspects.

1. It is assumed by Laplace that nebulous rings were abandoned only in the vicinity of the present orbits of the planets. While I have for many years believed that the matter of the solar system originally existed in a gaseous condition, and hence that *a* nebular hypothesis in *some* form must furnish the true explanation of the planetary motions, I have more than once ventured the opinion that this assumption of Laplace is wholly unwarranted. I make a single quotation from the Monthly Notices of the Royal Astronomical Society for January, 1869 :

"The known facts in regard to the zone of minor planets, as well as the phenomena of Saturn's rings, seem to demand a modification of the nebular hypothesis as generally held. No reason has ever been assigned why the solar nebula should not have abandoned rings at distances intermediate between the present orbits of the planets. On the contrary, it seems highly probable that, after first reaching the point at which gravity was counterbalanced by the centrifugal force arising from the rotation of the contracting spheroid, a continuous succession of narrow rings would be thrown off in close proximity to each other, and revolving in different periods according to Kepler's third law."

The view thus expressed in 1868 has never been called in question, and I have seen no reason to modify it. The *ring* theory thus seems to require that after matter began to be thrown off at the equator of the revolving mass, the process should have been almost continuous until the nebula became transformed into a close system of rings presenting the appearance of a thin plate or disk. The theory would thus fail to account for the formation of the solar system as it actually exists.

2. But even if we adopt Laplace's theory of ring formation, we at once encounter difficulties no less serious. It is obvious, on the slightest examination, that the mutual attraction of different portions of a zone could have very little influence in bringing its molecules together around a common nucleus. Laplace, it is true, supposed the fragments of a ring to have been thus collected into a single planet. "Almost always," he says, "each ring of vapors ought to be divided into several masses, which, being moved with velocities that differ little from each other, should continue to revolve at the same distance from the sun. These masses should assume

* Published at Paris in 1813.

a spheroidal form, with a rotary motion in the direction of that of their revolution, because their inferior particles have a less real velocity than the superior; they have, therefore, constituted so many planets in a state of vapor. But if one of them was sufficiently powerful to unite successively by its attraction all the others about its centre, the ring of vapors would be changed into one sole spheroidal mass, circulating about the sun, with a motion of rotation in the same direction with that of revolution."

In regard to the mutual attraction here referred to, it may be remarked, that two parts of the Neptunian ring on opposite sides of the sun could produce no sensible perturbation of each other's motion. If, moreover, the fragments of any ring were distributed around the orbit with approximate uniformity, their mutually disturbing effects would nearly destroy each other. That this state of things should have obtained in the case of some of the eight principal planets is extremely probable. The theory, therefore, of planetary aggregation by the attraction between different parts of the rings, requires an indefinite antiquity of the solar system. Let us suppose, then, that the planet-forming process was due to the different velocities of the fragments into which a ring had been broken up. Take, for example, the ring which was transformed into Neptune. Let us assume that two fragments, A and B, differed in longitude by 180°, and that the mean distance of the centre of gravity of A from the sun's centre exceeded that of B by 1000 miles. It is then easy to show that the corresponding difference of their angular velocities would not bring them together around the same nucleus in 15 millions of years. But even after *all* the fragments had thus been collected, other millions of years—assuming with Laplace that the united mass was still in the gaseous form—would be required for the process of condensation. The supposition we have made is not an extravagant one. In Laplace's cosmogony, therefore, hundreds of millions of years are involved in the separate history of a single planet. Is so great an implied age of the solar system admissible?

According to Helmholtz, whose theory is now generally accepted, the sun's heat is but the transformed motion of its parts condensed or drawn together by the force of gravitation. Now, the law of the conservation of energy enables us to calculate the age of the sun, knowing (1) the amount of solar heat radiated in a given time, and (2) the amount produced by a given contraction of the sun's mass. It has thus been found that condensation from the distance of the nearest fixed stars to the sun's present volume, would have kept up a supply of heat equal to the present for about twenty millions of years. This estimate, it will be understood, is based on the assumption that the sun's density is uniform from centre to surface. If, as is altogether probable, the density increases towards the centre, the age of the sun may be considerably greater.*

* "On the only hypothesis science will now allow us to make respecting the source of the solar heat, the earth was, twenty millions of years ago, enveloped in the fiery atmosphere of the sun."—*Prof. Simon Newcomb in the N. A. Review, for July*, 1876.

3. The difficulty here presented is one of no small importance. If removed, however, we are immediately met by another perhaps still more formidable. Assuming the increase of Neptune's radius to have been uniform during the time required for the accumulation of the ring around a single nucleus, the daily superficial deposit would be less than one-sixtieth of an inch; the density being equal to the present density of the planet. This extremely slow transformation of the nebulous zones would develop little heat; so that the planets would be nearly cold during the process of their formation. Laplace's theory, therefore, obviously fails to account for the origin of satellites.

4. It is easy to show that the period of a rotating nebula in the process of condensation would vary as the square of the radius. If the solar nebula, therefore, rotated once in 164.6 years when it filled the orbit of Neptune, its period when it had contracted to the orbit of Uranus ought to have been 67 years; at the orbit of Saturn, 16.7 years; at that of Jupiter, 4.94 years, &c., &c. This obvious inconsistency with Kepler's third law* has been noticed by astronomers, and recourse has been had to the additional supposition that the rate of variation of density from surface to centre was continually changing through all the cycles of planetary formation.† Till this latter hypothesis—invented to sustain the hypothesis of Laplace—shall itself have been placed on a basis of facts, the superstructure must be regarded as eminently unstable.

Conclusion.

It has been shown (1) that the hypothesis of Laplace gives no explanation of the immense intervals between the planetary orbits; (2) that, apart from this objection, the periods required for the formation of planets from nebulous rings are greater than the probable age of the solar system; (3) that it fails to account for the origin of satellites; and (4) that it is apparently incompatible with a known physical law. The conclusion seems inevitable that this celebrated hypothesis must yet be abandoned, or that its principal features must be essentially modified.

* Let r, r', and t, t' represent the radii and periods of rotation of the solar nebula at two different epochs; then $t : t' :: r^2 : r'^2$. But by Kepler's third law, $t : t' :: r^{\frac{3}{2}} : r'^{\frac{3}{2}}$.

† See the able and interesting memoir on the Nebular Hypothesis by Prof. David Trowbridge, in the Am. Journal of Science for Nov., 1864.

Additional Notes upon the Collection of Coins and Medals now upon Exhibition at the Pennsylvania Museum and School of Industrial Art, Memorial Hall, Fairmount Park, Philadelphia. By Henry Phillips, Jr., A. M.

(*Read before the American Philosophical Society, October 3d*, 1879.)

Since the notes I had the honor of presenting to our Society last February there have been so many additions to this collection that a further description may be of interest.

Recurring to the arrangement originally projected, the first head to which I would call the attention of the Society is that of Medals.

The medal issued to commemorate the 21st anniversary of the foundation of the Numismatic and Antiquarian Society of Philadelphia (January 1, 1879), and the twelfth presidential term of the Hon. Eli K. Price, has been placed in the medal case, and likewise the full materials for exhibiting its process of manufacture. First there is the large plaster cast taken from the wax medallion originally modeled from life; this latter being perishable has not been preserved, but the plaster representation exhibits a perfect *fac simile* of the original. Secondly, is the same portrait in plaster reduced by mechanical means to the size it is to occupy on the die. Third is the *hub* upon which the portrait is cut in alto relievo by a machine which reproduces in any desired size the figure which it is to bear, and which is afterwards tempered to hard steel. Fourth, the die which is struck from the hub and shows in intaglio the portrait intended to be impressed upon the medal. It is at first soft, so as to easily receive the impression, and it is then afterwards hardened so as to bear the necessary amount of pressure and blows. There are also leaden trial impressions of the dies. These show the whole process of making the dies.

The medal bears upon its obverse the portrait of the venerable gentleman in whose honor it was struck, surrounded by the inscription, ELI K. PRICE, PRESIDENT, 1879. On the reverse the seal of the Society and the inscription, THE NUMISMATIC AND ANTIQUARIAN SOCIETY OF PHILADELPHIA, *founded January* 1, 1858. The meaning of the devices on the seal are as follows:

The owl, which is the crest, symbolizes wisdom and learning; it is taken from the device upon the coins of Athens, issued in the fifth century before the present era, and is a faithful copy of that archaic work of art.

The shield, upon which the quarterings are displayed, is the *Saxon* shield, emblematic of English ancestry and associations; the emblems on each of the four portions of the shield represent, respectively, Europe, Asia, Africa, and America.

Europe presents the cross as found upon the coinage of the first Christian kings of England; Africa, the Egyptian sphynx; Asia, a Chinese coin, and America, the stone arrow heads, axes and implements of the Aborigines. The motto *vestigia rerum sequi* refers to the nature of the Society's occupations.

There is also a medal (in bronze) of the late Joseph J. Mickley, the first President of the Numismatic and Antiquarian Society of Philadelphia.

This medal was cut by Mrs. Lea Ahlborn, of Stockholm, medalist and designer of the Royal Swedish Mint. The execution of the flesh is remarkably well done, and the whole medal is a credit to the skill of the female artist.

There are also medals of Lavater, Cervantes, Shakspeare, of the *Series Numismatica*, and of Alexander the First of Russia, and Louis XVI. of France, deposited by H. Dumont Wagner, Esq., of this city.

A bronze medal commemorating the Massacre of St. Bartholomew bears on the obverse the head of Pope Gregory XIII.; on the reverse an angel armed with sword and cross destroying and putting to flight a multitude, with the inscription HUGENOTORUM STRAGES.

It may be observed in regard to this medal that doubts have been cast as to whether it was actually issued by the Papal authorities, but rather that it was done by those inimical to the Church of Rome, in order to cast discredit upon it by appearing to exult over such a scene of carnage. The present medal, however, is of most undoubted genuineness, having been purchased in Rome with the whole series of the Pontifical Medals direct from the Director of the Papal Mint. The author of "La Science des Medailles" (Paris, 1715), says, *il ne faut pas confondre avec les veritables medailles des Papes, certaines que les ennemis du Saint Siege ont fabriquées pour les insulter, ou pour les rendre odieux. Telle est celle de Jules III. avec cette inscription qui lui sert de revers,* GENS ET REGNUM QUOD NON SERVIERIT TIBI PERIBIT. *Telle est la Medaille de Paul III,*

ΦΕΡΝΗ ΖΗΝΟΣ ΕΥΡΑΙΝΕΙ,

que l'on ne doit jamais placer parmi les medailles veritables. (No. 52 in the Hockley collection.)

Pinkerton, however, is of the opinion that this latter described medal is genuine and was cut by Michael Angelo. It is certainly a handsome piece of workmanship and would do no discredit even to that great artist if the attribution be correct.

All the medals before Paul the Second, according to the same author, were issued during the Pontificate of Alexander the Seventh. It is stated that the Abbé Bizot had the design of issuing a full line of all the Popes, which he was prevented from accomplishing by the death of the reigning pontiff under whose auspices the undertaking had been begun.

Pinkerton states that the medal of Julius the Second, "*contra stimulum ne calcitras,*" is the first medal which was struck instead of being cast. He attributes to Cellini the medal of Clement the Seventh, "*ut bibat populus;*" that of Gregory XIII. upon the reformation of the Calendar to Parmegiano and to Bassiano and Cavino (the celebrated Paduan forgers) the dies of the medals of Julius the Third.

Mrs. Henry Bohlen of this city has deposited a number of interesting gold and silver coins and medals, among which latter are the following:

A very large silver medal (size 42 of the scale of the Numismatic and Antiquarian Society of Philadelphia), bearing on the obverse a view of the city of Amsterdam; in the foreground the river Amstel filled with vessels containing armed men. Above the city and below a shield charged with its coat of arms a hand appears holding a heart, projecting from a cloud and surrounded by luminous rays. The inscription consists of these Hollandish verses:

ONS HERT EN HANDT
IS VOOR HET LANDT.

On the reverse a garland of olives encloses the words GODT HEEFT ONS BEWAERT.

Around the wreath is the inscription, ZYN HOOGHEYT WILLEM PRINS VAN ORANGE HEEFT DE STADT AMSTERDAM BELEEGERT DEN 30 JULY ENDE WEDEROM AFGETROCKEN DEN 4 AUGUSTY, 1650.

This medal appears to have been chased entirely by hand, and not to have been struck from a die. Dissensions arose among the States comprising the Dutch Federation during the early summer of 1650, and the Prince of Orange after endeavoring to procure a peaceable settlement of the existing difficulties resolved to obtain justice by force of arms. To this end he sent a secret order to the troops in garrison at Nimeguen, Arnheim and elsewhere to march against Amsterdam, rendezvousing there on the 30th day of June, at an early hour of the morning to force the sturdy burghers into submission. The Prince joined the army, after arresting treacherously six of the prominent men of Horn, Delft, Dort and Harlem, and proceeded in his enterprise, which, however, failed of success, the citizens of Amsterdam having received timely warning. They had placed themselves in a condition of defense, and were prepared to open the sluices and dykes in order if necessary to flood the country, and render it uninhabitable for an army.

The Prince seeing that he could not capture the city had recourse to negotiations, the result of which was that after an agreement had with the Burghers he withdrew his troops from before the city on the 4th of August, 1650.

The present medal is one of a series struck to commemorate this occurrence. (Van Loon Vol. II. p. 329 et seq.)

A beautiful silver medal bearing on the obverse a Janus bust on a pedestal, female head facing left, male head facing right. Above is the inscription,

VERGANGENHEIT, GEGENWART, ZUKUNFT,

AUS ALLEN SCHOEPFE DIR FREUDEN.

Reverse. Upon a band in centre extending from side to side of the medal is the sign of Aquarius, between Capricornus and Pisces. Above is the sun in full glory, sending down beams which fill the whole field and penetrate a cloud which is below the band referred to.

A grand silver medal commemorates the repulse of the Turks before the City of Zenta on the Theiss.

Obverse. A river god standing holding on his left hand a victory which is offering him a crown. In his right an urn from which a river is flowing. Under his left arm is a tablet with the inscription,

AUSPICIIS
LEOPOLDI MAGNI
VIRTUTE EUGENII
SABAUDIÆ D.
EXERCIT. TURCIC.
CLADE XX. Host.
FACTA
PRIMARIIS DUCIB.
DELETIS
CASTRIS UNIVERS.
TORMENT. XCVIII.
OMNIQUE APPARATU
BELLICO
INTERCEPTIS.
CŒSUS PROFLIGAT
D. $\frac{1}{11}$ SEPT
A^o MDCXCVII

Reverse. A besieged city, in the background a river and bridge and mountains: over the town the word ZENTA. In the foreground, cannon, horsemen, infantry, camp, &c. Above is the inscription, INTERFECIT EXERCITUM EORUM ET SUBVERTIT ROTAS CURRUUM FEREBANTURQUE IN PROFUNDUM EXOD. 14.

On the edge in raised letters is the Chronogram, *En novvs ex voto fe*LIX L*eopo*LDE *tr*IVM*ph*VS., making the date 1697.

A silver medal shows on obverse a winged female figure standing by a monument overhung with floral wreaths and on whose summit is a casket of flowers, and around whose base plants and flowers are growing. Inscription, DEIN SCHUTZ GEIST KRÆNZE DEINE TAGE.

Reverse. A branch with flowers horizontally across the field and dividing the inscription, MIT FREUNDSCHAFT LIEB UND FREUDE STETS

—(branch)—

WUNSCH AUS REINEM HERZEN GLÜCK.

There is a noble medal in gold with a clasp, evidently to be worn as a decoration, of Frederick III of Denmark and Sofia Amalia, his Queen, in commemoration of the courageous defence of Copenhagen against the Swedes under Charles Gustavus in 1658.

Obverse. A finely executed male laureated bust in high relief. Inscription, DOMINUS PROVIDEBIT.

Reverse. A laureated female bust with the inscription, SPES MEA IN DEO.

The peace of Rodschild (Feb., 1658) had scarcely been concluded, when Charles Gustavus, of Sweden, formed the design of conquering the whole kingdom of Denmark, and, under the pretext that the stipulations of the treaty were not being carried out, in the month of August he unexpectedly blockaded the roadstead of Copenhagen. All was consternation, and the courtiers begged the King, Frederic the Third, to take to flight for safety into Norway. But his noble spirit revolted, and with Roman bravery he resolved to defend his capital to the last gasp, gave his personal superintendence to all the necessary preparations for its defence, planted the Royal Standard on the ramparts, armed the citizens, assigned to his officers the command of different portions of the city, and, animated by the hopes and promises of succor held out to him by the Netherlandish provinces, whose interests were in common with those of his kingdom, he resolved to perish beneath the ruins of Copenhagen, with his whole family and court, rather than fly or fall into the hands of his enemies. Nor were his hopes unfounded. When the States of Holland knew the design of the King of Sweden to be the conquest of Denmark so as to fall upon the Elector of Brandenburg and be avenged upon him for his having deserted the Swedish cause, and saw that his efforts were to obtain the complete control of the Baltic Sea, to the exclusion of their commerce, they resolved to send a fleet and an army to the relief of the threatened nation, although by some it was argued that to do so might imperil their relations with France and England, which were supposed to be favorable to the Swedish pretensions. On the 17th of October, Admiral Obdam set sail to succor the King of Denmark, who was continuing to defend his capital, with valor and fortitude, although the enemy had became masters of the Castles of Cronenbourg and Helsinbourg, and held the mouth of the Sund blockaded by their vessels, so that the Hollandish fleet in order to bring relief to the besieged would be obliged to run the gauntlet of the fires of these two fortresses, and at the same time manœuvre their ships in a narrow passage to avoid the dangers of an intricate navigation. On the 8th of November the Admiral divided his fleet into three squadrons and proceeded to engage the enemy's vessels, manned chiefly by Scotch and Irish sailors, and commanded by the illustrious Wrangel, as Captain General of the Kingdom of Sweden. About 9 o'clock in the forenoon the combat began, and raged for six hours with great fury in the presence of the King of Sweden himself, who in company with his wife and sister and other personages of high rank watched from the Castle of Cronenbourg the fortunes of the fight. The Swedes fought bravely as ever, but the extraordinary valor of the Hollanders was ultimately crowned with success. Of the enemy's vessels they captured three, and burned and sunk eight others, forcing the rest to take to flight, thus permitting a juncture to be made with the the Danish flotilla under Admiral Bielke. The Sound was opened by valor and force of arms, and the Swedes chased out of that sea by a most glorious victory, whose memory was preserved in this and some other medals.

A silver medal presents on the obverse Neptune boldly engraved standing in a chariot drawn by two horses upon a stormy ocean whose waves are lashed into fury by Æolus in the right corner. In Neptune's left hand is his trident upright, his right is extended open pointing right. Upon the seat of the car is a crown. Inscription, MOTOS. PRÆSTAT. COMPONERE. FLUCTUS.

Reverse. Upon a calm and stilly sea is floating a nest in which are two halcyons. On the right the setting sun is illumining by his rays the whole field of the medal. Above on a band is the inscription. HALCIONIBUS. REDUCTIS. SENATUS. AMSTELOD. CIVIBUS. SUIS. HOC ANTIQUÆ. VIRTUTIS SPECTATÆQ. FIDEI PRÆMIUM. LARGITUR.

In the exergue, MDCXCVI. (Vide Van Loon. Vol. 4, p. 221.)

It would be hardly credible what a tumult could always be started in the Netherlands from the most trivial causes were not history so very explicit. The present medal was struck to commemorate a sedition which grew out of an ordinance regulating the number and the salaries of the criers at the public funerals. Those who were excluded from this employment felt at one blow their whole subsistence taken away from them; were full of discontent and clamored loudly against the magistracy, alleging that their offices had been wrested from them in order that the underlings and parasites of their rulers might be provided for comfortably. To further augment the popular feeling it was given out that the bodies of the poor were mutilated by branding previous to interment. The people became inflamed and maltreated the new criers wherever they met them, till at last, emboldened by the usual applause and serenity of the bystanders, on the night of the 30th of January, the day preceding that on which the new regulation was to go into operation, they assembled in great numbers on the *Dam*, a public place in front of the Hotel de Ville. The troops were called out but their presence only served to increase the tumult while the populace, armed with stout cudgels, formed themselves regularly into companies, rallying under aprons of blue cloth and beating for drums upon empty beer barrels.

The mob continued to grow and traversed the streets like madmen, followed by a troop of children. Arrived at the *Aelmoessenier's Huis* they put to flight the soldiers placed there as a guard to the syndics of the criers of funerals, and fired by their exploit, in thus having overturned constituted authority, they turned to pillage the houses of obnoxious officials. The Burgers were called to arms, now realizing that the rioters intended to sack the city if possible, using their grievance merely as a stalking horse. Night fell upon the scene, but in the early morning before the citizens had assembled to take arms, the rabble came together again and after pillaging with renewed fury laid siege to the house of Burgomaster De Vries. The Magistracy now issued an order declaring that force must be resisted by force; the citizens assembled and marched towards the field of battle, fired upon the riotous assembly, killed two and put the others to flight. Whilst this was taking place a portion of the mob engaged in sacking the house of a rich Jew named Pinto (and could there ever be popular uprising in Europe without a Jew's house being pillaged?) was fallen upon by another detachment of the citizens who drove them away at the point of the sword. The bridges were all raised, and the gatherings in other quarters dispersed by a summary administration of justice.

Two of the robbers taken in the field were hung to the neighboring lamp-post, and a strong force was posted on the Dam and other exposed parts of the city. At the first news of the insurrection the regiment of Guards, which was stationed at 'S Gravemoer, had taken up its march toward the city to assist, if needed, in quelling the disturbance, but when distant only two leagues from Amsterdam, the Council did not judge it expedient to receive the troops, but thanking them heartily for their zeal, begged them to hold their present position unless it should so happen that the riot could not be put down by the fidelity and the valor of the citizens. Volunteers under the command of Messrs. Hinlopen, Six, Burg and Huydekooper, patrolled the streets to preserve order until the fourth of February. On the 6th, six of the rioters were executed, and the corpses of four others, who had been killed in the tumult, were hung up by the feet on the same gallows. Several of the survivors were shut up in the House of Correction.

The Magistracy sensible of the zeal and courage of the train bands and of the volunteers, and desiring to exhibit in an honorable way the gratitude of the citizens, caused the present medal to be engraved in three different sizes, which, on the 28th of November of the same year, were distributed publicly to all the troops, each man receiving a different size according to his rank.

A silver medal bears upon the obverse a widow seated between two children in a cemetery, pointing to the all-seeing eye in the heavens in a triangle surrounded by rays from which an angel is descending and emptying upon their heads the contents of a cornucopia. On the left is an obelisk (upon which is engraved the letter C), surrounded by English yew-trees. Above, on a ribband, is the inscription, HY IS DER WEEZEN VADER. In the exergue, TER GEDACHTENIS AAN DE *weezen uit gedeeld.*

The reverse exhibits three sides of a building enclosing a court-yard; above is the inscription, LUTH. DIAC. WEESHUIS. In the exergue, *gesticht* MDCLXXVIII. *Jubile gevierd* 24 *Aug.* 1778.

A bronze medal commemorates an Industrial Exposition, held at Berlin, in 1844. Obverse, Germania seated upon a rock holding a wreath in right hand, a sword partially drawn from its scabbard reposing on her lap. Her left hand rests on the rock which bears the inscription, *Seid einig.* Exergue, GERMANIA. Inscription, ERINNERUNG AN DIE AUSTELLUNG DEUTSCHER GEWERBSERZEUGNISSE ZU BERLIN, 1844. Reverse, a locomotive crossing a bridge. Around this is a wreath on which are five shields with emblems respectively representing navigation, manufactures, mining, philosophy and agriculture. Inscription, VORWAERTS MIT DEUTSCHEN FLEISSE UND DEUTSCHER KRAFT.

A bronze medal represents on the obverse a King standing by a throne, with his right hand extended in the act of swearing, between two female figures. The one on the left holds a tablet on which is inscribed GROND

WET; that on the right, a spear. Inscription, NEDERLAND 12 MEI 1849; exergue, *Je maintiendrai.*

Reverse, a female uncovering a male portrait before a throne, and a kneeling female inscribes upon tablet XXV JAAR. Inscription, NEDERLAND 12 MEI 1874; exergue, *Jubilæum.*

A fine bronze medal exhibits a beautiful laureated head of Napoleon within a wreath tied with ribbands on which are inscribed, *Wagram, Tivoli, Pyramids, Marengo, Luneville, Amiens, Codes, Lejion d'honneur, Austerlitz, Jena, Tilsit, Simplon.*

Reverse, a view of the Island of St. Helena, with ships in the foreground, setting sun to right, eagle on branch in air. Inscription, IL MOURUT SUR UN ROCHER. Exergue, *Ile Ste Helene. 5 Mai* 1821.

A gilt medal bears on obverse, a male bust in costume of the fourteenth century and inscription, JOAN GALEATIUS VICE COM. A FUNDAMENTIS INCHOAVIT AN. MCCCLXXXVI.

Reverse, the Cathedral at Milan with the inscription, LATUS, ECCL. METROP. MEDIOLANI.

A bronze medal bears on the obverse a Cathedral with date in exergue, 1342–1516. Inscription, DER VÄTER FROMMER SINN RIEF DICH INS LEBEN. Reverse, the rear of the same building in a ruined, incomplete condition; in exergue, *zerstört am 7 Mai* 1842. Inscription, VEREINTE KRAFT WIRD WÜRDIG DICH ERHEBEN.

A white metal medal, on obverse an unfinished Cathedral with date in exergue, 1242. Inscription, as follows:

DAS ALTE CÖLN HAT EINST GEGRÜNDET
DIES WUNDERVOLLE GOTTESHAUS;

Reverse, the same finished with inscription,

DOCH DEUTSCHLAND HAT SICH JETZT VERBÜNDET
UND BAUT MIT GOTTES HÜLF' ES AUS.

Exergue, the date 1842.

Mr. Isaac F. Wood, of New York city, has presented to the Numismatic and Antiquarian Society of Philadelphia, a number of medals in white metal and copper, issued by himself commemorative of various events, and which have been placed in the exhibition. One of Haverford College (Series B. No. 2), bears on the obverse a well executed head of William Penn, with an inscription, and on the reverse a view of the college building. Another bears on the obverse the head of Washington in a keystone with dates 1732–1799; on the reverse, the inscription, "Washington, fit keystone in the triumphal arch which spans the nation's century."

Another (Series C, No. 4), has on the obverse the head of Washington surrounded by the inscription, "The lover of peace he espoused the sword for the colonies' birthright. 1775—100 years—1875;" reverse, a representation of a house and trees with inscription, "The Washington Elm, Cambridge, Massachusetts; June 3d, 1875. Centennial Celebration."

Another bears the head of Washington with the inscription, "True, and wise, and merciful and just. 1732–99 ;" on the reverse, a representation of Washington's tomb with the inscription, "Mount Vernon Chapter, No. 228, R.·.A.·.M.·. Mnt. Vernon, N. Y." Another struck to commemorate the dedication of St. Patrick's Cathedral, New York city, by Cardinal McCloskey, on the 25th day of May, 1879, bears on the obverse a representation of that building, and on the reverse an inscription setting forth the event for which it was issued.

Another bears on its obverse a representation of "Founder's Hall," Haverford College, and on the reverse a chapel, with the inscription, "Alumni Association of Haverford College, Pennsylvania."

A bronzed medal. Obverse, the head of Major Andrè, with the inscription, MAJ. JOHN ANDRE, OCTOBER 1, 1780. Reverse, a church, with the inscription, OLD DUTCH CHURCH, TAPPAN, WHERE MAJ. ANDRE WAS TRIED.

A bronzed medal. Obverse, head of Washington, "HISTORICAL AND FORESTRY SOCIETY OF ROCKLAND COUNTY, ORGANIZED FEB. 22, 1878. Reverse, a farmhouse, "WASHINGTON'S HEADQUARTERS, 1780, TAPPAN. ERECTED 1700."

A bronzed medal. Obverse, bust of General Wayne, CENTENNIAL ANNIVERSARY OF THE BATTLE OF STONY POINT, JULY 16, 1879. Reverse, an army besieging a fortress across a river and on a bluff. STONY POINT EXPUGNATUM, XV JULY, MDCCLXXIX.

Among the series of copper Dutch medalets, which are on exhibition in the first medal case, the following are of the most interest :

No. 34141, bears on its obverse upon a sea violently in commotion, lashed by storms, a ship whose topmasts have been broken off, above which is the date 1565. Inscription, INCERTUM . QUO . FATA . FERENT. On the reverse, a female figure holding her right hand towards heaven, and in her left an anchor ; from above rays are streaming down upon her head. Insciiption, SPES . ALMA . SUPERSIT.

This jetton was struck in reference to the dissensions and lack of unity then prevalent in the Netherlands and the unfavorable outlook of the times.

No. 34179 has on the obverse the inscription, LAPIS . REIECTUS—CAPUT . ANGULI. Within a circle of very fine lines a three-cornered stone, showing its broadest part downwards ; below is a crowned lion with a shield near the inscription on the border. Reverse, DNS. FECIT. HOC. ET. FU. (it) MI. (rabile) IN OC. (ulis) H. (ominum.) 1574 The sacred name of Jehovah in Hebrew letters within a circle, beneath which are clouds, whence beams and rays are spreading downwards.

No. 34214. Obverse, AFFLICTOS . DOCET . VIAM . SUAM. 1577, and a five-leaved rose. In the lower foreground is the figure of a man resting upon the earth (the prophet Elijah), receiving in his right hand a piece of bread, which a hand is reaching to him from out of the clouds. In the background of the landscape appears a city. In the clouds the name of Jehovah in Hebrew letters. Reverse, LIBRAT . A . CONDEMNANTIBUS . ANIMAM . EJUS. Daniel in the lion's den by the side of two lions. Above the name of Jehovah in a cloud (as on the obverse), and a hand stretched out. This piece refers to the gloomy state of affairs and is intended to recall to the mind of the distressed or doubting Hollanders the two signal examples of the Divine beneficence that are commemorated upon this coin.

No. 34379. Obverse, ZELUS . DOMINI . EXERCITUUM . FECIT . HOC. Upon the upper portion of the field the name of Jehovah in Hebrew letters, surrounded by a cloud from which a naked arm holding a sceptre is projecting; below is a landscape in which several cities and towns are visible. Reverse, STENOVICO. | OTMARSIA. | COVORDIA. | CAPTIS. | HOSTE. | REPULSO. | SEN. | FŒD. PRO. | F. | F. | M·D·XCII. This piece refers to the capture of the cities named.

No. 34404. Obverse, CASTRACON | SPEXIT INSE | ADVERSARIA | SELVOLDA CUM | BISLECHIO AD | NOV· MDXCV. Reverse, a battlemented tower, at whose base a battering ram worked by eight warriors is being operated and has effected a breach. This and the next jetton commemorate the capture of the towns of Selvold and Bislich.

No. 34405. Obverse, QUÆRERE. Within a circle of vines Mars stands armed with lance and shield; by his side the trunk of a tree, upon which a bird is resting; in the foreground a mass of infantry. Reverse, ET. TUERI. MDXCV. A female figure seated facing front, with a large helmet upon her head, holding in her right hand a shield, upon which is displayed the Lion of Holland; in the left a lance; at her right side is seated an owl upon a branch. In the background is an encampment of tents. This relates to Prince Maurice's prudence in preserving his conquests and to his Mars-like valor in effecting them.

No. 34407. Obverse, FRUSTRA . OPPUGNAT . USQUEDUM . PROTEGIT . DEUS. Soldiers standing by a river bank with a crowned leader; the other side of the river is protected by a shield which a hand holds out from heaven. Under the shield are four soldiers ready for the fray, and behind them are seen kneeling three persons in prayer. Reverse, VIGILATE . ET . ORATE . DEO . CONFIDENTES . MDXCVI. A seated female figure with folded hands; upon her right a sentry is keeping watch; on her left a shield displaying a crowned lion, by the side of which is a tower, upon whose summit there is also a sentinel.

This jetton refers to the province of Zeeland being threatened by the Archduke Albert.

No. 34423. Obverse, ORDIN. | AUSPIC. PRIN. | MAURI. DUCTU. | HOSTE AD TUM | NOUTUM CÆSO. | DECEM OPIDIS. ET. | TRIBUS. ARCIBUS. | EXPUG. ET. TOTA. | CISRHE. DITIO | NE. PACATA. | 1597. Reverse, SOLI. DEO. HONOR ET GLORIA. The Belgian lion rampant, holding a sword and bundle of arrows. This celebrates the victory at Turnhout and the recapture of nine towns.

No. 34457. Obverse, IMPERATOR. MARIS. TERRÆ DOMINUS. A full-rigged ship under sail. Reverse, LUCTOR ET EMERGO. 1602. A four-leaved rose between small crosses. This relates to commerce and navigation once more beginning to be lively.

No. 34461. Obverse, ARS. GRAVE. TOLLIT. ONUS. A man bending down over a lever is endeavoring by its means to raise a huge millstone. Reverse, INDUSTRIA ET LABORE. A spade transpiercing a crown. In the exergue MDCII.

This relates to the surrender of Grabe.

No. 34491. Obverse, SERVAT. VIGILANTIA. CONCORS. MDCVI. A ship in a storm-tossed ocean, whose waves are breaking its masts ; clouds are in the heavens. Seven figures are to be seen upon the ship who are busied in taking necessary measures for the preservation of the ship and bringing it to its destination. Reverse, MODICÆ. | FIDEI. QUID. | TIMETIS. | S. C.

This refers to the general depression and consternation of the Netherlanders.

No. 34518. Obverse, FORTITUDO . BELGICA. A bundle of arrows with their points upwards. Reverse, MDCXII. | INDUCIAR. | IIII. | S. C. | This commemorates the fourth year of the truce.

2ND. COINS.

Among the coins a number of fine specimens have been added, of which the following are a few of the more important.

There is a very interesting silver coin of ancient Spain. It bears on the obverse a head with a stern forbidding countenance, and crisp curled hair and beard, calling to mind the conventional Assyrian type. There are also certain rude letters both on the obverse and on the reverse. It is the current opinion among Numismatists that these coins were copied after those issued by the early Greek monarchs with such changes as the lack of skill on the part of the artists would naturally cause. The reverse exhibits a horseman charging with a lance seated upon a steed whose forefeet are raised in motion from the ground. The action is spirited, and by no means so stiff as the low state of the arts would have warranted us in expecting. The head on the obverse does not, in my opinion, bear out its presumed Greek origin, and I incline to the belief that it is rather a representation of some one of their gods, possibly the Phœnician Hercules.

The first settlements in Spain were those of the Carthagenians, established ages before the earliest known periods of classical history.

There exist numerous varieties of these early Spanish coins with various inscriptions, which have only been deciphered in the last few generations, and even as yet their true signification is in doubt. The author of *La science des Medailles*, an early work on Numismatics, published at Paris in 1715, speaks of these coins as being truly *medallas desconnocidas*, which no one had undertaken to collect or reduce into order, although "Lastanosa *ait crû rendre un grand service aux curieux, de se donner la peine d'en faire un Volume, qui fut imprimé a Huesca en* 1645 *ou il a fait graver environ deux cents de ces medailles qu'il avait dans son Cabinet, la plûpart d'argent.*"

Lastanosa had an insight into the true status of these coins which had been considered as bearing Punic letters. He maintained that the characters on them were those of the early language of Spain, and that it was to these coins Pliny referred when speaking of the booty carried away by the Romans from Spain, *argentum signatum oscense*.

The coin of which we are speaking has been ascribed by both Henin and Akerman to the city of Tarragon, the capital of the Province of the same name, much celebrated in ancient authors for its beauty and opulence. Pliny writes of it that it was *Scipiorum opus ut Carthago Panorum.* Augustus erected in honor of his visit, an altar, upon which subsequently a palm-tree grew. It issued coins while under the dominion of the Romans, and there are some extant bearing the heads of the Gothic rulers of Spain.

Carthage is probably one of the best known cities of antiquity, and abundant specimens of its coinage have descended to our own times. The pieces in the exhibition are small bronze coins bearing on the obverse the head of Demeter (or Persephone) adorned with necklace, earrings, &c., and on the reverse the figure of a horse and a palm tree.

The Carthaginians adopted from Sicily the worship of Demeter and Persephone, and the horse possibly refers to Libya, which was famous for its horses, or perhaps to the horse's head fabled to have been dug up at the foundation of the city. Carthage was ultimately destroyed by the Romans 146 B. C., and the coin was probably issued about the third century before the present era.

There is a very fine didrachm of VELIA in Lucania bearing on the obverse a beautifully executed head of Apollo, and on the reverse a lion in the act of leaping upon a stag, which it is rending to pieces. The muscles are admirably portrayed, and the action is depicted entirely without stiffness, but with the ease and grace which arises from the consciousness of power and strength.

Velia was a large and prosperous city founded by the Greeks, and its coinage exhibits the undoubted confirmation of history. Greek culture alone could have produced such fine specimens of Art It is now known as *Castella mar della Brucca*, and lies between Policastro and the Gulf of Salerno. It was mentioned by both Strabo and Pliny, and was the seat of the Eleatic sect of Philosophers, who received their appellation from the city; their leaders were Zenophanes, Parmenides, Zeno and Melissus. The speculations of this school rose to a higher region of pure thought than those of the Ionic or Pythagoric schools, and among the Eleatics for the first time comes distinctly into play the dialectical movement in human thought.

Corinth, in Achaia, is represented by a fine didrachm, bearing on the obverse helmeted head of Venus; and on the reverse, Pegasus. with the letter ϙ (Koph), the ancient or Phœnician form of K. "A city," says Strabo, "large, rich and prosperous; replete with men fit for the handling of every sort of affair, civil, artistic and political." Founded by Bellerophon, the type of the reverse refers to his subjugation of the steed Pegasus.

The coinage of this city exhibits a high degree of artistic culture, a thorough proof, were any wanting, of the truths which history records of its refinement and luxury. From the earliest days of its coinage, when the reverse was simply the rude punch mark, to the last periods when its money was issued, the pieces struck and engraved for this city are worthy of a high rank and possess a great merit.

The very first coins issued by Corinth bear on the obverse Pegasus, with the archaic letter ϙ (Koph), which disappeared from the later Greek alphabet. Reverse, the so called key pattern punch mark. The execution of the flying horse is very bold.

This city was colonized at a very early period by the Phœnicians, and was destroyed by the Romans under L. Memmius, B. C. 146. The present piece was issued about 480 B. C.

It is interesting to compare the coinage of this city with that of Sybaris, both of infamous renown for the pursuit of pleasure.

There are also specimens of what is known as the *incused coinage* of Magna Græcia. These pieces were issued by the Grecian colonies settled in lower Italy, and are probably the most remarkable specimens of the monetary art which have ever been produced. Instead of being thick and hemispherically raised towards the center, they are thin and flat, and bear on the reverse in intaglio the same subject which the obverse bears in alto-relievo. This coinage had been abandoned before the sixth century B. C., and all these coins are of very great antiquity, yet their workmanship is fine and artistic, even when the design is of the simplest. What the object for the adoption of so peculiar a form could have been, has been the subject of numerous conjectures, but as yet none seem satisfactorily to explain this abnormal condition of coinage.

The specimens which the Numismatic and Antiquarian Society have placed on exhibition are Sybaris and Metapontum.

The coinage of Metapontum bears on the obverse an ear of corn, on the reverse the same incused. This city was founded about 700 B. C., by a colony from Northern Greece, and its prosperity became exceedingly great, owing to the fertility of its soil, which was especially rich in wheat. The Metapontines sent annually to the temple at Delphi a golden sheaf of wheat and considered Ceres as their tutelary goddess, impressing her emblem, the ear of corn, upon their coinage.

Sybaris presents, on the obverse, a bull standing and looking backwards, and the same type incused on the reverse, with the inscription *VM*, being written from right to left in the most ancient manner and with the *sigma* of an archaic type, resembling a *mu*. The history of Sybaris and its successor city, Thurium, is well told by Dr. Cardwell.

"The people of Sybaris, on the bay of Tarentum were conquered and their city destroyed by the Crotoniats about the year 500 B. C. Fifty eight years afterward the Sybarites endeavored to rebuild their city, but were again driven away six years later by their old enemy. The aid of Athens and the Peloponnese was invoked, which in 444 B. C. laid the foundations of Thurium, near the site of the ancient Sybaris, taking the name from a fountain in its neighborhood. Soon the foreign element prevailed over the

Sybarites and put them to the sword. * * * What then is its numismatic history? We have several coins of Sybaris, bearing in the form of their brief inscriptions and workmanship the strongest evidence of high antiquity, so that we may fairly assign them to a period fully five centuries before the Christian era. The constant device on these coins was *Bos stans et respiciens*, showing that it was the acknowledged cognizance of Sybaris. The next coins belonging to the place are more recent, as we may judge from the form of their letters and their highly finished style of workmanship, and taken on the analogy of coins in general, they might be assigned to a period not much anterior to the time of Philip and Alexander. But we find from these that the devices of the place have undergone an important change. The ancient cognizance of Sybaris is now of secondary consequence and has given way on one face of the coin to the *Caput Palladis*, the well-known badge of Athens. The inscription, too, is, in one instance, the abbreviated word Sybaris, in another a similar abbreviation of the newly contracted name, Thurium. So then, these coins strictly mark the period when the natives and foreigners were living together in compact, mutually endeavoring to conciliate each other, each party preserving tokens of its hereditary attachments.

"The next set of coins is distinguished by a minuteness of ornament which marks them decidedly as the most recent of the three, and these coins, in perfect accordance with the historical narration, bear no memorials of the ancient Sybaris. The inscription in every instance is of Thurium, the *Caput Palladis* is prominent, and the ancient cognizance of the Bull is no longer *stans et respiciens* but *irruens et cornupeta*. Doubtless there was found in the meaning of the word θουρίος, a reason for the difference they adopted 'a bull running and butting.'

"When, later in the history of the town, Athens and other powers of Greece began to claim it as a dependency, they boldly refused to acknowledge any other founder or patron than the deity of Delphi. And what say the coins? Some of them, which seem to have been minted when the republic was yet scarcely free from its ancient habits, retain the badge of Athens, but some also bear the emblems of Ceres, the tokens of agricultural prosperity, and others are impressed with the head and insignia of Apollo."

The device of the bull occurs upon the reverse of a denarius of Augustus (of which a specimen is in the present collection), and also those of the gens THORIA. "The 'Bos irruens,'" says Smyth (Northumberland family coins, p. 238), "or a fierce bull charging, is no doubt a punning allusion to the moneyer's cognomen, θούριος, impetuous, and not an agrarian emblem. Some antiquaries, however, insist that it alludes to an agrarian law introduced by the tribune Sp. Thorius Balbus, which lex concerning the Roman public lands was engraved upon the back part of the same tablet which contained the Lex Servilia de Repetundis; this tablet was broken

*Cardwell Lecture, III, p. 66 et seq. Diodorus Siculus, lxi., § 90, &c.; lxii., § 11 and 35.

at some unknown time, but seven of its fragments have been preserved and published by Fulvius Ursinus about A. D 1577."

"The symbol of the bull plays an important part in many mythoses. This animal was intended to represent power of body and unwearied masculine energy, two great attributes especially coveted by ancient kings and great men. The bull seemed to be, in a manner, sacred to Venus, whilst the lion was emblematic of the male creator. The bull and the lion, among the Assyrians, occupied much the same place as the lion and unicorn do in modern heraldry. Lajárd (*Culte de Venus*) has summed up the matter in the following words:

"Les deux principaux attributes characteristiques de Vénus furent en orient comme en occident le taureau et le lion, l'un symbole du principe de la chaleur et du pouvoir generateur actif, l'autre, symbole du principe humide et du pouvoir generatif passif; et tous les deux signes du Zodiaque, mais avec cette difference que le taureau etait le premier signe de l'equinox vernal et la domicile de la lune á l'epoque de sa plus grande exaltation, et que le lion placé au solstice d'été etait le domicile du soleil pendant la canicule. Ces deux animaux furent donc aussi les hieroglyphes ideographique de l'hermaphroditisme de Venus, divinité a laquelle les anciennes traditions assignent, comme a Mithra, une place entre les equinoxes et les solstices et donnent pour monture le taureau." In another passage he writes thus: "Premier être sorti des mains d'un dieu créateur du monde, le taureau, symbole de vie, est appelée d'un nom qui signifie à la fois *vie* et *taureau*. Par une conséquence immédiate d'une doctrine qui enseignait que les premiers êtres vivants étaient né dans l'eau, il est, en même temps, le symbole de principe humide, du pouvoir passif de la génération ou du sexe feminine." (Inman's Ancient Faiths, Vol. 1, p. 376, et seq.)

The symbol of the bull also is frequently taken to represent water, or the watery principle in which life takes its beginning* and hence, no doubt, the reverence paid to rivers, as instanced, even at the present day, in India, by the burial of the Hindoo dead in the holy waters of that region. It may therefore be considered as a representative of the *ΚΤΕΙΣ* or the great humid principle of nature.

Not a trace now remains of Sybaris, this great city which once ruled over twenty-five of its neighboring towns, and sent into the war that resulted in its downfall three hundred thousand fighting men. Nothing is known of its mansions and its palaces, not one stone is left to show the spot where "men slept upon beds of roses and those renowned banquets took place to which women were bidden a year in advance that they might have the whole interval for rendering their beauty more irresistible." Recent explorations have resulted in the finding of a sarcophagus full of carbonized matter, showing that the corpse had been cremated prior to interment.

Amidst the remains of the funeral pyre, near the head of the corpse, were some golden fragments, the ornamentation of a box, and afterwards the bronze nails with which it had been fastened were found. Near the breast

*cf Inman, p. 377, *note*.

of the deceased were two small silver plates, of the size of large buttons, which bore in relief two beautiful female heads. Near the remains of the skull was discovered a small plate of thin gold folded together, on which were visible some traces of Greek writing, and which, on being opened, disclosed within its folds another similar tablet likewise bearing an inscription. The learned professor to whom this find was given to decipher, believes that the larger plate contains mystic matter written by one familiar with the Eleusinian mysteries; the small plate contains an inscription in capital letters in the Doric dialect, in which a hierophant addresses the dead, congratulating him that after having suffered the worst of evils he had from a miserable mortal become a god, having pursued the right path which leads to the fields reserved for the just in the bowers of Persephone.

There is a fine Tetradrachm of the famous city of Tyre (in Phœnicia), bearing on the obverse a laureated head of Heracles, on the reverse an eagle on rudder behind a palm branch, to left date *IH* (year 18), inscription, *ΤΥΡΟΥ ΙΕΡΑΣ ΚΑΙ ΑΣΥΛΟΥ*.

Tyre was one of the grandest cities of all antiquity, and its commerce and riches are frequently spoken of in the classical writers. From Tyre, as from modern London, ships went to visit all parts of the globe to which they could reach; and to Tyre came merchandise from all parts of the continents of Europe and Asia. According to Herodotus it was founded about 2755 B. C., and received its independence about 126 B. C. This coin was therefore issued about 108 B. C. The execution of this coin is especially noteworthy. The massive boldness of the head of Melkarth (the Tyrian Hercules) exhibits a brutal and repelling countenance; the eagle (sacred to this god) on the reverse is in an attitude of life-likeness almost unsurpassable. The rudder exhibits the maritime character of the city and the palm was the emblem of Tyre and Sidon. Phœnicia is fabled to have taken its name from this tree, which in Greek was known as *ΦΟΙΝΙΞ*. The palm was likewise the well known emblem of victory. As found upon coins it is, according to Spanheim, of three varieties, viz:

1st. That which is tall, thick-branched and leaved, but bears no fruit.

2d. Smaller, less dense and bears fruit.

3d. The small sterile dwarf palm.

The palm tree of Judea, which bears fruit, is found upon the coinage of that country. As a branch the palm is found upon the coins of Arabia; as a tree, upon those of Tyre, Damascus, Alexandria and the Phœnician Colonies of Sicily, Africa and Spain.

The palm tree was one of the ornaments sculptured in Solomon's Temple, and among modern writers (*e. g.*, Inman's Ancient Faiths) has been considered to be a Phallic emblem equivalent to Asshur. "On a coin of Ephesus a palm tree is represented as springing up by the side of a stag cut asunder, meaning that the 'Great God (Kronos or Ilos) being cut off, the palm tree repairs all.'"*

* Inman, Vol. I, p. 195.

The epithets, *ΙΕΡΑΣ* (Holy) and *ΑΣΥΛΟΣ* (inviolable sanctuary) were adopted by many other cities. After a very long period of life, with checkered prosperity, Tyre was finally destroyed by the Saracens, A. D. 1291, after having withstood many sieges, including one by Alexander the Great.

In addition to these already described in my previous paper there are a number of so called family coins, among which are well preserved specimens of the Cornelia, Fulvia, Hostilia, Maiania, Opeimia, Pomponia, Scribonia, Vibia, and other gentes, presenting interesting types. The gens Cornelia was a most noble family, both Patrician and Plebeian, and has left a number of devices upon the denarii which are attributed to it. The gens Fulvia although "confessedly one of the most conspicuous of the Roman gentes, is only known by one denarius, except some colonial ones figured by Morell" (Smyth Family Coins, p. 85). It bears on the obverse the head of Pallas Nikephora with alated helmet and the word ROMA; on the reverse, "Victoria alata holds out a chaplet in a biga galoping to the right. Under the horse is CN FOUL, and in the exergum M GAL Q MET. Although we do not hear of the Fulvii till L. Fulvius became consul in B. C. 322, it is known that even then they were of long standing in Tusculum. * * Of the ladies of this gens two played a very conspicuous part; the first, a woman of rank, divulged the Catalinian conspiracy, the second married Mark Antony for her third husband, breathing nothing but war and domination. This is the fury who pierced the dead Cicero's tongue with a bodkin, uttering all sorts of opprobrious epithets all the while." (Smyth, *loc. cit.*)

A denarius of the gens Maiania presents on the obverse "a winged and galeated head of Roma with the mark ✕; on the reverse, a winged Victory in a rapid viga holding the reins firmly with her left hand, while her right is whipping the horses, which are unusually free from harness. Below is the inscription C MAIANIA; exergue Roma. History makes no mention of this gens and its rank is unknown." (Smyth, p. 127.)

The gens Opeimia presents "the galeated head of Pallas, bearing stern and manly features, wearing an earring with a long pendant and a necklace; in front is the denarial stamp ✕, and at the back is a chaplet. On the reverse, L. Opeimi; exergue Roma. Victoria alata in a galloping quadriga holds the reins with her left hand and a laurel crown in her right. This was probably struck by L. Opeimius, the aristocratic prætor who suppressed the revolt of Tregellæ, B. C. 125. This is the man who being consul four years later, hunted C. Gracchus, with personal animosity, to his destruction; and being himself condemned for receiving Jugurtha's bribes, died, hated and insulted, a poverty stricken exile at Dyrrachium. * * * The Opeimii are first brought on the stage of history at the time of the Samnite wars, yet the components of the gens are but little known." (Smyth, 157.)

The denarii of the gens Pomponia occur frequently and are of many devices. Upon some are seen the figures of the Muses, Clio, Euterpe, Thalia, Melpomene, Terpsichore, Erato, Polyhymnia, Urania, and Calliope, with the symbols respectively indicative of their supposed avocations. Upon one denarius is found the representation of Hercules Musagetæ playing upon a lyre. "The temple of Hercules Musarum was built in the Flaminian circus by the consul Fulvius, who having, when imperator in Greece, recognized Hercules as Musagetes, consecrated to his tutelar protection the nine statues of the Muses, which he had brought over from Aetolia, B. C. 189. The Pomponia, though a plebeian gens, were very proud, and, towards the end of the Republic, followed the example of the other Roman gentes by claiming high antiquity, pretending descent from Pompo, one of the sons of Numa." (Smyth, p. 184, et seq.)

The gens Vibia likewise affords many varieties of obverses and reverses. Among the former we find the laureated head of Apollo, the head of Pallas, an ivy crowned head of Bacchus, a scenic mask of Pan, a laureated female head supposed to represent the Goddess Libertas, laureated head of Hercules, bearded head of Jove; on the reverses are galeated figures in quadriga, Ceres crowned with wheat marching across a field, Jupiter Axuris, Roma seated on a pile of bucklers, holding in her right hand a spear, in her left the parazonium, pressing with her left foot on a globe, and in the act of being crowned by a flying Victory, two clasped right hands sustaining a winged caduceus (relating to D. Brutus, who being besieged by Mark Antony at Mutina, B.C. 45, was liberated by the consuls Hirtius and Pansa), a panther with his fore feet raised on a decorated cylindrical altar on which are the Bacchic attributes, a bearded mask and a long thyrsus adorned with ribbons, Victoria alata placing a garland upon a trophy composed of spoils, and Ceres, crowned with corn, holding a lighted torch, seated in a car drawn by two dragons." These dragons are portentous creations of the ancient imagination in all countries. The serpent worship was all but universal. It is alluded to in the earlier portions of the Bible, and it is known to have prevailed among the Chaldees, the Persians and the Egyptians as emblematic of the Sun and Time and Eternity. From the Orientals it descended to the Greeks, and from them to the Romans, among whom it became a type of Victory, Prosperity and Health." (Smyth, p. 255, et seq.) Ceres in her car, drawn by dragons, likewise occurs upon the coins of the gens Volteia.

There is a handsomely executed Paduan fabrication of a first brass of the Emperor Otho, bearing his head on the obverse, and on the reverse the Emperor standing with his right hand extended over an altar clasping the hands of three soldiers who bear military ensigns; inscription SECURITAS P. R. S. C. A Roman first brass of the Emperor Otho is something that has always been a desideratum; none are known to exist or to have ever existed. Bronzes from the Egyptian Mint are to be met with and these alone must replace the Roman issue in collections unless the unexpected, which is always occurring, should some day bring to light a hoard of these coins. The usual explanation given for the absence of the first bronzes of this Emperor is based upon the power retained by the Senate of striking copper, while their rulers had usurped the privilege of coining gold and silver. The denarii of Otho are of not infrequent occurrence, notwithstanding the extremely short duration of his reign.

We cannot more appropriately conclude this sketch than with the words of the Spanish writer, Gussême:

"No pretendo que la aficion á las medallas sea la únicà; pero sí que no se olvide, que no se abandone, antes sí que se cultive. Ella es de tal calidad, que siempre recrea, que ofrece a cado paso nuevas satisfacciones, y con una solidez, que no se halla con tanta freqüencia en los demas estudios. * * * *La Erudicion debe ser en todos tiempos, y en todas Naciones apetecida y solicitada; y seguramente no hay modo para adquirirla con mayor extension que el uso de los medallas, el estudio para su perfecto conocimiento, y el manejo de los libros que tratan de ellas. Quien las cultiva va adquiriendo de grado en grado los mas utiles conocimientos, y una vasta extension en el campo de las bellas lettras.*

"Cada medalla es un diploma o instrumento autentico; que comprueba la verdad de la Historia; y no habrá en el mundo archivo de mas seguros y antiguos documentos. * * * * *El estudio de la antigüedad es cosa que no debemos jamas olvidar y abandonar segun Claudiano;*

Nec desinat unquam
Tecum Graia loqui, tecum Romana vetustas."

On the Formation of Dibenzyl by the Action of Ethylene Chloride on Benzol in the Presence of Aluminium Chloride. By William H. Greene.

(*Read at the Meeting of the American Philosophical Society, October* 17, 1879.)

By a series of the most remarkable chemical investigations of late years, MM. Friedel and Crafts have shown that the radicles of the saturated hydrocarbons can be grafted upon the benzol nucleus by the action of aluminium chloride upon a mixture of benzol and the monatomic chlorides, bromides, etc. Thus, on passing methyl chloride into benzol in which aluminium chloride is suspended, all of the methyl derivatives of benzol, from toluol to hexamethyl benzol, may be formed, according to the proportions of benzol and methyl chloride which are brought into contact. In the same manner, the ethyl, propyl, and other derivatives of benzol may be obtained abundantly.

In these reactions, hydrochloric acid is disengaged, and the explanation proposed by Friedel and Crafts supposes the reaction to take place in two phases: In the first, a compound of benzol and aluminium chloride is formed, with elimination of hydrochloric acid.

$$C^6H^6 + Al^2Cl^6 = C^6H^5. Al^2Cl^5 + HCl$$

In the second, the aluminium-benzol compound reacts upon the monatomic chloride present, the organic radicle entering the benzol nucleus, and aluminium chloride being reformed.

$$C^6H^5.\ Al^2Cl^5 + CH^3Cl = C^6H^5.\ CH^3 + Al^2Cl^6$$

A small quantity of aluminium chloride serves for the preparation of an indefinite quantity of the new hydrocarbon.

By the action of aluminium chloride on the monatomic chlorides alone, hydrochloric acid is also eliminated, and the radicle is condensed. Hence, the reaction which would take place between benzol and a polyatomic chloride under the same circumstances cannot be entirely foreseen. It seems possible that in the case of ethylene chloride, for example, both atoms of chlorine might be replaced by phenyl groups, but it would seem more probable that, after the first substitution, one molecule of hydrochloric acid would be removed from the ethylene chloride, and that a more condensed hydrocarbon, styrol, would be formed. However, the first reaction is that which actually occurs.

When aluminium chloride is introduced into a mixture of benzol and ethylene chloride, the reaction begins in the cold, and becomes energetic on the application of heat. Hydrochloric acid is disengaged abundantly; when the reaction has ceased, the mixture is thrown into water to separate the aluminium chloride, and the oily liquor which separates is heated with alcoholic potassium hydrate, in order to decompose any remaining ethylene chloride.

After washing and drying the product, it yields, on fractional distillation, very nearly the theoretical quantity of dibenzyl, after which a thick oily mixture remains, which does not completely distill at 200° in a vacuum. This mixture consists of condensation products, and yields no satisfactory results, as it cannot well be fractionated, and does not solidify in a freezing mixture.

Pure dibenzyl melts at 52.5–53°, and boils at 279°, under a pressure of 767 millimetres, the thermometer being entirely immersed in the vapor. This boiling point is lower than that given by Cannizarro and Rossi (284°), and higher than that indicated by Fittig (272°).

On Dioxyethyl-methylene, and the Preparation of Methylene chloride. By *Wm. H. Greene, M.D.*

(Read before the American Philosophical Society, November 21, 1879.)

With the exception of the diethyl ether of methylene glycol, all of the oxyethyl substitution compounds of methane have already been described. Orthoformic ether, $CH(OC^2H^5)^3$, was studied by Kay and Williamson, and is generally known as Kay's ether: orthocarbonic ether, $C(OC^2H^5)^4$, was discovered and described by H. Bassett: methyl-ethyl oxide has long been known.

By a reaction similar to that by which these ethers are formed, I have isolated dioxyethyl-methylene, the reaction between sodium ethylate and methylene chloride taking place as indicated by theory.

The chief difficulty lies in the preparation of pure methylene chloride; the process described by Perkin, and depending upon the reduction of chloroform by zinc and ammonia, yields only small quantities of methylene chloride, and the direct chlorination of methylchloride yields equally unsatisfactory results. The method which, after numerous experiments, I have found to answer best, consists in the reduction of an alcoholic solution of chloroform by zinc and hydrochloric acid.

The zinc and chloroform mixed with several times its volume of alcohol are placed in a flask connected with a suitable condensing apparatus, and hydrochloric acid is added in small portions. The reaction develops considerable heat, and methylene chloride and chloroform distill over; when the reaction has somewhat subsided, and no more liquid distills, more hydrochloric acid is added, and a moderate heat is applied, if necessary. In any case, the mixture is heated towards the close of the operation, until alcohol begins to distill in quantity. The operation is then arrested, and the product in the receiver is washed, dried and rectified, that portion which passes below about 53° being retained. The residue is returned to the flask and again submitted to the action of the zinc and hydrochloric acid. By several careful rectifications of the product passing below 53°, pure methylene chloride, boiling at 40–41°, is obtained.

By several operations in this manner the yield of methylene chloride may be brought up to about twenty per cent. of the chloroform employed.

Little or no advantage is gained by attempting to fractionate the product as it distills from the flask, so that the chloroform may flow back into the reducing mixture, for such distillation necessarily takes place in a stream of hydrogen which carries with it about as much chloroform as methylene chloride.

Dioxyethyl-methylene.—This compound was prepared by gradually introducing one molecule of sodium into a mixture of one molecule of methylene chloride and about four times the theoretical quantity of absolute alcohol, contained in a flask connected with a reflux condenser. After all of the sodium has been introduced, the mixture is heated on a water-bath for about an hour, and is then distilled. The distillate is fractionated, and the portion which passes below 78° contains all of the diethyl ether. It is agitated with a tolerably concentrated solution of calcium chloride, and the light ethereal layer is separated, dried over calcium chloride and carefully rectified, until a liquid is obtained which boils at 86–89°.

Dioxyethyl-methylene so obtained is an ethereal liquid, having a penetrating, pleasant odor, somewhat recalling that of mint. Its specific gravity at 0° is 0.851, and it boils at 89°, under a pressure of 769 millimetres. It is slightly soluble in water, from which it may be separated by the addition of calcium chloride; it mixes in all proportions with ether and alcohol, and it cannot readily be separated from its alcoholic solution if much alcohol be present; in such a case, fractional distillation and treatment of the portion which passes below 78° with solution of calcium chloride, effect the separation.

On the Coördination of the Various Methods of Expressing Thought as Applied to the System of Public School Instruction. *By Lewis M. Haupt, C. E., Prof. of Civil Engineering, University of Pennsylvania.*

(*Read before the American Philosophical Society, November* 21, 1879.)

Language, in its most general signification, is any medium by which thoughts or ideas may be conveyed from one person to another, and the avenues through which it affects the human intelligence are the senses.

In transmitting an idea, the senses may be called into action either singly or in combination. Thus speaking involves the sense of hearing, for a person born deaf must of necessity be dumb also. We may therefore regard the vocal organs and the ear as complementary functions for the transmission and reception of audible intelligence. These may be supplemented or entirely supplanted in their absence by the hand and eye, also complementary. In both of these cases the vocal organs and hand are the media of, while the ear and eye are the guides to, the proper form of expression.

From this it follows that there may be two distinct forms of language, namely, *Oral*, or that proceeding from the mouth, as in speaking, and *Graphical*, or that produced by the hand, as in writing, drawing, and printing. *Oral* language appeals to the ear of the recipient, *Graphical*, to the eye, for the correct interpretation of the idea intended to be expressed. If the same meaning be given to a combination of words, by the recipient, as was intended by the originator of an idea, then the result will be an identity of thought and a mutual understanding resulting in harmony. But as words have many meanings, the same words may produce very different impressions upon different minds even under similar circumstances, hence, to avoid misunderstanding, with its attendant confusion or discord, it is desirable to employ, if possible, a less ambiguous form of language.

A single instance will serve to illustrate this proposition.

Let the name of a substance, as *iron*, be mentioned. An audience composed of physicists, chemists, engineers, artisans, artists and literati immediately begin to think of some of its characteristic properties.

While the man of letters may regard it as a rigid, incombustible substance, the chemist considers it flexible and burns it with great brilliancy; while the prisoner may look upon it as an obstruction, the electrician makes it a channel of communication. The agriculturalist may use it as an implement of peace, whilst the soldier will make it an instrument of war. With the civil or mechanical engineer it is an important material of *construction*, whilst with the military engineer it is an engine of destruction.

"The meaning of such a word is like the rainbow: everybody sees a different one, yet all maintain it to be the same."

It is thus with many words in our vocabulary, and hence arise sectarianisms, difficulties, violations of contracts and tedious litigation to determine the sense of some particular form of expression.

It is not necessary to dilate further upon the ambiguities of language, nor of the many serious and sometimes comical mistakes resulting from them, but a few suggestions may not be out of place as to the necessity for more extended instruction in that branch of it which relates to the expression of ideas by graphical representations and especially by drawings.

It is a matter of primary importance to the progress of civilization that every avenue for the interchange of thought should be unobstructed, that there may be an unification of purpose and action; and secondarily, that the media used to convey such thought should be unambiguous and of general application. Now, since all ideas must have for their subject matter things physical or metaphysical, it follows that there may be a different form of language used in giving expression to each. As most physical conceptions treat of tangible objects, having form, and as such form or line of apparent contour is the first characteristic observed by the eye, and is more or less familiar to all persons living within the habitat or range of the object, it is natural that this form, more or less conventionalized or symbolized, should have been used to represent the object in an unmistakable language.

In developing the intellectual faculties of mankind, beginning with the child, there is first the inception of an idea, derived from some form and an associated sound, expressing its name; this is followed by the repetition of the sound by the child, giving rise to vocal language which is developed in later years in the public school system of instruction by spelling and reading. Thus the first, or oral, division of language is cultivated, while the second, and more extensive in its range and application, the graphical, does not receive the attention which its importance deserves.

It is true that writing has long held an important place in our popular educational systems, and of late years drawing has also been introduced systematically, but as yet only so far as to cultivate the eye and hand in sketching outlines and shading, that is, in making pictures and elementary designs either for decorations or for the practice which such operations afford in estimating magnitude, distance and direction.

That important division of drawing which is the basis of the correct interpretation of all forms and magnitudes and is of the greatest practical importance to all artisans and many artists and professional men, is as yet entirely ignored.

I refer to a knowledge of elementary projections, without which a working drawing can neither be made nor understood, and the artisan destitute of it is obliged to acquire the practical knowledge for the successful application of his handicraft by long years of apprenticeship while he learns the uses of the various templates that may be placed in his hands by a master.

A moment's consideration will convince an observer that there are two methods of representing objects, viz.: 1st, as they *appear* to exist, constituting *perspective;* and 2d, as they *do* actually exist, as in *projections,* in which, relative position, form and magnitude are given. The perspective view is of little practical importance to the workman, as he is unable to obtain from it the data necessary to reproduce the object.

No two persons in an audience can see the same object from the same point of view, and hence unless it be symmetrical with reference to a point in space, as a sphere, the line of apparent contour will be different to each. The magnitude will also appear larger or smaller according to the distance of the observer from the object. Thus, if a circular disk be held up before an assembly it will appear circular only to that person at the end of its axis, while to those in the plane of the disk it will appear to be a straight line, and to all others the ellipses of which the line and circle are the limits, thus verifying the aphorism of the poet Longfellow, when he says,

"And things are not what they seem."

With projections, however, the case is different, as, if understood at all, they can only convey one impression to the reader. But it must be confessed that they are no more intelligible without a knowledge of the principles upon which they were constructed than is a printed work to one ignorant of letters.

The principles of projections are, however, as simple as those of elementary geometry, upon which they are based, and can be readily comprehended by the pupils in our public schools. And a knowledge of these principles would enable many of them to work much more intelligently in the various trades in which they may thereafter become apprentices.

The application which may be made of such information is very extended. As a disciplinary study it is one of the first order, developing the conceptive faculties and enabling one to grasp an idea readily. It has its application in nearly all manufactured articles and in all constructions and designs, in wood, iron, stone, clay, or other materials. It is used constantly by the engineer, architect, builder, pattern-maker, iron or sheet metal-worker, stair-builder, stone-cutter, designer, and a host of others. It is the basis of all perspective drawings which are generally made by rule and without reason, and is essential to a correct interpretation of all suggestions relating to constructions of any kind. It is used to explain and reinforce verbal language, and should be so used whenever possible.

One of the most important applications of graphical language must not be overlooked. To the statistician as well as merchant it is valuable as furnishing at a glance information which if expressed in a mass of figures would be unintelligible. It cannot be surpassed as a method of exhibiting rapidly the distribution of population, of products, of poverty or wealth, of crime or morality, of vital, or in fact any statistics which may be expressed numerically. To the physicist it is also particularly useful in investigations into the properties of molecular or mass physics, and enables him to discover almost immediately the laws governing the motions of matter.

Fluctuations of prices, in the market values of daily commodities, may be more intelligently expressed by this means than any other and can be compared at a glance. In short, the number of intelligent and eminently practical applications that may be made of projections is almost limitless.

Its introduction would supplant a certain amount of mnemonical by rational and manual development, and would thus be a relief to a system already overtaxed with memorizing.

Another means of disseminating thought, as well as of developing the mental and manual faculties simultaneously, would be the introduction of type-setting in the public school as a weekly exercise, but as it is not the purpose of this article to discuss here the means and methods of industrial education, any further remarks on this head will be out of order.

It is merely intended to call attention to the fact that there is need of a more complete development of all the faculties used to convey or receive impressions and to coördinate them into a closer and more efficient system of instruction as a basis for the more intelligent expression of thought.

Stated Meeting, June 20, 1879.

Present, 5 members.

Vice-President, Mr. Fraley, in the Chair.

A photograph of Mr. J. F. Mansfield, was received for insertion in the album.

Letters of acknowledgment were received from the Natural History Societies at Württemberg, April 1 (101, 102); Freiburg, Feb. 2 (101); the Societies at Harlem, Aug., 1877 (97, 98, 99); Lyons, Aug. 1, 1878 (I to XV); Edinburgh, Oct. 31, 1878 (100, Cat. III); the Royal Academy, at Amsterdam, Oct. 22, 1877 (100, Cat. III); New Hampshire Historical Society, June 16 (103); the Essex Institute (103); the U. S. Military Academy, at West Point (103); the New York Historical Society (103); the American Ethnological Society (103), and Astor Library (103); the Numismatic and Antiquarian Society (103), and Historical Society at Philadelphia (103); the Wisconsin Historical Society (103); and various members (103).

Letters of envoy were received from the Royal Academy, at Amsterdam, Feb. 7, 1879; Imperial Academy, at Vienna; Royal Academy, at Munich, April 10, 1879; Holland Society, Harlem, Dec., 1877; Government Surveyors, Victoria, Feb. 12; Greenwich Observatory, June 20; Meteorological Office; and Mrs. Sarah S. Pickering, May 19, 1879.

Donations for the Library were received from the Academies at Amsterdam, Bruxelles, Berlin, Vienna, Rome, and

Philadelphia; the Societies at Copenhagen, Harlem, Göttingen, Görlitz, Freiburg, Stuttgard, Liège, Lyons, Bordeaux and Salem; the Observatories at St. Petersburg, Munich, Paris, Greenwich and Cape Town; the University at Christiania; the Statistical Commission of Belgium; the Anthropological Society and Geological Institute at Vienna; the German Geological Society and Botanical Association, at Berlin; the Zoological Garden, at Frankfurt; the Geographical, Anthropological and Antiquarian Societies, Ethnographical Institution and Museum of Natural History, at Paris; the Physical, Linnæan and Geographical Societies, at Bordeaux; the British Association; the Astronomical, Meteorological, Geographical, Geological and Zoological Societies, Victoria Institute and London Nature; Mr. L. C. Miall, of Leeds; T. P. James, of Cambridge, Massachusetts; Mrs. Pickering, of Boston; the Cambridge Library and Museum of Comparative Zoology; Prof. J. D. Whitney, Prof. W. A. Norton and Silliman's Journal, of New Haven; the Brooklyn Entomological Society; the American Chemical Society and Mr. F. R. Rathbun, of New York; the Franklin Institute, Zoological Society, Medical News, American Journal of Pharmacy and International Committee of Philadelphia; the American Journal of Mathematics, at Baltimore; U. S. Smithsonian Institution and Wm. B. Taylor, of Washington; the Wisconsin Natural History Society; the Geographical Society and National Museum in Mexico.

A medal of Joseph Henry, was received from the engravers of the Mint, Messrs. Wm. and Chas. E. Barber, for which, on motion, the thanks of the Society were presented to the donors.

Mr. Henry Phillips, Jr., offered for the acceptance of the Society, under certain conditions, a copy of Sabin's Bibliotheca Americana, as far as published, which, on motion, was accepted for the Library.

No. 103 of the Proceedings, just issued, was laid upon the table for examination.

A simple and closely approximate diagrammatic solution of the problem of squaring the circle was communicated by Prof. P. E. Chase. (See page 281.)

A communication entitled, "Eleventh Contribution to the Herpetology of South America," was received from Prof. E. D. Cope. (See page 261.)

The Committee on a Eulogy on Dr. G. B. Wood reported a recommendation that Dr. Henry Hartshorne be appointed in the place of Dr. Alfred Stillé, to prepare an obituary notice of the deceased, which was adopted.

Pending nominations 878 to 884 were read, and the meeting was adjourned.

Stated Meeting, July 18, 1879.

Present, 5 members.

Vice-President, Mr. Fraley, in the Chair.

A photograph of Prof. John LeConte, and a vignette of Gen. F. E. Spinner, were received for insertion in the album.

Letters acknowledging the receipt of Proc. No. 102, were received from the Royal Danish Society, June 17; and of Proc. No. 103 from Prof. Steenstrup; Mr. A. Agassiz; the New Jersey Historical Society; Prof. Fred. Prime; the Maryland Historical Society; the Engineers' Club; the U. S. Naval Observatory; Mr. Asaph Hall; Prof. Kirkwood; the Davenport Academy; the Georgia Historical Society and Prof. John LeConte.

Letters of envoy were received from the Batavian Observatory, May 7; Dr. H. Scheffler, of Braunschweig, April 20; the Bureau des Longitudes per U. S. State Department; and the Engineers' Club of Philadelphia.

On motion, the Librarian was authorized to supply a copy of Proceedings No. 97 to the Cherbourg Natural History Society.

On motion, the Journal of Medical Sciences was ordered to be placed upon the list of correspondents to receive the Proceedings.

An offer from the State Librarian of Michigan to exchange was accepted.

Donations for the Library were received from the Academies at St. Petersburg, Berlin, Brussels, Rome and Minneapolis; from the Geographical Societies of Russia, Paris and Bordeaux; the Observatories at Prag and Adelaide; from the Bureau des Longitudes; London Astronomical Society; and the Corporation of the City of London; Essex Institute; Boston Society of Natural History; Brooklyn Entomological Society; American Chemical Society and the New York Mercantile Library Association; Franklin Institute, American Pharmaceutical Association, Union League and Engineers' Club of Philadelphia; Smithsonian Institution; and Argentine Scientific Society; Yale College; Wabash College; U. S. Engineers' Department; Mexican Agricultural Bureau; Melbourne Mining Bureau; Young Men's Association at Buffalo; Dr. Scheffler, of Braunschweig; Canadian Naturalist; Silliman's Journal; New York Entomological Society, and Mercantile Library; Journal of Pharmacy, Journal of the Medical Sciences, Pennysivania Magazine of History, &c., Prof. Frazer, Dr. Genth, Mr. Benson, Prof. Jacques, and Dr. Gross.

A communication was received, entitled, "On Pyrophyllite" from Schuylkill Co., Pa., by Dr. F. A. Genth (p. 279).

Mr. Lesley described a recently discovered ancient buried river channel crossing the Allegheny river twice, from the mouth of the Clarion, above and below Parker, at the northern limit of Armstrong County.

As Mr. Carll has shown that the preglacial Allegheny river had its heads in the high ridge south of Tidioute, in Venango County, it is evident that the Clarion river was then the main Allegheny river; which explains the ancient double curve at Parker. After the ice had retreated from the northern country, leaving all the valleys choked with drift, the combined waters which until then had entered the basin of Lake Erie, at Dunkirk, in New York State, broke away through the ridge below Tidioute, and cut the present straight channel at Parker, across and 100 feet lower than the ancient channel.

Pending nominations No. 878 to 884, and new nomination 885, were read.

Pending nominations 878 to 884 were balloted for, and after scrutiny of the ballot boxes by the presiding officer, the following persons were declared duly elected members of the Society:

Prof. Charles Martins, of Montpellier, France.

Sir George Biddle Airy, Astronomer Royal of Great Britain.

Mr. Charles M. Wheatley, of Phœnixville, Pa.

Mr Andrew S. McCreath, of Harrisburg, Pa.

Prof. Ira Remsen, of Baltimore, Md.

Prof. E. Reneviers, of Lausanne, Switzerland.

Mr. Benjamin B. Comegys, of Philadelphia.

And the meeting was adjourned.

Stated Meeting, August 15, 1879.

Present, 2 members.

Secretary, Dr. J. L. LeConte, in the Chair.

A portrait of George Ord was presented by Dr. M. Hay, for insertion in the album.

Letters accepting membership were received from Mr. Charles M. Wheatley, dated Phœnixville, July 24, and Mr. Andrew S. McCreath, dated Harrisburg, Pa., July 24.

Letters of acknowledgment were received from the Reale Academia dei Lincei in Rome (101, List. Cat. III); and the Boston Society of Natural History, July 21 (103, List. Cat. III).

Letters of envoy were received from the Zoologico-Botanical Society of Vienna, May 20; and the Natural History Society of Görlitz, March 2, 1879.

Donations for the Library were received from the Institute of France; the Geological Institute, Zoologico-Botanical Society, and Anthropological Society at Vienna; M. Joseph de Lenhosáck, of Buda-Pest; the Societies at Görlitz and Bremen; Prof. F. Sandberger; the Royal Danish Academy; the Geographical and Anthropological Societies, School of Mines, Polytechnic School, and Revue Politique, of Paris; the Linnæan and Geographical Societies at Bordeaux; the Royal Institution, Astronomical, Meteorological, Geographical, Geological, Zoological, Asiatic Societies, and Prof. Bickerton, of London; the Royal Geological Society of Ireland; the Canadian Naturalist and Survey of Canada; Essex Institute; Boston Natural History Society; Museum of Comparative Zoology; Old Colony Historical Society, at Taunton; North American Entomologist; American Journal of Otology; American Chemical Society of New York; Franklin Institute, American Journal of Pharmacy and Medical News and Library, in Philadelphia; the U. S. Naval Observatory, Engineer Department, Department of the Interior, and the Department of the U. S. A.; the Cincinnati Society of Natural History; Indiana State Geological Survey; American Antiquarian; Botanical Gazette; and M. Barcena, of Mexico.

A donation for the Cabinet was received from M. Joseph Von Lenhossák, of Buda-Pest, per M. Eugene Turnoosky, M. D., 73 West Forty-fifth street, New York, March 30, 1879, viz., a cast of the skull figured and described in his work, entitled, "Deformations, &c.," received of same date for the Library.

A communication entitled, "Surface Geology of Southwest Pennsylvania and adjacent portions of West Virginia and Maryland, by John J. Stevenson, Professor of Geology in the University of the city of New York," was read. (See page 289.)

And the meeting was adjourned.

Stated Meeting, September 19, 1879.

Present, 10 members.

Vice-President, Prof. KENDALL, in the Chair.

Letters accepting membership were received from Prof. J. Reneviers, dated Lausanne, Aug. 5, 1879; from Prof.

Ch. Martins, dated Montpellier, Aug., 1879; and from Sir Geo. B. Airy, dated Royal Observatory, Greenwich, London, S. E., Aug 12, 1879.

A photograph of Charles Martins was received for insertion in the album.

Letters of acknowledgment, were received from the Astronomical Society at Leipsig, dated Aug., 1879 (101); the Natural History Society at Newcastle-upon-Tyne, dated Aug. 13, 1879 (102); the Philosophical Society at Glasgow, dated Sept. 5, 1879 (102); the Society of Antiquaries at London, dated Aug. 5, 1879 (102); and the Free Public Library at New Bedford, dated Sept. 11, 1879 (103?).

Letters of envoy were received from the Royal Irish Academy, dated Aug., 1879; and the U. S. Naval Observatory, dated 1879.

Letters asking for back numbers of the Proceedings were received from Trübner & Co., in behalf of the Geological Survey of India (II 15, 17, 19; IV 28, VII 62, 63, 64, X 73, XIV 92), and in behalf of two public libraries in London (XV Trans. 2, 3; Proc. 101, 102).

A letter from the Society "Amigos del Pais" of Santo Domingo, July 21, forwarded by H. Bellini, Dominican Consul, Aug. 13, requesting Trans. XVI was read.

Donations for the Library were received from the Department of Mines, Melbourne; the Observatory at Adelaide; the New Zealand Institute; the Asiatic Society of Japan; the Academies at Berlin, Rome, Bruxelles, and Boston; Prof. C. A. Dohrn of Stettin; the Geographical Societies at Paris and Bordeaux; the Museum of Natural History and Revue Politique, Paris; the Geological and Antiquarian Societies at London; Profs. G. J. Brush and E. S. Dana, of New Haven; Mr. H. C. Bolton of Hartford; the American Chemical Society; the North American Entomologist; the Franklin Institute, Journal of Pharmacy, College of Physicians, and Medical News; the Departments of War, Engineers, and Agriculture, at Washington; the Observatory at Mexico; and Dr. Hugo von Meltzel, Koloszvar, Hungary.

A communication was read entitled, "The Cosmogony of Laplace. By Daniel Kirkwood." (See page 324.)

A communication was read entitled, "The Philosophy of the Biblical Account of the Creation. By Aug. R. Grote, A. M." (See page 316.)

On motion it was resolved that the Hall Committee be authorized to provide additional shelving for the Library.

And the meeting was adjourned.

Stated Meeting, October 3, 1879.

Present, 9 members.

Vice-President, Mr. ELI K. PRICE, in the Chair.

A letter accepting membership was received from Mr. B. B. Comegys, dated Philadelphia, Sept. 27, 1879.

A letter of acknowledgment was received from the Royal Geological Society of Ireland (101 : Cat. III).

Letters of envoy were received from the Botanical Garden at St. Petersburg, Sept. 1; the Harvard College Observatory, Sept. 15: the Flora Batava, per the Consul-General of the Netherlands, New York, Sept. 25; and the New York State Library, Sept. 19, 1879.

Donations for the Library were received from the Botanical Garden at St. Petersburg: the Flora Batava: the Annales des Mines, and Revue Politique; the Commercial Geographical Society at Bordeaux: Harvard College Observatory: Prof. O. C. Marsh: the American Chemical Society; the New York University; the Engineering and Mining Journal: the Brooklyn Entomological Society; Botanical Gazette; and the American Journal of Pharmacy.

A communication was received, entitled, "Additional Notes upon the Collection of Coins now on exhibition in the Pennsylvania Museum and School of Industrial Art, Memorial Hall, Fairmount Park, Philadelphia. By Henry Phillips, Jr." (See page 327.)

Mr. Lesley exhibited a mounted set of uncolored proof sheets of the contour curve map of Morrison's Cove, Canoe Valley and contiguous region to the west, extending to the crest of the Alleghany Mountain, in Blair County, surveyed and drawn by Mr. H. N. Sanders, Assistant Geologist on the Second Geological Survey of Pennsylvania, and executed on stone by Mr. Julius Bien, of New York, for publication in Report of Progress T, by Mr. Franklin Platt, Assistant Geologist. He pointed out its most striking topographical and geological features.

Pending nomination No. 885 was read.

On motion, the Librarian was authorized to complete the printing of the Catalogue.

And the meeting was adjourned.

Stated Meeting, October 17, 1879.

Present, 18 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Belgian Academy (102, 103) and the Royal Zoological Society in Amsterdam (102, 103).

Donations for the Library were received from the Victoria Mining Bureau; Russian Academy; Revue Politique; Victoria Institute; Royal Asiatic Society; Cobden Club; Harvard College; Silliman's Journal; Prof. Newberry; Engineering and Mining Journal; North American Entomologist; Franklin Institute; Journal of the Medical Sciences; Medical News; U. S. Departments of the Navy and Education; Mr. A. R. Grote; Mr. Philip H. Law, and the Ministerio de Fomento.

The death of Henry C. Carey, at Philadelphia, on the 13th inst., in the 86th year of his age, was announced by Mr. Fraley; and, on motion, Prof. Robert Ellis Thompson, Professor of Political Economy in the University of Pennsylvania, was appointed to prepare an obituary notice of the deceased.

Dr. Le Conte, on behalf of himself and others, presented to the Society a portrait in oils of the late Joseph Henry, copied by Mr. Ulke, of Washington, from Mr. Ulke's original portrait from life, painted in 1876.

A communication was read, entitled, "On the formation of dibenzyl, by the action of ethylene chloride on benzol in the presence of aluminium chloride. By Wm. H. Greene." (See page 345.)

Mr. Lesley exhibited a photograph fac-simile of a contour map of a region of Western Pennsylvania, extending from Johnstown in Cambria County on the east and Indiana on the north, to Latrobe on the south and Greensburg and Saltsburg on the west. He described its eventful history: how it had been surveyed and drawn by himself, under orders from the President of the Pennsylvania Railway Company, for geological purposes, in 1852–3–4; lost for twenty-five years; recovered without explanation in the spring of 1879; and recently photographed in duplicate by Mr. Julius Bien, of New York, for future completion and publication in the Reports of the Geological Survey.

Pending nomination No. 885 was read and postponed, on account of the absence of its nominators.

The resolutions of Dr. Le Conte, offered May 2, and postponed from May 16, were called up for consideration and, after debate, passed (with an amendment of the third resolution), as follows:

Resolved, That the further consideration of processes for economically utilizing anthracite coal dust be indefinitely postponed.

Resolved, That the Committee appointed to investigate the subject be discharged, and the thanks of the Society be tendered to the Committee, for the industry and patience with which they have endeavored to come to a decision on the subject.

Resolved, That the prize heretofore offered by the Society for a process for the economical use of anthracite coal-dust, be withdrawn.

And the meeting was adjourned.

Stated Meeting, November 7, 1879.

Present, 9 members.

Vice-President, Mr. E. K. Price, in the Chair.

A photograph of Mr. Juhlin Dannfelt was received for insertion in the album.

A letter accepting his appointment to prepare an obituary notice of the late Henry C. Carey was received from Prof. R. E. Thompson, dated October 22.

Letters of envoy were received from the U. S. War Department Nov. 6, and Smithsonian Institution, Nov. 4.

Donations for the Library were received from M. Dannfelt, of Stockholm; the Academies at Copenhagen, Berlin and Brussels; the Vaudois Society; the Geographical Society and Political Review of Paris; Annales des Mines, and Museum of Natural History; Commercial Geographical Society at Bordeaux; Nova Scotia Institute; Essex Institute; Boston Natural History Society; Cambridge Museum; American Antiquarian Society; American Journal of Sciences; American Chemical Society, and Journal of Otology, N. Y.; Brooklyn Entomological Society; North American Entomologist; Pennsylvania Historical Society, Medical News, American Journal of Pharmacy, and Mr. H. Haupt, Jr., of Philadelphia; Second Geological Survey of Pennsylvania; Prof. Himes, of Carlisle, Pa.; the Cincinnati Society of Natural History; Dr. Saml. D. Gross; Mr. Geo. W. Ranck; the American Antiquarian, of Chicago; the Ministerio de Fomento; and the U. S. War Department.

The death of Prof. James Clerk Maxwell, of England, Nov. 5, 1879, in the 48th year of his age, was announced by the Secretary.

Dr. LeConte exhibited a piece of iron pipe much corroded and obstructed by deposit from city water during the last thirty years, as illustrating the formation of brown hematite ore beds. The pipe connected the Juniper street main with the laboratory of the U. S. Mint, and leaked from having spontaneously parted.

Pending nomination 885, and new nominations 886, 887 and 888 were read.

And the meeting was adjourned.

Stated Meeting, November 21, 1879.

Present, 12 members.

Vice-President, Mr. FRALEY, in the Chair.

A photograph of Mr. H. Phillips, Jr., was received for insertion in the album.

Letters of acknowledgment were received from the R. Society, Tasmania, Hobartstown, July 17, 1878 (99); from the R. Academy, Lisbon, July 28, 1879 (101); from the R. Observatory, Brussels, Nov. 3 (102, 103); and from the Victoria Institute, London, July 2 (102).

Letters of envoy were received from the Car. University, Lund, Aug. 15; R. Saxon Society, Leipsig, May 29; Holland Society, Harlem, June 10; and the Second Geological Survey of Pennsylvania, Nov. 17, 1879.

A letter, offering on the part of the family of the late Joseph Henry to restore for use to the Society back numbers of the Proceedings, was received from Prof. Baird, dated Smithsonian Institution, Washington, Nov. 15.

Donations for the Library were received from the Academies at St. Petersburg, Berlin, Bordeaux, Madrid, Lisbon and Dublin; the Observatory at Adelaide; the University at Lund; the R. Societies at Hobartstown, Leipsig, Göttingen and London: the Anthropological and Geographical Societies, Geological and Meteorological Institutes at Vienna; the German Geological Society; Jablownowski Society and Natural History Society at Leipsig; the Natural History Society at Bonn; Zoological Garden at Frankfurt; Holland Society at Harlem: Geographical and Anthropological Societies, and Revue Politique, Paris; Physical, Geographical and Linnaean Societies at Bordeaux; Zoological, Geographical, Meteorological and Astronomical Societies, and Victoria Institute at London; Philosophical and Literary Society at Leeds; R. Cornwall Polytechnic Society; Mr. James Henry, of Dublin; the Mining Bureau at Melbourne; the Wesleyan University, Connecticut; American Chemical Society, N. Y.; Princeton Museum of Geology and Archæology; Franklin Institute; and Pennsylvania Geological Survey.

The death of Mr. John Walter Harden, in West Philadelphia, Nov. 8, aged 63 years, was announced by Mr. Lesley, who was appointed to prepare an obituary notice of the deceased.

A communication, entitled "On Dioxyethyl-methylene, and the preparation of Methylene-chloride, by William H. Greene, M.D.," was read. (See page 346.)

Dr. Greene stated that a paper on the formation of *dibenzyl* by the reaction described by him at the meeting of Oct. 17, had been published by M. Silva in the Comptes Rendus of Oct. 6. Priority must therefore be granted to M. Silva, although the journal containing the results of his investigations did not arrive here until after the presentation of Dr. Greene's paper.

Mr. Haupt made a short verbal report of the progress of the extension of the U. S. Trigonometrical (Coast) Survey in Berks, Chester and Lancaster counties, Pennsylvania.

A communication, entitled "On the Coördination of the various methods of expressing thought as applied to the system of public school instruction, by Lewis M. Haupt, C. E., Prof. Civ. Eng., Univ. Pa.," was read. (See page 348.)

Mr. Eli K. Price referred to the growing use of graphical testimony in the law practice of the courts.

Mr. Briggs described the recent invention of a perpetual battery by Profs. Houston and Thompson, exhibited at a meeting of the Franklin Institute.

Notes on the etymology of ἠρακλῆς were read by Mr. Lesley.

The minutes of the last meeting of the Board of Officers and members in Council were read.

Pending nominations 885 to 888, and new nomination 889 were read.

Mr. Fraley reported the receipt of $131.81, being the last quarterly interest on the Michaux Legacy fund, due Oct. 1.

And the meeting was adjourned.

Stated Meeting, December 5, 1879.

Present, 13 members.

Vice-President, Mr. Fraley, in the Chair.

A letter enclosing a photograph for insertion in the album was received from Prof. Richard Akerman, dated Stockholm, Nov. 13, 1879.

An acknowledgment of the receipt of Proc. No. 103, was received from Professor J. J. Stevenson, dated New York, Nov. 28.

A letter of envoy was received from the Central Physical Observatory at St. Petersburg, dated Oct. 1879.

A letter was received from the Cleveland Library Association requesting exchanges.

Donations for the Library were received from the Senkenburg Society of Natural Sciences; Revue Politique; Commercial Geographical Society, Bordeaux; London Nature; Geological Survey of Canada; Boston Society of Natural History; Yale College; Mr. Redfield, of Philadelphia; the Botanical Gazette; North American Entomologist; and the Ministerio de Fomento, Mexico.

The death of M. Michel Chevalier, at Paris, Nov. 28, aged 73, was announced by the Secretary.

Mr. Moncure Robinson was appointed to prepare an obituary notice of the deceased.

Mr. Lesley exhibited a slab of roofing slate covered with casts of *Buthotrephis flexuosa*, obtained by Prof. Frazer for the Museum of the Second Geological Survey of Pennsylvania, from the Rev. Prof. Rendall, of Lincoln University, who obtained it (with several others) from a miner in the Peach Bottom slate quarries on the Susquehanna river near the Maryland State Line. The other slabs are in the York Museum, in York County, Pennsylvania. The species of fucoid was determined by Prof. Lesquereux from a careful drawing, which he pronounced sufficiently characteristic.

The great importance of this discovery in confirming the long suggested possible existence of Hudson river slates (Lower Silurian, No. 111) so metamorphosed as to be almost totally destitute of organic remains, in the so-called sub-palæozoic, hypozoic, hypazoic, azoic, or eozoic (Huronian, Cambrian, or Laurentian) belt of the Atlantic sea coast, was dilated upon and discussed by Prof. Lesley, Prof. Frazer, Prof. Cope, and Prof. Hayden. Mr. Lesley said:

Prof. Lesquereux has just determined *Buthotrephis flexuosa* on a slab of roofing slate from the quarries on the Susquehanna river near the Maryland line. This is a most important discovery. Prof. Frazer has been studying the roofing slate belt and adjoining chlorites for several years in connection with his York and Lancaster county work. He never found any traces of organic life, nor could hear of any. But he found several curious forms in the rocks across the State line in Maryland, one of which looked like a flattened *Orthoceras*. Prof. James Hall and Mr. Whitfield were disposed to consider them not organic. They have been figured for the American Philosophical Society's Proceedings and for the Reports of the Survey. These are the only fossils ever seen in that region to our knowledge. The slab of *B. flexuosa*, is in our Museum and will be figured. Prof. Frazer received it from a Presbyterian clergyman, President I. N. Rendall of Lincoln University, who got it from a miner, as part of a mass four or five times as large, the remainder of which he sent to the York Museum, York, Penna., in acknowledgment of aid from the citizens to the university. There seems to be no doubt that the slabs came from the Peach Bottom quarries as asserted.

There are two species of *Buthotrephis* known, one in the Trenton, three in the Hudson river slates, one in the Clinton. One is reported from the Devonian of Russia. Several from the Subcarboniferous remain unstudied. *B. flexuosa* is characteristic of the Hudson river. It is in the upper part of the Hudson river formation, along the foot of the Kittatiny or Blue or North Mountain, on the Lehigh river, in eastern Pennsylvania, that we have our Slatington and other roofing slate quarries; and no trap is known in the neighborhood, and no reason can be assigned for excessive metamorphosis of structure (not of lithology); but on the Maryland line, a trap dyke many miles long has been followed by Prof. Frazer, across Lancaster county, from the Peach Bottom roofing slate belt *through the Gap Nickel mine*, north-eastward into the Welsh mountains. But, as the roofing slate belt is several miles long, I can see no important connection between the trap at one end of it and its metamorphism.

Prof. Frazer feels sure that the roofing slates are part and parcel of the chlorite slate formation which makes such a show along the river for miles north of the quarries. But the structure is very obscure. To the north of the (south dipping) chlorites, a bold, double-crested anticlinal (of Tocquan creek) crosses Lancaster and York county, and is finely exposed upon the two banks of the Susquehanna river, bringing up massive gneisses, &c., evidently referable to our Philadelphia gneisses, to those of the Welsh mountains west of the Schuylkill river, and to those of the Highlands of New Jersey and New York states. The chlorite slates are always seen in this region in juxtaposition with limestones which we feel confident are No. II ("Magnesian" "Calciferous"); but the structural connection is not yet quite satisfactory. Mr. C. E. Hall is disposed to look upon them all along the Chester county "south valley hill," and across the Schuylkill into Philadelphia, and towards Trenton, as No. III (Hudson river) metamorphosed.

Everything points towards nonconformable basins or outlying patches of metamorphosed Silurians in the heart of our Azoic country of southern Pennsylvania and Maryland, and this discovery of *B. flexuosa* leaves very narrow room for further doubt on the subject.

Prof. Frazer gave a partly detailed description of the section along the Susquehanna,—an analysis of the difficulties he encountered in making out its true structure,—and the doubts which still hang over the relationship of the roofing slate belt to the chloritic, mica slate and gneissoid areas, on each side of the great Tocquan anticlinal.

Prof. Frazer said that in reference to the effect of the determination of the Peach Bottom slates as of Hudson river age, a word of explanation would make its extent clear.

The Susquehanna section was prepared carefully foot by foot with a perfectly accurate 200 ft. = 1 inch R. R. plotting in the hand. The exact position of every station (the stations were all 100 feet apart) and the outline of the shore and curves in the road were given on the plot, while the inner side of the outer rail was painted with the number corresponding to each station. Locations were therefore almost perfectly accurate. From Columbia to Turkey hill (± 5 miles south) was filled with limestone. Chlorite slates come in abruptly at Turkey hill, and last along the shore (still going south) to within a mile or so of Safe Harbor, when they gradually alter to mica schist, and beyond Safe Harbor to true gneiss. This lasts for about eleven miles, with its dips about evenly divided by the Tocquan creek, the northern portion dipping gently N. W. and the southern portion S. E. Whatever be the age of the chlorite series therefore, and whatever be the age of the Tocquan rocks, the latter interpose a limit to the extent to which a change of horizon of the former may affect the structure. The Tocquan anticlinal is too broad and flat and extensive, not to mention its strongly marked lithological characteristics, to be anything else than what it seems. Nobody can invert either of its limbs. It is a Safe Harbor to the bewildered stratigrapher; and a Mount Ararat to the ark of the propounder of theories. This welcome element of structure, however, fades out into inconclusive and rare exposures near Fishing creek, after which the chlorite series begins to appear, and continues, with numerous exposures, to a point a little less than half a mile north of Peters creek, quartz entering largely into the composition of the rocks which are otherwise highly convoluted, green and unctuous. Here come in the Peach Bottom slates with but little time for transition, and pass, after a breadth of a few hundred yards, equally abruptly, into chlorites again, and finally into a greenish chloritic quartzite, which is the northern boundary of Peters creek (when in flood). This greenish quartzite puzzled the speaker so much that in his report written two years ago, but not issued, he deemed the matter important enough to present two views of its age. He says, page 135, "The structure supposed in the section will not assign to this rock contemporaneity with the Chikis quartzite, nor form a continuity with the quartzites to be noted further down the river" (which are ascribed to Potsdam age). "But the interpretation of the stratigraphy here is of the greatest difficulty," &c., &c. Again, page 141, another structure than that adopted is given which makes "the hydromica schists in the basin of the first synclinal the lower limestone slates or hydro mica schists." Not because of any lithological considerations, however, but solely on the hypothesis that the column of formations appear in their normal order, which needs to be established.

In other words, if the Peach Bottom slates be established as of Hudson river age, the real difficulty would seem not be a stratigraphical one; for they might be supposed to be deposited unconformably on any of the older series, without the intervening members of the column. But the only difficulty—not an insurmountable one perhaps—will be to account for the alteration of the argillaceous strata characteristic of that horizon, to the highly crystalline magnesia hydromicas which remind one so much of what the speaker asks permission still to regard as the *true chlorites*—the chlorites of the South Mountain.

It is interesting in this connection, to call attention to the analysis of these Peach Bottom slates, made at my request by Mr. A. S. McCreath, at Harrisburg.

The specimen is from J. Humphrey & Co.'s Quarry, half a mile east of Delta, York county.

Silicic Oxide (SiO^2)	55.880
Titanic Oxide (TiO^2)	1.270
Sulphuric Oxide (SO^3)	0.022
Alumina (Al^2O^3)	21.849
Ferrous Oxide (FeO)	9.033
Manganous Oxide (MnO)	0.586
Cobaltous Oxide (CoO)	trace
Lime (CaO)	0.155
Magnesia (MgO)	1.495
Soda (Na^2O)	0.460
Potash (K^2O)	3.640
*Carbon (C)	1.794
Water (H^2O)	3.385
Iron Bisulphide (FeS^2)	0.651
Total	99.800

Mr. McCreath added a note which is not at hand, but to the effect that he believed this 1.794 p. c. of carbon (so common an ingredient in Hudson river rocks) was not in the form of graphite.

Carbon might be looked for lower as well as higher than the horizon assigned to the chlorite series, but, if the former, it would be more likely to appear as graphite.

The following extracts from a letter of President Rendall to Professor Frazer, in answer to further inquiries as to the genuineness of the fossil, are of importance in view of the length of time which may possibly elapse before another specimen is brought to light.

In 1875, I visited the quarries in company with Dr. S. B. Howell of Philadelphia. .... I am not certain whether he obtained a specimen at that time. I think he did of the rock but not of the fossil. I went from quarry to quarry inquiring of the old workmen and of the owners, whether they had at any time seen any marks on the slate. The answer for the most part was no; but two of the more experienced workmen said they had noticed some marks, but they had a vague notion of them, and could not give an adequate description. They thought they had seen them recently, and searched some piles of slate without success.

I left an order with them to preserve for me any specimens which might turn up. They promised in a friendly way to keep whatever might be found. There was no promise of money. They did not expect reward, and had no reason to procure specimens to deceive, unless for the pleasure of deceiving. They were to notify the resident Pres. minister who promised to take possession for me. In a little while they sent word to him that they had found some marks on a slab. He omitted to go for it, or to notify me,

* Average of three determinations.

and after keeping it for some time, they threw it out among the rubbish. In 1876 (in the fall), I was on the ridge myself, and went to each of the quarries, and learned what I have just written; and at one of the quarries the superintendent said they had found a few days before a slab with some marks on it, and had thought of me, but not seeing that the marks were indicative of anything especially interesting, they had thrown it away over the edge of the rubbish pile. The superintendent called three or four workmen, and directed them to search for the block which he said could not be buried very deep.

We threw the top pieces over, rolling them further down, and in perhaps half an hour came upon the piece they were looking for, and with it the piece which is in your possession. All the indices are in favor of its origin in the quarry at Peach Bottom. There was the first report that certain marks had been seen, but that they were rare. The workmen were not in the habit of finding and holding for sale specimens of the rock. These specimens were not regarded as interesting or valuable, but were thrown away, and only recovered as I have said. The block I speak of must have weighed, as I saw it, not less than seventy-five pounds.

The State geologist has the opportunity of identifying the slate on which the stems of the fucoid are with the slate of Peach Bottom, or of some other locality. Until some evidence is obtained that ends all doubt, this would be a confirmatory mark. The slate at Peach Bottom is not identical with the Lehigh slate. But I have no doubt the evidence on the spot can be made sufficient. The fossil is rare. Any one might have to wait there a long time to see one. ...... I do not know the name of the men, who found the piece for me, but I can get them by correspondence. ....

Prof. Cope presented a communication entitled, "Second contribution to a knowledge of the Miocene Fauna of Oregon."

The paper for the Magellanic premium being called up, and no report from the Board of Officers presented, a special meeting of the Board was ordered; and on motion of Mr. Briggs, it was resolved that a Committee of five be appointed by the Chair for considering and reporting upon the value of the claim. The Chair appointed Mr. Briggs, Prof. Chase, Prof. Kendall, Prof. E. H. Houston, and Mr. Coleman Sellers.

The Treasurer's annual report was read and referred to the Finance Committee.

Pending nominations Nos. 885 to 889, and new nominations 890 to 892, were read.

And the meeting was adjourned.

Second Contribution to a Knowledge of the Miocene Fauna of Oregon. *By E. D. Cope.*

(Read before the American Philosophical Society, December 5, 1879.)

Two contributions to the present subject have been heretofore made by the writer, viz., in the Proceedings of the American Philosophical Society, for November, 1878; and in the Bulletin of the U. S. Geological Survey of the Territories for February, 1879. In the latter article thirty-eight species of vertebrata were enumerated as having been discovered in the Truckee beds of the White River formation of Oregon, of which all but one were mammalia.

I have since conducted explorations in that region, the expeditions being mostly under the direction of Jacob L. Wortman. This gentleman has obtained a great many specimens, several of which indicate new species, which it is the object of the present article to describe. In addition to these discoveries, Mr. Wortman has sent remains of *Lacertilia* and *Ophidia*, orders previously unknown in Oregon. I had discovered them in the White River formation in Colorado in 1873.

Hesperomys nematodon, sp. nov.

This rat is represented by a beautiful skull, discovered by Prof. Thomas Condon, of Eugene city, and by several jaws, and other fragments subsequently found by Mr. Wortman.

The frontal region is not contracted as in *Eumys elegans* and *Fiber zibethicus*, but the superciliary ridges are well separated from each other, as in *Hesperomys americanus*. The frontal and posterior nasal regions are slightly concave in transverse section. The molars display tubercles on one side, and crescents on the other, the former being external in the superior series. The first superior molar has an additional tubercle at its anterior extremity. The incisors have a transverse anterior face, which is divided by several delicate ridges.

Length of superior molar series, .0065; length of first superior molar, .0028; interorbital width, .0042. Length of inferior molar series (specimen No. 2), .0064; length of first molar, .002; width of incisor, .001; depth of ramus at second molar, .004.

Sciurus vortmani, sp. nov.

Like the *S. relictus*, of the Colorado White River beds, this is a rare species, being only represented by a mandibular ramus in my collection. This part is remarkable for its depth as compared with its length; and the base of the coronoid process has an anterior position. It rises opposite the posterior part of the third molar, and its anterior border descends to a point just below the posterior part of the first molar. The inferior border of the masseteric fossa is a prominent edge, which descends below the inner inferior margin of the ramus. The molars diminish regularly in size forwards; their crowns are basin-shaped, with the anterior angle of the external border elevated, and the inner border notched medially. Incisor compressed.

Length of inferior molar series, .010; antero-posterior diameter of first molar, .0024; length of fourth molar, .003; depth of ramus at diastema, .0055; depth at third molar, .0095.

This species is considerably larger than the *S. relictus*. It is dedicated to Jacob L. Wortman, of Eugene, Oregon, a successful explorer of the paleontology of that State.

PACICULUS INSOLITUS, gen. et sp. nov.

Char. gen. Superior molars three, rooted. Enamel forming three entrant loops on the external face of the crown, and one on the internal face.

While the number of the superior molars of *Paciculus* is as in the *Muridæ*, the details of their structure is much as in *Dasyprocta* and *Stenofiber*. But one species is known.

Char. spec. Size small. Molars regularly and rapidly diminishing in size posteriorly. Inner enamel loop turned forwards; the external straight and transverse, excepting in the first molar, where the anterior column of the tooth is extended forwards, and the anterior loop is turned backwards.

Length of superior molar series, .006; length of first molar, .0021; width of first molar, .0018; length of third molar, .001.

CANIS LEMUR, sp. nov.

This species is represented by several crania in my possession. It is the smallest of the genus yet discovered in the Miocene formation of Oregon. It is characterized by the contracted proportions of the muzzle, the width of the front, and the large size of the eyes. The postorbital process is only a short angle. The superior border of the temporal fossa is traceable from the postorbital process. Those of opposite sides embrace a smooth sagittal area of an elongate urceolate form, and unite posteriorly in a very short crest. The species is further characterized by the large size of the first superior tubercular molar, which with the second, has a distinct inner cingular border, and median tubercle. The superior sectorial is short, and its inner cusp is anterior.

Some mandibles probably belonging to this species exhibit posterior cutting lobes on the third and fourth premolars. The blades of the sectorial are very short, and the heel large and wide. The tubercles of the tubercular are large.

Length of cranium to front border of orbit, M. .0525; elevation of occiput, .058; length of superior sectorial, .007; length of first tubercular, .0058; width of first tubercular, .0078; width of second tubercular, .005; length of second tubercular, .0035; interorbital width of second specimen, .0056; length of inferior dental series, .048; length of sectorial, .008; length of heel of sectorial, .0035; length of inferior tubercular, .055; depth of ramus at sectorial, .0105.

This species is smaller than *Canis gregarius*, and differs from both it and the C. *cuspigerus* in the larger orbits, more contracted muzzle, and in the distinct superior border of the temporal fossa, etc.

The dog which I referred to the genus *Enhydrocyon* (Cope) under the name of *E. basilatus*, probably belongs to another genus. Portions of the maxillary bone present the dentition of *Icticyon*, viz., P-m. 4, M. 1, thus differing from *Enhydrocyon*, which possesses P-m. 3; M. 2. As there are but three premolars in the inferior series, this species cannot be referred to *Icticyon*, but must be accepted as typical of a new genus. This I propose to call *Hyænocyon*. It resembles *Hyæna* more nearly than any genus yet discovered in North America, but probably belongs to the *Canidæ*.

AMPHICYON ENTOPTYCHI, sp. nov.

This rather small species is represented by a skull which lacks the extremity of the muzzle and the mandible, and has its parietal region crushed.

The superior premolar teeth are rather short in anteroposterior diameter, while the tubercular molars are relatively large. There are no posterior lobes on the former; the internal and external cingula are well developed in the first and second of the latter. The third tubercular is about as wide as the second is long. The sagittal crest is only distinct on the posterior part of the parietal region. Estimated length of skull, M. .110; length of superior molar series, .041 ; length of true molar series, .016 ; length of first tubercular, .0075 ; length of second tubercular, .055 ; width of second tubercular, .0074 ; length of third tubercular, .0036; width of third tubercular, .052 : Length of sectorial width between anterior external angles of first tuberculars, .030.

The teeth of this species are about half the size of those of *A. vetus* Leidy.

ARCHÆLURUS DEBILIS Cope.

American Naturalist, 1879, p. 798*a*, December.

Char. gen. Dentition, I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{3}$; M. $\frac{1}{2}$; mandible with the anterior face of the symphysis separated from the lateral face by an angle which is not produced downwards. Superior sectorial without anterior lobe; inferior sectorial with heel. The characters place *Archælurus* at the base of the *Felidæ*, showing that it is the most generalized form yet known, and about equally related to the feline and Machærodont series.

Char. specif. General structure of the jaws weak. Superior canine small, little compressed, with an acute posterior edge which is not serrulate. First premolar in each jaw one-rooted ; second inferior premolar large ; sectorials large, diastemata very short. Alveolar border below the inferior sectorial and tubercular teeth everted, forming a large osseous callus, which has a free inferior and posterior margin, the latter rising into the base of the coronoid process. Zygomata slender ; postorbital processes little prominent ; front wide, convex transversely.

Length of cranium, M. .200 ; superciliary width, .052 ; zygomatic width, .124 ; length from orbit to superior incisors, .066 ; length of superior sectorial, .023 ; length of inferior molar series, .061 ; diameter of superior canine, .012. About the size of the panther, or of the *Nimravus brachyops*.

The osseous callus below the true molars is a remarkable character, unique in the order of *Carnivora*. It is evidently a provision against the weakness of the mandibular rami, at the point of greatest strain.

Hoplophoneus platycopis Cope.

American Naturalist, 1879, p. 798*b*, December.

This is the largest sabre tooth discovered in North America. It was twice the bulk of the *H. primævus* Leidy, and differs from that species and the *H. occidentalis* in the relatively larger size of the premolar teeth, which are less obliquely placed than in the latter. The first superior premolar is very small. The canine is large and compressed as in the species of *Machærodus*, and has serrulate posterior and anterior cutting edges. Inferior incisors with conic crowns. The symphysis is very deep in consequence of the large development of the inferior flares for the canines. Sagittal crest making a steep angle with the front.

Total length of cranium, M., .280; zygomatic width, .192; length from orbit to superior incisors, .095; length of inferior sectorial, .025; of inferior sectorial, .022; length of inferior molar series, .055; length of crown of superior canine, .060; width of superior canine at base, .026. This skull is less than one-sixth smaller than that of the Bengal tiger (*Uncia tigris*).

Chænohyus decedens, gen. et sp. nov.

The characters of this genus will be best understood by comparison with those of the two other genera of suilline animals which occur in the same formations.

Premolars three, a wide diastema between the anterior one and its successor.. *Chænohyus.*
Premolars four; diastemata before and behind the first ... *Thinohyus.*
Premolars four, in a continuous series.................. *Palæochœrus.*

It is then apparent that *Chænohyus* differs from *Dicotyles* in having the diastema behind the anterior premolar instead of in front of it.

Char. spec. This hog is represented in the collection of Prof. Condon at Eugene City, Oregon, by the anterior part of a cranium, which includes both maxillary bones. Its size is a little less than that of the *Dicotyles torquatus*. The series of maxillary teeth is slightly convex externally, and the teeth diminish rapidly in size anteriorly. The difference in dimensions between the first and last true molars is much greater than in the other suillines of this period known to me. The external tubercles of the true molars are somewhat flattened externally, and a distinct cingulum passes entirely round their external bases. The first superior premolar has one root, the other premolars possess two.

I suspect that the *Dicotyles hesperius* of Marsh belongs to *Chænohyus*. It differs from the *C. decedens* in its materially smaller size. According to Marsh, it is considerably smaller than his *Thinohyus socialis*, which is about as large as the *C. decedens*.

Discovered by Prof. Condon in the region of the John Day river.

Thinohyus trichænus, sp. nov.

Represented by the greater part of the maxillary and mandibular bones of both sides, with teeth.

There is a diastema behind the second inferior premolar, about equal in extent to that in front of it, which is twice as wide as the one in front of the first premolar. The first and second premolars have but one root, while the two others have two. The first superior premolar is close to the canine, and has but one root; it is separated by a diastema from the second. The latter has one root, and is near the third, which has two roots. The third and fourth superior premolars have each one compressed external, and one internal lobe. That of the third is lower and is pressed against the external. It is continued as a ridge posteriorly, enclosing a shallow basin with the external tubercle.

The true molars of both jaws have the intermediate tubercles well developed. The external tubercles of the superior molars are not flattened, and have a low cingulum surrounding their bases. Surface of enamel nearly smooth. Length of true molar series of upper jaw, M. .046; of last superior molar, .017; width of do., .013. Diameter of first true molar,—anteroposterior, .012; transverse, .011 Length of posterior three premolars along base, .028; of diastema, .011. Length from inferior canine to third inferior premolar, .028; length of diastema anterior to second premolar, .008; do. of diastema posterior to second premolar, .007.

This is the species I formerly called *Palæochærus condoni** Marsh (*Platygonus* Marsh). That species belongs to the Loup Fork fauna, and not to the present one. Some teeth which probably pertain to it in Prof. Condon's collection, exhibit the peculiarity of not possessing any basal cingula on the molars of either jaw.

From the fact that Pomel† implies that some of the species of *Palæochærus* present a diastema, I have referred the *Thinohyus* of Marsh to it as a synonym.‡ Pomel's genus was, however, established on a species (*P. typus*) which has no diastema, hence *Thinohyus* is probably to be preserved.

This species is about the size of the *Thinohyus lentus* of Marsh, and agrees with his descriptions in several respects. There appears, however, to be a material difference between the specimens in the relations of the inferior premolars. Marsh describes a much more considerable diastema in front of the first premolar, and does not mention the one behind the second premolar. I am acquainted with a second species of the genus of about the same size, in which there are but two diastemata, viz., one before and one behind the first premolar, and I suppose this one to resemble the *T. lentus*. Specimens of this character are in my collection, and I have seen one in that of Prof. Condon.

PALÆOCHŒRUS SUBÆQUANS, sp. nov.

This suilline is represented by an entire cranium which was discovered by Prof. Condon. It indicates a species of the size of the *Dicotyles torquatus*, and smaller than the *Thinohyus trichænus*.

The first true molar is not disproportionately smaller than the third; and

* Bull. U. S. Geol. Surv. Terrs., 1879, V, p. 58.

† Catal. Vertebr. Foss. Basin Loire, 1853, p. 86.

‡ Bull. U. S. Geol. Surv. Terrs., 1879, V, p. 44.

there is a distinct cingulum at the external base of the superior true molars. The external faces of the external tubercles of these teeth are somewhat flattened. The first premolar has one root, the others have two. They are equidistant and not very closely crowded.

Several suillines are described by Marsh and Leidy, either imperfectly or from imperfect material, so that I have had some difficulty in determining my specimens. The *D. hesperius* of Marsh is probably, as above observed, a *Chænohyus*. I have specimens agreeing with Marsh's description of *Thinohyus socialis*. They belong to an animal of the size of the *Chænohyus decedens*, but the superior molars have no basal cingulum. Its generic position is yet uncertain. Other specimens agree in characters with the *Dicotyles pristinus* of Leidy, with which *Thinohyus lentus* of Marsh agrees in size. In this hog there is no diastema in front of the third inferior premolar, so that it is clearly distinct from the *Thinohyus trichænus* of the present paper.

MERYCOPATER GUIOTIANUS Cope.

Having obtained several crania of this species, I can give the characters of the genus *Merycopater** more fully than hitherto. Dentition; I. $\frac{1-2}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$. A diastema above and below; fourth superior premolar with two external crescents; fourth inferior premolar identical in form with first true molar; the first inferior premolar functionally the canine. Orbit open posteriorly; no facial fossæ or vacuities.

This genus is *Agriochœrus*, with a considerable diastema, and very much reduced superior premaxillary teeth. In my best preserved cranium there is no alveolus for the first; that of the second is rudimental, and that of the third is small. The premaxillary bones are very small and distinct from each other. The enlargement of the cingula represents the posterior internal tubercle of the fourth superior premolar, so distinct in *Coloreodon*.

The deficiency in superior incisors is an interesting approximation to true ruminants not heretofore observed in *Oreodontidæ*. I have found the inferior incisors deficient in the genera *Cyclopidius* and *Pithecistes*.

COLOREODON FEROX, gen. et sp nov.

Char. gen. Dentition, I. ?; C. ^{1}; P-m. ^{3}; M. ^{3}; a wide diastema above; the first inferior premolar functionally the canine. Last superior premolars with two external and two internal crests Orbit open posteriorly; no facial fossæ or vacuities. The genus differs from *Agriochœrus* in the wide diastemata, presence of but three superior premolars, and two inner tubercles of the fourth premolar.

I possess two species of this new genus, which are represented in my collection by crania without premaxillary bones and mandibles.

Char. specif. Size of *Oreodon culbertsoni*. Maxillary bone excavated above the diastema, the superior border of the concavity extending nearly to the base of the zygoma. Zygomatic arches expanded, their external face concave below the orbit, and plane posteriorly. Saggittal crest very

* Cope, *American Naturalist*, 1879, p. 197.

high, dividing anteriorly into two ridges, which diverge widely, and terminate at a point opposite the postfrontal process. The space enclosed in their angle is plane. Space between supraorbital foramina convex.

The posterior internal tubercle of the fourth premolar is much smaller than the anterior; the inner basal tubercles of the second and third are subposterior and acute. The length of the diastema is equal to that of the premolar series. The enamel of the molars is wrinkled. The canines are robust.

Estimated length of skull, M. .200; length of superior molar series, .066; of diastema, .028; diameters of second true molar, — anteroposterior, .016, transverse, .017; width of palate at do., .033; interorbital width, .060.

The strongly developed crests and wide zygomata of this animal, together with the large canine teeth, evidently indicate that it was a formidable antagonist even for the *Carnivora* of its time.

Discovered by Charles H. Sternberg.

COLOREODON MACROCEPHALUS, sp. nov.

This Oreodont is considerably larger than the *C. ferox*, being of the size of the *Eucrotaphus major*, while the former equals the *Oreodon culbertsoni*. It also differs from its congener in the relatively longer and narrower frontal region. The sagittal crest is elevated, and divided into two crests opposite the posterior part of the zygomatic fossa. These branches are nearly straight, and diverge at an acute angle, terminating above the postorbital processes. They enclose a deep concavity, which is continuous with the front anteriorly. In *C. ferox* these crests diverge much more abruptly and widely from a more anterior point, and enclose a much smaller concavity. The supraorbital foramina are close together and are separated by a small protuberance of the middle line. The parietal walls of the temporal fossa are rugose. The posterior tubercle of the fourth premolar is well developed, while a single tubercle is present on the preceding premolar.

Length of cranium from inion to above superior canine, M. .230; length from superior canine postorbital angle (axial), .124; length from junction of crests to supraorbital foramina, .060; interorbital width, .072; length of bases of the molars except the last, .050; length of three premolars .027. Length of diastema, .030.

From the North Fork of John Day River; found by J. L. Wortman.

Stated Meeting, December 19, 1879.

Present, 10 members.

Vice-President, Mr. FRALEY, in the Chair.

A letter of acknowledgment and envoy was received from the Linnæan Society, London, Oct. 20 (99, 100, 101; XV, 2).

Letters of envoy were received from the Batavian Society of Arts and Sciences, Feb. 23, 1877, and April 15, 1878; from the Royal Observatory, Brussels, April, 1879; from the Bunker Hill Monument Association, Boston; and from the Society of Geography and Statistics, Mexico, Nov. 17, 1879.

A letter requesting cabinet exchanges was received from the Bridgeport Scientific Society, Conn., Nov. 20, 1879.

Donations for the Library were received from the Asiatic Society of Japan; Royal Society, Victoria; Batavian Society, Batavia; M. Joachim Barrande, Prag; the Academies at Berlin, Munich, Brussels, and Philadelphia; the German Geological Society; Zoologische Anzeiger, Leipsig; Societies at Bonn, St. Gall, Cherbourg, Cambridge (England); the Commercial Geographical Society at Bordeaux; Geographical and Statistical Society, Mexico; Geographical Society, Paris; Geological, Geographical, Zoological, Linnæan, and Antiquarian Societies, Victoria Institute and Nature, in London; Dumfrieshire and Galloway A. N. H. Society; Bunker Hill Monument Association and Natural History Society, Boston; Silliman's Journal; Brooklyn Entomological Society; Journal of Pharmacy, Medical News, and Mr. Henry Phillips, Jr., Philadelphia; Peabody Institute, Baltimore; Smithsonian Institution; Milwaukee Public Library; and National Museum, Mexico.

A bronze medal for the cabinet was received from the

Batavian Society, with the inscription:—SOCIETAS . ART . SCIENT . BAT . IN . MEMORIAM . I . SAEC . FEL . CLAUSI . in a wreath, and around the margin A.P. VIII . X . MAI . MDCCLXXVIII—MDCCCLXXLVIII . ——— On the reverse, a palm, labeled on its trunk ‡; mountains in the background; marginal legend: TEN NUTTE VAN'T GEMEEN BATAVIA'S GENOOTSCHAP.

Mr. Chase communicated a note on the Sun's apparent diameter and the nebular origin of the terrestrial day.

Dr. Horn communicated two papers: 1. "A monographic revision of the species of *Cremastochilus* of the United States;" 2. "A Synopsis of the *Euphoridæ* of the United States." With one plate.

Mr. Hale gave an interesting verbal account of his acquaintance with the various Indian tribes collected on the Canadian reservation at Brantford, east of London, Upper Canada; of the most distinguished surviving chief of the Six Nations, Sakayenkwaraton (disappearing mist), known to the English as John S. (smoke) Johnson, now 87 years old. His son, Chief George Johnson, bears the official title of the one of the original 50 council chiefs whom he represents.

Mr. Hale described the formation of the confederation, three centuries ago, and testified to the accuracy of Mr. Morgan's history of it.

He then described the *Book of Rites*, which after two centuries of verbal tradition was reduced to writing by some one connected with the early missions. Two copies exist, and Mr. Hale is obtaining a translation of it. It is the only known American aboriginal piece of literature, north of Mexico. It has many archaic words, and is engrossed, in an old-fashioned current English hand, in a common schoolboy's copy book.

He then described the Wampum belts of the confederation, partly preserved by the Onondagas in New York, and partly among the Indians in Canada.

He also told of his discovery that the Tutelos were not an Iroquois tribe, but were allied to the Dakotahs or Sioux of the West. Their first seat was in North Carolina. Brainard reported that Tutelos, Iroquois and Delawares lived together at Shamokin, Pa., speaking three entirely different languages. The syntactical position of the personal pronoun before, after, or between any two syllables of the verb allies the Tutelo language with the two dialects of the Dahcotah, and separates it from all the other Indian dialects. But Tutelo seems to be older than the Dahcotah. So also Huron (Quebec) was older than Iroquois (Six Nations); and Delaware older than Chippeway. It looks as if the movement was from east to west, and not from west to east.

Repeated questions from the members present elicited many curious and interesting personal details from Mr. Hale, who hopes to have before long a memoir ready for publication.

Pending nominations 885 to 892, were read.

The Minutes of a special meeting of the Board of Officers and Members in Council were read, and the claim for the Magellanic premium was referred to the Committee appointed at the last meeting of the Society.

The Report of the Trustees of the Building Fund was read, dated December 16, 1879, by which it appeared that the receipts since January 30, 1877, had amounted to $2882.04; and that the Fund now consists of assets to the value of $12,586.50. Signed, Benj. V. Marsh, Treasurer; Eli K. Price, F. Fraley, auditors of the Finance Committee.

The Report of the Finance Committee was read, and the appropriations for the expenses of the ensuing year, recommended in the report, were on motion, ordered.

And the meeting was adjourned.

Astronomical Approximations. I. Apparent Semi-diameter of the Sun, and Nebular Origin of the Terrestrial Day. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, Dec.* 19, 1879.)

The various mathematical deductions which I have drawn from the nebular hypothesis, as modified by Herschel's theory of "subsidence," furnish many independent tests for judging of the probable accuracy of delicate and difficult astronomical observations. The consistency of the tests may be shown by examples, one of which is given in the present note.

The hypothesis that the solar system has been shaped by undulations, moving with the velocity of light, leads to the following equation :

$$\left(\frac{1 \text{ year}}{1 \text{ day}}\right)^3 = \frac{\pi^2}{2} \times \left(\frac{\text{Earth's distance}}{\text{Sun's semi-diameter}}\right)^3$$

From this equation we find, for Earth's mean distance from Sun, 214.54 solar semi-diameters; and for Sun's apparent diameter, 32′ 2″.85. The accordance of this result with observations is as follows :

	Distance.	Diameter.	
Newcomb,	214.86	32′	0″
Chase,	214.54	32	2.85
Fuhg,	214.52	32	2.99
British Naut. Almanac,	214.45	32	3.64
American " "	214.41	32	4
Lockyer,	214.39	32	4.205

Dr. Fuhg's estimate, which approximates most closely to my own, is deduced from 6827 measurements.* Notwithstanding the vast labor which is represented by those measurements and their subsequent discussion, I cannot but believe that my own result is still more accurate. For it involves no careful micrometry, no allowance for irradiation, and no other elements of possible uncertainty than small fractions of a second, in the estimated lengths of the sidereal year and of the mean solar day.

This result may, perhaps, be rightly regarded as an *experimentum crucis*. Therefore, to avoid the trouble of referring to the papers in which I have established the data for my formula, I will repeat the fundamental considerations on which it rests.

Any body, revolving in a circular orbit, under the influence of a central force g, which varies inversely as the square of the distance, would acquire the velocity of revolution $(\sqrt{gr})$, in the time of describing an arc equivalent to radius. It would acquire a parabolic velocity $\sqrt{2gr}$, in $\frac{1}{\pi\sqrt{2}}$ of a revolution, and it would acquire $\frac{\pi}{\sqrt{2}}$ times the parabolic velocity in a half revolution, provided all the increments of the central

Astron. Nachrichten, 2010, cited in *Am. Journ. Sci.* for Aug. 1875, p. 57.

force were retained. The parabolic velocity is the limit between the tendencies to incipient aggregation and to complete dissociation, in the subsidence of dense nebulous particles.

In a body which is both revolving about the centre of a system and rotating on its own axis, every particle is subject, during each half-rotation, to cyclical variations in the systematic stress, which are antagonized by the constant central force of the body itself.

In a condensing or expanding nebula, the time of rotation varies as the square of radius. At any given instant, the squares of the velocities, or the living forces of different rotating particles, are proportioned to the squares of their radii, or to the times of nebular rotation and synchronous revolution when condensed to their respective positions.

If the velocity of synchronous rotation and revolution is determined by the aggregate resistances of the central force of the nucleus, to cyclical variations of stress which may be represented by a wave-velocity, while the velocity of rotation of a detached planet is determined by a force which may be represented by an incipiently aggregating or parabolic velocity, the representative parabolic velocity of the nucleus may be found by taking $\frac{\sqrt{2}}{\pi} gt$; g representing the force of gravity at any past, present, or future equatorial limit of the nebula, or Laplace's limit of possible rotating atmosphere, and t being $\frac{1}{2}$ the corresponding time of synchronous rotation and revolution. I have already shown that gt, in the solar system, is *the velocity of light.*

Let α represent the time of synchronous rotation and revolution when Sun's surface should contract so that Laplace's limit would correspond with its present equatorial radius; β, a mean solar day; γ, Earth's mean distance ÷ Sun's radius; δ, a sidereal year. Then $\alpha = \delta \div \gamma^{\frac{3}{2}}$; tang. Sun's apparent semi-diameter $= \frac{1}{\gamma}$.

According to Leverrier and Hansen, Earth's present aphelion, or limit of incipient condensation, is at 1.016771 rad. vec. This corresponds, within $\frac{1}{100}$ of one per cent., to Stockwell's determination of the centre of the belt of greatest condensation.* The relations between the primitive solar and terrestrial centres are thus simplified, so that the foregoing considerations lead us at once to the following equations:

$$\left(\frac{\delta}{\beta}\right)^3 = \frac{\pi^2}{2}\gamma^3$$

$$\frac{\delta}{\beta} = \frac{\pi^2}{2}\left(\frac{\beta}{\alpha}\right)^2$$

*The arithmetical mean between Mercury's secular perihelion (.2974307) and Mars's secular aphelion (1.7363251) is 1.016878.

A Monographic Revision of the Species of CREMASTOCHILUS *of the United States.*

By George H. Horn, M.D.

(*Read before the American Philosophical Society, Dec.* 19, 1879.)

In the Trans. Amer. Ent. Soc. 1871, p. 339, et. seq., will be found a table prepared by me of the species then known, after a short study, the object of which was to present some means for their identification in a ready manner, the descriptions being scattered in books, inaccessible to many, and sometimes unintelligible, either from their brevity or want of appreciation of characters which have since come to be of greater value. The above mentioned table was made use of by Prof. Westwood (in his "Thesaurus Oxoniensis," p. 58), who at the same time described a certain number of supposed new species, since which others have been described by Dr. LeConte, so that the aggregate assumed quite formidable dimensions for a genus so peculiar.

The types from which Prof. Westwood's descriptions were made are for the most part in the Royal Museum of Berlin, where I had the opportunity of examining them, through the kindness of the curator in charge. The descriptions appeared soon after my examination had been made, and left nothing to be desired for their identification.

Having had occasion to study the species more closely, I have seen no reason for any great alteration of the table already given, further than to add the new species and transpose one which seemed rather out of place. The accompanying table is, however, made so full as to contain nearly all the important characters of each species, so that the chances of a mistake in identification are reduced as near as possible to the minimum.

Before proceeding to the table it seems proper that the characters should receive more extended notice and comparison, which can be accomplished by considering the different members in order.

The head is short, oval, rather deeply inserted in the thorax, the vertex usually convex, the clypeus more suddenly deflexed, forming an angle with the front. In *planatus* and *saucius* the head is more exsert and presents in each characters worthy of special observation, these are—the carina on the middle of the clypeus common to both species, the supraorbital carinæ of the first and the sudden narrowing of the head behind the eyes in the second. In neither species is there an obtuse ridge indicating the limits of the clypeus and front, but the upper surface of the head is gradually declivous in *planatus* and very convex in *saucius*. In *pilosicollis*, *crinitus* and *Knochii* the front is rather flat and the limit between it and the clypeus is indicated by an obtuse arcuate ridge, so that the clypeus seems suddenly deflexed from the front. In *leucostictus* the front and clypeus are on the same plane, nearly flat, while all the other species not already mentioned have the front convex but to a variable degree.

The clypeus normally is not broader than the head, the margin reflexed, the anterior edge more or less arcuate, the angles rounded. In two species the clypeus is wider than the head, in *Wheeleri* conspicuously so with the angles rather acute, in *crinitus* less dilated with the angles rounded. The anterior margin is rather widely reflexed and is useful in aiding the species in their fossorial tendencies.

The mentum presents important modifications, the simplest being that of *leucostictus* or *saucius*, in which the face is quite flat and the margins narrowly reflexed. From this form the mentum becomes more concave and the sides more widely reflexed so that it becomes cupuliform. Those species with the mentum least concave have the posterior margin entire, as the concavity increases we find a slight notch, which in the last four species becomes a rather wide and deep excision semicircular at bottom. These modifications of the mentum form a very natural means of dividing the species.

The thorax is so modified in form and structure in all the species, that nearly all can be separated by it alone. The simplest form is that of *leucostictus* which resembles that of Trichius; apex feebly emarginate, sides feebly subangulate, hind angles rounded, the margin acute posteriorly, there is no incisure about the front angles nor are there any pubescent spots such as occur in every other species. In *planatus* the sides are subacutely margined, arcuate in front and gradually narrowed behind, not very unlike Iphthimus, in fact the species resembles a Tenebrionide when walking. The anterior angles are small, the notch or fovea within feeble, and there is a notch in the lateral margin which limits the angle. The hind angles are continuous with the margin, not very prominent and limited by an oblique groove within. The next modification in degree is in the *Schaumii* group, in which the thorax is broader and less depressed, the anterior angles are feeble, the fovea within them, but no lateral notch in the margin. In two of the species the hind angles are not limited by any groove and the anterior margin of the thorax beneath is not notched. In *angularis*, however, the hind angles have a limiting groove, and beneath the front angles is a slight incisure.

The three species following *angularis* do not present any very important modification of its type, the angles are nearly the same and there is the subangular incisure, but in *pilosicollis*, we observe a groove running outward from the fovea and limiting the anterior angles. This gives the first intimation of the tuberculiform angle which is observed further on.

In *nitens*, the front angles begin the nodiform structure by the greater depth of the transverse groove. The hind angles are also much retracted within the line of the sides, and the groove which limits them within is so deep that the angle is depressed below the surface of the disc of the thorax.

In passing to *variolosus*, the anterior angles become so completely surrounded by deep grooves as to become almost like isolated tubercles, and may be assumed to be the result of the gradual exaggeration of the various grooves and incisures mentioned in the preceding forms. In *Harrisii* the anterior angles are rather broad and more obtuse than in any of the species described and the incisure beneath them is very feeble.

Of a totally different type of thorax we must consider *saucius* and *Wheeleri*, which require special mention. These have the disc of three parts, a central more depressed portion and the lateral more convex, which may be compared with Hetærius or Plegaderus. The division is best marked in *saucius*. The region of the anterior angles in this species presents a curious modification, in which the anterior angles appear to be auriculate, but this is really an extension upward and forward of the anterior margin or collar of the thorax, and corresponds in homology with that portion of the under side of the thorax of the other species which is below the incisure. The true anterior angle will be observed in the figure behind the auriculate process. The hind angles are spiniform, their structure will be observed in the figure. In *Wheeleri*, the tripartite character is less observable. The anterior angles do not depart much from the normal type, and the incisure beneath is well marked. The hind angles are broad but obtuse, and have a feeble trace of an oblique limiting groove. This species deserves mention as being the only one with the middle coxæ absolutely contiguous and the prosternum behind the coxæ slightly elevated.

The legs also vary to an important extent, and will be found described with each species. The tarsi follow the modifications of the legs, and, from being as long as the tibiæ, are reduced to even less than half that length in *Schaumii*. As a rule the shorter the tarsi the more compressed do they become, the only exception being in *leucostictus*, which with short tarsi has the upper side flat, so that the transverse section of a joint would be an isosceles triangle.

The distribution of the species in accordance with the form of the mentum is well known. Those with the mentum entire belong from the eastern base of the Rocky Mountains to the Pacific Coast, there being but one exception, *leucostictus*, from Maryland. Where the mentum is notched or deeply emarginate, the species belongs to the Atlantic fauna, most of them having a wide range of distribution, except in the case of *squamulosus*, which is limited to Georgia and Florida.

In the accompanying table and descriptions there is very rarely any mention made of the hairs of the surface. These exist to a greater or less extent on all the species, but are very easily removed and are therefore of uncertain value. So also with the spots of whitish exudation which I have observed to a greater or less extent on *leucostictus*, *pilosicollis*, *angularis*, *Schaumii*, *Westwoodi*, *canaliculatus*, and *castaneæ*. These have all been observed in ants' nests.

Mentum plate entire behind.

Anterior tarsi with last two joints thickened.

Clypeus carinate at middle, head with lateral carinæ above the eyes prolonged backward in obtuse processes.......... **planatus** Lec.

Anterior tarsi not thickened, more slender at tip.
  Disc of thorax trilobed.
    Clypeus carinate at middle ; tibiæ slender at base......**saucius** Lec.
    Clypeus not carinate, broader than the head ; middle and posterior tibiæ broad and flat; middle coxæ contiguous...**Wheeleri** Lec.
  Disc of thorax simple, not trilobed.
    Hind angles of thorax rounded, the margin posteriorly acute ; tarsi very short and flat above..................**leucostictus** Burm.
    Hind angles of thorax more or less prominent.
      Legs and tarsi short, the former decidedly fossorial, the latter much compressed.
        Tarsi very short, less than half the tibiæ, hind angles continuous with the disc.........................**Schaumii** Lec.
        Tarsi longer than half the tibiæ.
          Hind angles continuous with the disc.....**Westwoodi** Horn.
          Hind angles limited by an oblique groove.....**angularis** Lec.
      Legs ambulatorial, tarsi as long as the tibiæ.
        Hind angles continuous with the side margin.
          Front angles smooth, limited behind by a transverse impression...............................**pilosicollis** Horn.
          Front angles continuous with the disc, punctured.
            Clypeus wider than the head................**crinitus** Lec.
            Clypeus not expanded......................**Knochii** Lec.
        Hind angles strongly retracted. Surface shining...**nitens** Lec.
Mentum plate with a small acute incisure behind,
  Hind angles of thorax much retracted, anterior angles prominent and distinct from the disc............................**variolosus** Kby.
  Hind angles feebly retracted, anterior angles continuous with the disc.. **squamulosus** Lec.
Mentum plate with a deep emargination at the middle of the posterior margin.
  Disc of thorax coarsely and densely punctured. Surface opaque.
    Anterior angles of thorax continuous with the disc.
      Hind angles feebly retracted, continuous at the outer margin with the disc.................................**canaliculatus** Kby.
      Hind angles strongly retracted, depressed below the surface of the thorax...................................**retractus** Lec.
    Anterior angles separated from the disc by a transverse impression, hind angles feebly retracted but depressed beneath the surface of the disc. ....**castaneæ** Kn.
  Disc of thorax sparsely and irregularly punctured.
    Anterior angles short, obtuse, hind angles moderately retracted and slightly depressed..............................**Harrisii** Kby.

In the above table *Wheeleri* is placed in the series with entire mentum, although that organ is usually, but not always incised posteriorly. It would be decidedly out of place anywhere else, when the aggregate of its construction is taken into account.

C. planatus Lec.

Elongate, black, sub-opaque. Head densely punctured, clypeus subtruncate in front, angles rounded, margin moderately reflexed, a short carina at middle, vertex above the eyes obtusely carinate, the carina prolonged backward in a pyramidal process, occiput deeply transversely impressed. Mentum plate transversely oval, pointed behind, the sides and posterior margin reflexed, the anterior margin thickened. Thorax broader than long, narrower at base, sides in front arcuate, posteriorly oblique, margin subacute, anterior angles nodiform, excavated in front, the concavity pubescent, posterior angles moderately prominent, smooth, limited within by a distinct groove, surface coarsely punctured and with a vague median groove. Elytra flat, the disc limited by an obtuse ridge, vaguely bicostate, and moderately closely sculptured with elongate punctures. Pygidium obtusely carinate surface with coarse ocellate punctures. Body beneath with very coarse punctures, less dense on the abdomen. Legs slender, moderately long, anterior tibiæ bidentate near the tip, the middle and posterior unispinose at middle, tarsi slender, at least as long as the tibiæ, the anterior with the last two joints suddenly thickened. Length, .66–.72 inch ; 17–18 mm. Pl. iv., fig. 1.

This species is one of the most peculiar in the genus from the length of the legs and the structure of the anterior tarsi. The latter character is not sexual, the female possessing it to an extent as great if not greater than in the other sex.

With this species I have united *depressus* Horn, founded on a specimen in which the hind angles are wanting by accident or deformity.

Arizona, Dr. Irwin ; southern coast-range of California, W. M. Gabb.

C. saucius Lec.

Castaneous or piceous, shining. Head sparsely punctured, widest at the eyes and rapidly narrowing behind them, clypeus oval in front, anterior margin broadly reflexed, at middle a strong carina, vertex convex without carinæ. Mentum flat, sides and posterior margin narrowly reflexed. Thorax broad, as wide as the elytra, surface of three parts, the middle less convex, and the sides more convex, forming a broad thickened border as in *Heterius*, anterior angle auriculate, separated from the thickened margin by a deep fissure, sides moderately arcuate, near the hind angles suddenly sinuate, the angles acute, surface sparsely punctured. Elytra slightly narrowed posteriorly, moderately convex, disc at middle vaguely impressed, surface sculptured with short strigæ. Pygidium finely punctured. Body beneath very sparsely and rather finely punctured. Lègs sub-fossorial, the femora broad and compressed, anterior tibiæ with the outer apical angle prolonged, and with a tooth at middle, middle and posterior tibiæ compressed, slender at base, gradually broader toward the tip, a spine at middle of outer margin ; tarsi slender and except the posterior as long as the tibiæ. Length 44–.52 inch ; 11–13 mm. Pl. iv, fig. 2.

A specimen which Mr. Ulke has loaned me is larger and darker in color than any other I have seen, its mentum is not pointed behind nor have the four posterior tibiæ the spine at middle, it, however, agrees in all other important particulars, and I take it to be an abnormal specimen, especially as there are three sets of claws on the left anterior tarsus, pl. iv, fig. 11. The trilobed form of the thorax is certainly a very remarkable character which at once suggests the similar structure of *Hetærius*.

Occurs in Kansas, Nebraska and Texas.

C. Wheeleri Lec.

Black, subopaque. Head sparsely obsoletely punctate, not narrowed behind the eyes, clypeus truncate or feebly bisinuate in front, wider between the anterior angles than the head, margin moderately reflexed, angles obtuse, vertex rather flat. Mentum transversely oval, pointed behind, very deeply cupuliform, lateral angles very prominent. Thorax transversely quadrate, broader at base, sides irregular, sometimes a little wider behind the middle than at base, anterior angles obtusely prominent, pubescent within, hind angles pyramidal, obtuse at tip, disc of thorax depressed, lateral third more convex, the former more densely punctured, the latter less so, the angles smooth. Elytra a little wider than the thorax, disc flattened, at sides gradually rounded, surface with elongate foveæ sparsely placed. Pygidium coarsely punctured. Prosternum behind the coxæ slightly elevated. Middle coxæ contiguous. Body beneath opaque, coarsely but sparsely punctured, abdomen with short yellowish hairs. Legs sub-fossorial. Anterior tibiæ bidentate near the tip, the apical tooth not much prolonged, middle and posterior tibiæ flattened, broad, very little narrowed at base, a small tooth at middle. Tarsi compressed, nearly as long as their respective tibiæ. Length .40–44 inch ; 10–11 mm. Pl. iv, fig. 3.

The mentum in some specimens is feebly notched as in *variolosus*, but in others less acute and entire, so that the present might be associated with that species. The division of the disc of the thorax into three parts, although less distinct than in *saucius*, seems to indicate some relation between them, although this is hardly supported by any other characters. The form of thorax recalls somewhat that of *Plegaderus*, and the hind tibiæ, *Psiloscelis*. The peculiar characters of this species are—the broad clypeus, the point of prosternum slightly elevated behind, the middle coxæ contiguous.

Occurs in Nebraska, New Mexico and in Eldorado county, California.

C. leucostictus Burm.

Black, shining, elytra with whitish spots at the sides. Head sparsely punctate, clypeus subtruncate in front, not wider than the head, angles broadly rounded, anterior margin moderately reflexed, vertex and clypeus nearly continuous in the same plane. Mentum plate flat, smooth and shining form hexagonal, margins, except in front, narrowly reflexed. Thorax broader than long, apex feebly emarginate, base truncate, feebly emarginate at middle, sides subangulate in front of middle, in front of which they are straight, posteriorly arcuate, margin very acute posteriorly and feebly reflexed, anterior angles not prominent, posterior rounded, disc sparsely punctate at middle, a little more densely at the sides. Elytra feebly depressed, disc very vaguely bicostate, surface with small foveæ sparsely placed. Pygidium moderately densely punctured. Body beneath shining, sparsely punctured and without pubescence. Legs sub-fossorial. Anterior tibiæ bidentate externally, the upper tooth distant from the apical. Middle and posterior tibiæ moderately compressed, narrow at base, a moderately strong oblique ridge at middle. Tarsi short, scarcely as long as half the tibiæ, slightly compressed, the upper edge, however, broad and flat. Length .52 inch; 13 mm. Pl. iv, fig. 4.

I have seen but one ♀ specimen of this species, which is peculiar by the absence of prominent thoracic angles. The short tarsi cause this species to approach *Schaumii* and *angularis* in which also the mentum is feebly concave. The tarsi themselves are peculiar in their very flat upper side, so that in transverse section the joints are very distinctly triangular.

One specimen, Maryland, in the cabinet of Mr. Ulke, who kindly loaned it for study.

C. Schaumii Lec.

Black, subopaque, above with short, black, erect hairs, sparsely placed, beneath with longer hairs. Head moderately densely punctured, clypeus smoother, at middle arcuate, sides oblique. Mentum nearly flat, punctured at the sides, posterior margin alone reflexed. Thorax one-half broader than long, a little wider at base than apex, sides regularly arcuate, anterior angles feebly prominent, excavated and pubescent on the inner side, posterior angles continuous with the curve of the margin or very slightly excurved, triangular, smooth above and with silken pubescence beneath, disc of thorax slightly convex, densely, coarsely punctured. Elytra slightly flattened on the disc, at sides convex, surface with oblong foveæ, sparsely placed. Pygidium with coarse shallow punctures. Body beneath coarsely punctured, abdomen less densely. Legs short, decidedly fossorial, femora short and broad, anterior tibiæ scarcely narrowed at base, near the apex feebly bidentate, middle and posterior tibiæ broad, scarcely narrower at base, compressed, outer margin unispinose near the middle. Tarsi short, compressed, gradually narrowed toward the end and scarcely as long as half the tibiæ. Length .60–.64 inch; 15–16 mm. Pl. iv, fig. 5.

This species is abundantly distinguished from all others in our fauna by the extremely short tarsi. The surface of the hind angles of the thorax is continuous with that of the disc, there being no limiting depression.

With this species must be united *crassipes* Westw. I have seen the type and know it to be identical with *Schaumii*, Prof. Westwood having mistaken the next species for the present.

Occurs in California, especially in the south, near San Diego.

C. Westwoodi, n. sp.

Similar to *Schaumii* in all its characters, except in the form of the tarsi. These are at least two-thirds the length of the tibiæ, compressed, but scarcely broader at base than at tip. The joints are moreover more loosely articulated and do not appear to be retracted the one within the other as in *Schaumii.* The body beneath and abdomen are more densely punctured. Length .60 inch; 15 mm.

Occurs in Owen's Valley, California, where it was not rare, being found usually in or near ants' nests.

C. angularis Lec.

Black, subopaque, very sparsely pubescent above and beneath. Head densely punctured, clypeus arcuate in front, lateral angles broadly arcuate. Mentum moderately concave, the entire margin narrowly reflexed. Thorax broader than long, sides moderately arcuate, anterior angles moderately prominent, excavated and pubescent within, and limited behind by a slight transverse impression, hind angles triangular, continuous with the lateral margin, smooth above, pubescent beneath and separated from the disc by an oblique impression, disc feebly convex, coarsely and deeply punctured, median line vaguely impressed. Elytra flattened on the disc, convex at the sides, surface with oval foveæ moderately closely placed. Pygidium coarsely and deeply punctured. Body beneath as in *Schaumii.* Legs decidely fossorial, the tibiæ a little narrowed at base, tarsi about half the length of the tibiæ, strongly compressed, and gradually narrowed to tip. Length .56 inch; 14 mm.

This species is closely related to *Schaumii*, but is always smaller, and more elongate. The impression within the hind angles gives them an aspect of being more prominent than in *Schaumii*. The tarsi are formed similarly to that species, but a little longer. The next species is also closely allied, but the legs lose their fossorial character and become ambulatorial.

This species is widely distributed in the Pacific region.

C. pilosicollis Horn.

Closely related to *angularis*, but usually flatter above, and, when recently captured, with longer hairs. The head and thorax do not differ especially, except that the transverse impression behind the anterior angles is more distinct, and the median line more marked. The legs are ambulatorial, the tibiæ slender at base. The tarsi are as long, or very nearly so, as the tibiæ, slender, compressed and scarcely wider at base. Length .40–.50 inch ; 10–13 mm.

Specimens recently captured have moderately long hair on the thorax, and the elytra have whitish spots arranged in irregular transverse strigæ, these characteristics are evanescent and are of no specific value. If the figure of the legs of *C. armatus* Walker be correct, the name should have priority over *pilosicollis* (see Westw. Thesaurus, pl. xiv, fig. 1).

Occurs in California, Nevada and Oregon.

C. crinitus Lec.

Black, opaque, body above clothed with long, yellowish hairs, which are, however deciduous. Head densely punctured, clypeus a little wider than the head, in front feebly arcuate, sides rounded, anterior margin broadly reflexed. Mentum plate smooth, transversely oval, pointed behind, at bottom flat, margins reflexed more widely at the sides. Thorax broader than long, between the basal angles wider than at apex, sides moderately arcuate, anterior angles moderately prominent in front, within foveate and pubescent, posterior angles triangular, smooth, limited within by an oblique impression, disc of thorax flat, a vague median line, surface very coarsely punctured. Elytra flat on the disc, very vaguely bicostate, surface coarsely foveate punctate. Pygidium coarsely, sparsely punctate. Body beneath coarsely punctate, more shining. Legs ambulatorial, anterior tibiæ bidentate near the tip, middle and posterior slender at base, gradually broader to tip. Tarsi nearly as long as the tibiæ, compressed. Length .50 inch ; 12.5 mm. Pl. iv, fig. 6.

I have seen but one ♀ of this species. It is closely allied to *pilosicollis* and *Knochii*, but differs from both by the clypeus being wider than the head between the eyes. It differs also from the former by the absence of transverse impression limiting the anterior angles, and from *Knochii* by its much more depressed form, coarser sculpture. The hind angles are continuous with the lateral margin as in the two species cited. The hairs of the upper surface, although few, are a marked feature, but as they are probably deciduous as in *pilosicollis*, too much value cannot be attached to them in a specific point of view.

Occurs in California or Utah, locality doubtful.

C. Knochii Lec.

Black, feebly shining. Head moderately densely punctured, front slightly concave on each side, clypeus arcuate in front, side rounded, anterior margin reflexed. Mentum plate flat at bottom, sides and posterior margin more widely reflexed. Thorax one-half wider than long, base not wider than apex, sides broadly arcuate, anterior angles feebly prominent, not limited behind by a line, and feebly pubescent within, posterior angles triangular, smooth, distinctly limited within by an oblique impression, disc of thorax usually moderately convex, at middle vaguely canaliculate, surface with coarse but not densely placed punctures. Elytra moderately convex, disc rarely depressed, surface with oval shallow foveæ not densely placed. Pygidium sparsely punctate. Legs as in *crinitus*, tarsi as long as the tibiæ, slender and feebly compressed. Length, .36–.52 inch ; 9–13 mm.

This species exhibits a slight range of variation in the sculpture of the upper surface, the punctures at times being coarser and more closely placed. This usually occurs in those specimens with the disc of thorax and elytra flatter, causing them to resemble the preceding species. The median line of the thorax is always more distinctly impressed. In very fresh specimens the surface is sparsely clothed with very short yellowish hair.

The three preceding species form a small group among those with entire mentum, by the legs being ambulatorial, tarsi moderately long, the hind angles continuous with the side margin of thorax, and not retracted.

To this species should be referred the *crenicollis* of Westwood.

Occurs from Illinois westward to Utah.

C. nitens Lec.

Castaneous, moderately shining. Head coarsely and densely punctured, vertex convex, clypeus arcuate, angles broadly rounded, margin moderately reflexed. Mentum plate smooth and flat at bottom, sides and posterior margin widely reflexed. Thorax one-half wider than long, base not wider than apex, sides rather broadly arcuate, margin crenate, anterior angles very little more prominent than the apical margin, pubescent on the inner side, limited within and posteriorly by a deep grove, posterior angles smooth, auriculate, retracted within the line of the sides, and much depressed below the level of the disc, surface moderately convex, shining, punctures coarse, sparsely and irregularly placed, leaving large smooth spaces. Elytra slightly convex on the disc, coarsely, deeply and closely punctured. Pygidium coarsely punctured. Body beneath shining; coarsely but irregularly punctured. Legs ambulatorial, anterior tibiæ bidentate near apex, the terminal tooth moderately prolonged, middle and posterior tibiæ stout. Tarsi as long as the tibiæ, feebly compressed. Length .44 inch; 11 mm. Pl. iv, fig. 7.

This species is the only one at present known in which the mentum plate is acute behind without notch, and the hind angles of the thorax retracted within the line of the sides. The middle and posterior tibiæ are thicker or less compressed than in any species of this series. It seems to be the link between the groups with the entire mentum and those with that organ notched or emarginate posteriorly, these all having the hind angles more or less retracted.

Two specimens, western Kansas.

C. variolosus Kby.

Black, slightly shining. Head coarsely and densely punctured, vertex convex, clypeus arcuate, margin reflexed. Mentum plate deeply concave, shining, posterior margin acutely notched. Thorax more than half wider than long, sides moderately arcuate and gradually wider behind, very suddenly and rather deeply constricted in front of the hind angles, anterior angles smooth, tuberculiform, completely surrounded by a deep groove, hind angles smooth, somewhat triangular, projecting laterally and separated from the disc by a deep impression, disc of thorax slightly convex, coarsely and densely punctured. Elytra flattened on the disc, surface with shallow oblong foveæ, somewhat confluent. Pygidium coarsely punctured. Body beneath very coarsely but rather sparsely punctate. Legs as in *squamulosus*. Length .36 inch; 9 mm. Pl. iv, fig. 8.

This species is abundantly distinguished from the preceding by the thoracic characters, the anterior angles being more completely surrounded by a groove than in any other species, in our fauna. In some specimens the median line of the thorax is feebly impressed.

Synonymous with this species are *cicatricosus* and *Percheroni* Westw.

Occurs in the Middle States region.

C. squamulosus Lec.

Brownish or piceous, moderately shining, sparsely clothed with very short inconspicuous pubescence. Head coarsely and densely punctured, vertex convex, clypeus arcuate in front, sides broadly rounded, margin reflexed. Mentum plate deeply concave, posterior margin acutely incised. Thorax broader than long, sides rather irregular, usually diverging at apical third, then parallel at middle, in front of hind angles suddenly but not greatly narrowed, anterior angles scarcely more prominent than the margin, nodiform, smooth, limited within by a rather deep depression and posteriorly with a very faint groove, hind angles triangular, not very prominent, feebly punctate and separated from the disc by a deep oblique impression, disc of thorax slightly convex, coarsely and very regularly punctate. Elytra slightly convex, surface coarsely, deeply and rather closely punctate. Pygidium coarsely and densely punctate. Body beneath coarsely but not closely punctate. Legs ambulatorial, tibiæ stout, the anterior bidentate near the tip, the middle and posterior with a slight oblique ridge at middle. Tarsi as long as the tibiæ, rather slender and feebly compressed. Length .36–.40 inch ; 9–10 mm.

The notch in the margin of the mentum plate varies in extent, sometimes being very slight, but usually extending through the reflexed edge.

With this species must be united *junior* Westw.

Occurs in Georgia and Florida.

C. canaliculatus Kby.

Black, feebly shining. Head densely punctured, front convex, clypeus arcuate in front, lateral angles broadly rounded, margin reflexed. Mentum plate deeply concave, side and posterior margin very widely reflexed, deeply emarginate posteriorly. Thorax one-third wider than long, sides moderately arcuate and slightly coarctate in front of the hind angles, anterior angles obtuse, feebly prominent, limited within by a deep fovea, surface continuous with the disc and punctured, hind angles triangular, punctured, tip slightly turned outward, limited by a moderately deep groove, but not depressed below the surface of the disc, disc slightly convex, coarsely and densely punctured. Elytra flattened on the disc, vaguely grooved, and with shallow foveæ moderately densely placed. Pygidium coarsely and densely punctured. Body beneath densely and coarsely punctured, abdomen less densely. Legs as in *nitens*. Length .50 inch ; 12.5 mm.

This species is known from *castaneæ* by the hind angles being much less retracted and not depressed below the disc, as well as by the form of the anterior angles.

Occurs in Canada, Georgia and Illinois.

C. retractus Lec.

Resembles very closely the preceding species in form and sculpture, and differs in the following characters: Disc of thorax more convex, hind angles much retracted, separated from the surface of the thorax by a deep impression, and depressed beneath it. Length .44–.48 inch; 11–12 mm. Plate iv, fig. 10.

The characters separating this species from *canaliculatus* are those in which it agrees with *castaneæ* from which the form of the anterior angles will distinguish it, the present species having the front angles of the first and the hind angles of the second.

Two specimens, Iowa and Texas.

Synonymous with this is *Walshii* Westw.

C. castaneæ Knoch.

Piceous, feebly shining. Head coarsely and densely punctured, front convex, clypeus arcuate in front, sides broadly rounded, margin reflexed. Mentum plate deeply cupped, the margin widely reflexed except in front, hind margin deeply emarginate. Thorax nearly twice as wide as long, sides moderately arcuate and slightly coarctate in front of the hind angles, anterior angles tuberculiform, limited within by the usual deep foveæ and posteriorly by an impressed line, hind angles triangular punctured at base, tips turned outward, separated completely from the surface of the disc by a deep impression, disc moderately convex, coarsely and closely punctured, median line sometimes feebly impressed. Elytra moderately flat, surface with large shallow foveæ. Pygidium very coarsely punctured. Body beneath coarsely and sparsely punctured, abdomen with very few punctures. Legs as in *nitens*, but with the tibiæ a little less thickened. Length .40 inch; 10 mm.

This species is known among those of the present group by the nodiform front angles which are separated from the disc by the transverse impression, the hind angles are also completely surrounded by a groove, and become depressed below the level of the disc.

C. Lecontei Westw. is merely a feeble form of this species, and is found in the more western regions.

Occurs in the Middle States region, extending westward to Colorado.

C. Harrisii Kby.

Piceous, moderately shining. Head very coarsely and deeply punctured, front convex, clypeus arcuate, angles broadly rounded, margin reflexed. Mentum plate deeply concave, margins reflexed, more strongly at the sides and posteriorly, the posterior margin rather broadly and deeply notched. Thorax more than one-half wider than long, sides very feebly arcuate, anterior angles short, obtuse, limited within by a deep impression and behind by a finely impressed line, hind angles moderately retracted, somewhat triangular, smooth, separated from the disc by a moderately deep impression, disc slightly convex, sparsely irregularly punctured with smooth spaces and a broad impression at the middle of the sides. Elytra flattened on the disc, surface very coarsely, deeply and densely punctured. Pygidium shining, coarsely and closely punctured. Body beneath coarsely but not densely punctured, abdomen nearly smooth at middle. Legs very closely resembling *nitens*. Length .40 inch; 10 mm. Pl. iv, fig. 9.

This species is easily known from the others of this group by its comparatively shining surface and the sculpture of the thorax. The impression of the disc near the sides is variable in extent, being in some specimens quite feeble.

Occurs in Canada, Middle States and Illinois.

Notes on the Species described or quoted by Prof. Westwood in his "Thesaurus Entomologicus Oxoniensis."

The work of Prof. Westwood, so repeatedly quoted in the preceding pages, seems to require a little more notice than has been given it, from the fact that its distribution in European Libraries will have considerable weight in the determination of our species; and as the species are (with one exception) peculiar to our fauna, it seems proper that they should be reviewed in the light of more material than Prof. Westwood possessed.

In this work there are described as new, seven species, *Lecontei, Walshii, cicatricosus, junior, Percheroni, crenicollis* and *crassipes*, the type of the latter being in the cabinet of Maj. Parry in London, *Percheroni* in the Univ. Halle, and the others in the Berlin Museum.

With the first six we have more especial need to deal. *Lecontei* and *Walshii* are described from specimens in the Berlin Museum, from very short notes made in 1869, before my synoptic table appeared giving succinctly the differential characters of the species. The next four species "are introduced in this work mainly on the authority of Dr. Schaum, who possessed specimens of them, and who was in an excellent position to judge of their specific rank, both from possessing the typical specimens of Gory, and from his actual acquaintance with the American collections made during a long visit to the United States." The authority from Prof. W.'s own statement is derived from letters written in 1847, '48 and '49! and had the science in America been dormant, those species might possibly have remained twenty-five years undescribed. That they are all to be added to our synonomy is to be regretted, while it is fortunate that so able a describer has made the task of their determination so easy.

As Prof. Westwood has given descriptions of all our species either by quotation or from nature, with figures of many, I propose to pass them briefly in review, giving the synonomy and notes on the figures.

C. (Psilocnemis) *leucostictus* Burm. Westw. Thesaurus p. 56, pl. ii, fig.

4. The thorax of the figure is incorrect in outline and sculpture, and the tarsi too long, except in fig. 4 d. (See annexed plate, fig. 4.)

C. canaliculatus Kby. Westw. p. 58 ; no figure given.

C. castaneæ Knoch. Westw. p. 59, pl, xiv, fig. 4 ; a fair figure.

C. Harrisii, Kby. Westw. p. 59 ; no figure given.

C. Lecontei Westw. p. 60 note, is our western form of *castaneæ*. No figure is given.

C. Walshii Westw. p. 60 note, is the same as *retractus* Lec. I can hardly determine the priority. The latter name appeared in March, 1874, the "Thesaurus" is simply dated 1874. No figure given.

C. variolosus Kby. Westw. p. 60, pl. xiv, fig. 7. The figure is good, except that the sides of the thorax in front of the posterior emargination are much too acutely prolonged.

C. cicatricosus Westw. p. 60, pl. xiv, fig. 9, is *variolosus*, and the figure much better than that above.

C. squamulosus Lec. Westw. p. 60, pl. xiv, fig 8. From the index to plates this figure belongs to the next.

C. junior Westw. p. 61, pl. xiv, fig. 8, is *squamulosus*, and the figure a moderately good one of that species.

C. Percheronii Westw.p. 61, pl. ii. fig. 5, is *variolosus*, and the figure a far better one than those above quoted (pl xiv, figs. 7 and 9).

C. planatus Lec. Westw. p. 62, pl. xiv, fig. 5. The figure is not at all good, the anterior angles of the thorax are represented as double, and the tarsal dilatation not well shown.

C. depressus Horn. Westw. p. 62. A quotation.

C. angularis Lec. Westw. p. 63, pl. xiv, fig. 1. This figure seems to be made from specimens collected by J. K. Lord, in Vancouver, which are the types of Mr. Walker's *C. armatus*. If the tarsi are correctly figured, then this name should have priority over *pilosicollis* Horn, which this figure fairly represents. The tarsi are not those of *angularis* Lec. Westwood says that this species (*armatus*) has been received from Japan.

C. pilosicollis Horn. Westw. p. 63, a quotation. See note above.

C. nitens Lec. Westw. p. 63, pl. xiv, fig. 2. Westwood appears to quote the description, yet gives a figure without stating its source ; it is, however, not good.

C. saucius Lec. Westw. p. 64, a quotation.

C. Knochii Lec. Westw. p. 64, pl. xiv, fig. 6 ; a fair figure.

C. Schaumii Lec. Westw. p. 64, pl. xiv, fig. 3. The figure is a copy from one drawn by Wagenschieber and sent by Schaum, in which the tarsi and tibiæ are not well drawn. The body fairly represents the above species, while, as it stands, it more nearly resembles *Westwoodi* Horn.

C. crassipes Westw. p. 204 ; Trans. Ent. Soc. London. 1878, pl. 1, fig. 6. This is the true *Schaumii*. I have seen the type. The figure is not a very good one.

C. crenicollis Westw. p. 65, pl. ii, fig. 6, is *Knochii* Lec., and, in 1819, was an undescribed species. The figure is from Schaum by the artist above named, and is a better representation of *Knochii* than that on pl. xiv, fig. 6.

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C. squamulosus Lec Journ. Acad. 1858, IV, p. 17.
junior Westw. Thesaurus, p. 61, pl. xiv, fig. 8.
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castaneæ ‡ Schaum. Germ. Zeits. III, p. 255; Burm. Handb. III, p. 681.
Hentzii Harris. Jour. Acad. V, p. 386.
C. retractus Lec. Trans. Am. Ent. Soc. 1874, p. 54.
Walshii Westw. Thesaurus, Entom. Oxon. Oxford, 1874, p. 60, note.
C. castaneæ Kn. Neue Beitr. p 115, pl. iii, fig. 1.
Lecontei Westw. loc. cit. p. 60, note.
C. Harrisii Kby. Zool. Journ. III, p. 152, pl. v, fig. 3*a*; Schaum, Germ. Zeitschr. III, p. 254; Burm. Handb. III, p. 680.
castaneæ ‡ Kby. Zool. Journ. II, p. 517; Harris, Journ. Acad. V. p. 384.

Synopsis of the EUPHORIÆ *of the United States.*

BY GEORGE H. HORN, M.D.

(*Read before the American Philosophical Society, Dec.* 19, 1879.)

The occurrence of several new species in our fauna affords an opportunity of briefly reviewing our entire series.

The first question presenting itself is the generic name which should be adopted, and this seems to be a difficult matter to determine. The ablest European authorities who have had to deal with the Cetonia group as a whole do not seem to be in accord as to the limits of genera, so that we have on the one hand a multiplicity and on the other a synonymic union which does not seem tenable. Lacordaire, under the name *Euryomia*, collects the contents of about ten genera, all of which, with one exception, are the creation of Burmeister. This aggregation is again dispersed in the Catalogus (G. and H.) with *Erirhipis* alone suppressed. It seems highly probable that neither of these extremes is correct.

The name *Euryomia*, at present used in our literature, has for its type a Madagascar species, which presents characters entitling it to be separated from the forms which occur in our fauna, whatever may be its relations with the other old world types which Lacordaire has united with it, consequently our species should bear some other name. *Euphoria* is adopted as most convenient, because the name suggests no special character. Lacordaire states that the genus is not capable of being defined, seeing that the species differ more among themselves than they do in the aggregate from the other neighboring genera. It is, he says, "a genus established on geographical distribution alone."

In a limited series, such as our fauna presents, *Stephanucha* might be allowed to remain separated, but this seems hardly necessary until the limits of all the genera are better defined than they are now.

Having given the reasons for adopting the generic name, the following table of species is presented for the consideration of our students:

Clypeus dentate in front. Base of thorax entire.
  Quadridentate [STEPHANUCHA] .... **areata** Fabr.
  Bidentate .... **verticalis**, n. sp.
Clypeus entire or feebly emarginate, the angles rounded.
  Mesosternal protuberance round or nearly so .... **2.**
  Mesosternal protuberance transverse .... **11.**
2. Thorax either shining or punctured and pubescent .... **3.**
  Thorax opaque, scarcely punctured, not pubescent .... **10.**
3. Base of thorax at middle not emarginate .... **4.**
  Base of thorax emarginate at middle .... **5.**
4. Thorax arcuate at base, elytra not sulcate .... **aestuosa**, n. sp.
  Thorax truncate at base .... **Kernii** Hald.
5. Punctuation of thorax dense, surface pubescent or hairy .... **6.**
  Punctuation sparse, surface glabrous or scarcely pubescent .... **7.**
6. Body beneath and legs very hairy .... **hirtipes**, n. sp.
  Body beneath and legs normally hairy .... **sepulcralis** Fabr.
7. Mesosternal protuberance punctured and hairy beneath.. **devulsa**, n. sp.
  Mesosternal protuberance glabrous beneath .... **8.**
8. Punctuation of thorax coarse, elytra with short and inconspicuous pubescence .... **melancholica** G. & P.
  Punctuation of thorax sparse, usually inconspicuous, body above entirely devoid of pubescence .... **9.**
9. Elytra reddish-yellow with black fasciae .... **fascifera** Lec.
  Elytra variable, the surface with green or blue lustre.... **fulgida** Fabr.

10. Clypeus longer than wide, rather deeply emarginate. . **californica** Lec.
Clypeus not longer than wide, feebly or not emarginate. . **herbacea** Oliv.
11. Elytra luteous, maculate with small black spots. . . . . **inda** Linn.
Elytra sooty, with small transverse luteous spots. . . . . **Schottii** Lec.

From the above table I have rejected *basalis*, *dimidiata* and *canescens*, as they are Mexican, and are very rarely found in Texas or Arizona. The species described by Say as *Cetonia vestita* is believed to be *C. hirtella* Linn. (Schaum, Am. Ent. Soc. Fr., 1849, p. 267), and nothing has ever been found since in our country which will fill the description, it is therefore dropped into European synonymy.

E. areata Fab.

Black, moderately shining, elytra luteous with black spaces at the humeri, and subapical umbone and along the suture, upper surface with short erect yellowish pubescence, longer on the head, denser on the thorax and very sparse on the elytra, beneath hairs long and sparse. Clypeus short, narrowed in front, quadridentate, the middle teeth closer and arising from a common base. Thorax oval, base arcuate entire, surface densely punctured. Elytra very obsoletely bicostate, the punctuation very indistinct. Mesosternum feebly prominent, the protuberance transverse. Pygidium usually moderately, densely punctured. Abdomen with very few punctures. Length .48 inch ; 12 mm.

The club of the male antennæ is a little longer than that of the female. The anterior tibiæ are tridentate in both sexes.

The normal form of coloration, and which is almost invariable in the eastern specimens, is that in which the elytra are in great part luteous, with the base narrowly black, the suture is also black, this color dilating into a large circum-scutellar patch, a smaller transverse space behind the middle, and again dilating at apex. In the specimens from Kansas and Nebraska, the elytra are more roughly sculptured and almost entirely black, the luteous color being reduced to a U-shaped mark by the extension of the elytral black spaces, and by the margin being dark.

A specimen in Mr. Ulke's cabinet requires special mention. It is of the size of *aestuosa*, the humeri and subapical umbone are similarly tipped with piceous, and the suture very narrowly piceous, disconnected from the suture and along the region occupied by the faint costæ are irregular small piceous patches. The sides of the thorax are irregularly bordered with a whitish coating, and the pygidium except at tip clothed with similar material. The clypeus is formed as in normal *areata*, and the characters generally are those of that species. From its appearance it might be suspected of being a hybrid between *aestuosa* and *areata*.

Occurs from the Middle States, westward to Kansas, and south to Texas.

E. verticalis. n. sp.

Black, moderately shining, upper surface without pubescence, form robust, moderately convex. Clypeus as long as wide, a little narrowed in front, anteriorly emarginate, the angles acute and reflexed, vertex with an obtuse tubercle, surface of head coarsely, densely and deeply punctured. Thorax oval, narrowed in front, broader than long, sides strongly arcuate, especially in front, base less arcuate, not emarginate, disc moderately convex with coarse punctures sparsely placed, but closer near the anterior margin, a narrow smooth median space. Scutellum smooth. Elytra one-half longer than the thorax, disc with rows of ocellate foveæ forming nearest the suture two distinct pairs separated by very feeble costæ, between the ocellate foveæ are simple punctures distantly placed, at the sides the punctures are irregular, and more densely placed; sutural angle obtuse. Pygidium sparsely punctate. Body beneath with brownish hair, abdomen nearly smooth, a few coarse punctures at the sides only. Length .52 inch; 13 mm. Pl. iv, fig. 12.

The sexes differ only in the form of the pygidium, that of the male being more convex and inflexed at tip. The anterior tibiæ are acutely tridentate, the upper tooth more distant than the other two. The antennal club is nearly as long as the entire stem in both sexes. The mesosternal button is transversely oval and hairy in front.

In general form this species resembles *areata*, but is a little more robust. It is easily known among the species in our fauna by its bidentate clypeus and totally black color, as well as by the elytral sculpture. By its form of clypeus it is allied to *E. Hera* Burm. from South America.

Two specimens are before me, one of each sex from Arizona, and the adjacent portion of California.

E. aestuosa, n. sp.

Piceous, moderately shining, body above luteous, thorax with a large median piceous space, humeral and subapical umbones of elytra tipped with piceous, form moderately robust, surface above and beneath with short, inconspicuous pubescence. Clypeus a little wider than long, slightly broader in front, angles rounded, anterior margin moderately reflexed and slightly emarginate at middle. Head and front coarsely and densely punctured with moderately long hair. Thorax oval, narrowed in front, slightly wider than long, sides moderately arcuate, base not narrower than middle, basal margin regularly arcuate, surface coarsely and densely punctured, with short erect yellowish pubescence. Scutellum smooth. Elytra moderately convex, disc very vaguely bicostate, surface irregularly sparsely punctate. Body beneath piceous, shining, sparsely hairy, tibiæ very feebly fimbriate. Pygidium concentrically strigose, smooth near the tip. Mesosternal button round, hairy. Length .54 inch; 13.5 mm. Pl. iv, fig. 14.

In the unique ♀ before me, the club of the antenna nearly equals the stem. The anterior tibiæ are acutely tridentate, the teeth rather long and equidistant. From the few species in our fauna which have the base of the thorax simply arcuate, this species differs, either by the form of the clypeus or the elytral and thoracic sculpture.

One specimen, Kansas, given me by Dr. S. V. Summers. It is probable that the color will vary from this unique. The scutellum is black, and the suture and apical margin narrowly piceous, and these spaces may possibly be found extending so as to form a style of coloration analogous to that of *areata*.

E. hirtipes, n. sp.

Piceous, elytra luteous, above with moderately long yellowish hair. Clypeus as broad as long, not narrowed in front, anterior angles broadly rounded, apical margin slightly reflexed, feebly emarginate. Head coarsely and densely punctured, clothed with rather long yellowish hair. Thorax oval, broader than long, narrower in front, sides strongly arcuate, base narrower than middle, the margin broadly arcuate, and opposite the scutellum emarginate, disc moderately convex, surface densely but rather irregularly punctured, a smooth space along the middle and one on each side, pubescence rather long and erect. Scutellum smooth, a median impression near the tip. Elytra slightly narrowed toward the tip, disc feebly convex, vaguely bicostate, the intervals irregularly punctured, the punctures bearing moderately long hairs. Pygidium moderately densely punctured and hairy. Body beneath and legs clothed with long yellowish hair. Abdomen coarsely punctured. Mesosternal button round and hairy in front. Length .42♂–.56♀ inch; 10.5–14 mm. Pl. iv, fig. 13.

The antennal club is about the length of the stem, and similar in the two sexes. The anterior tibiæ are rather broad, tridentate, the apical tooth longer and more distant than the other two. The legs are less hairy in the female than in the male, which has, especially on the hind tibiæ, a dense brush of long hair on the inner side.

In form, this species bears a resemblance to *sepulcralis*, but so differs in color and vestiture, not only from this, but also from all our others, as to make it very conspicuously distinct.

Occurs in Dodge county, Nebraska.

E. Kernii Hald.

This species has become so generally known as to need no extended description. The clypeus is nearly square, the angles rounded, the anterior margin feebly emarginate. The thorax is transversely oval, base truncate at middle, surface densely and coarsely punctured. The elytra are each rather broadly and deeply bisulcate, the surface sparsely punctate and at the sides transversely wrinkled. The pygidium is concentrically strigose. The mesosternum does not project in a button-like protuberance. Length .40–.52 inch; 10–13 mm.

The male antennal club is a little longer than that of the female. The anterior tibiæ are very decidedly tridentate in the female and either simply bidentate in the male or with the upper tooth showing a very feeble trace.

No species in our fauna exhibits such a wide range of color variation.

In the normal form the under surface and legs are piceous or black. Head black. Thorax black, sides more widely, base very narrowly bordered with yellow. Elytra in great part yellow or reddish-yellow, maculate with black spots of irregular size and shape, becoming more or less confluent.

The first noticeable variety (*Clarkii* Lec.) has the abdomen, posterior legs and the anterior four tibiæ pale reddish-yellow. The discal black space of the thorax is divided by a pale median stripe, the elytra remaining normal in color.

Fully as common as this last variety is one in which the entire body above and beneath is black.

These last forms resemble the species described further on as *devulsa*, but this has the base of thorax emarginate.

Occurs over the region of the Plains from Kansas to Texas.

E. devulsa, n. sp.

Piceous black, shining, sparsely clothed with very short inconspicuous pubescence. Clypeus a little wider than long, sides feebly arcuate, anterior angles broadly rounded, apical margin slightly reflexed and feebly emarginate at middle. Head coarsely and densely punctured, more sparsely on the clypeus. Thorax oval, narrowed in front, broader than long, sides regularly arcuate, basal margin emarginate at middle, disc moderately convex, coarsely but not densely punctured. Scutellum coarsely punctured at the sides. Elytra moderately convex, sub-bicostate on the disc, the intervals with variolate fovea, which gradually become simple punctures toward the sides of the elytra, sutural angle rectangular. Body beneath sparsely clothed at the sides with yellowish hair, abdomen very sparsely punctate and with few hairs at the sides. Tibiæ slightly fimbriate within. Pygidium concentrically strigose. Mesosternal button punctured and hairy beneath and in front. Length .40 ♂–.48 ♀ inch; 10–12 mm. Pl. iv, fig. 15.

The anterior tibiæ are tridentate in the two sexes, the upper tooth more distant. The antennal club is very nearly as long as the rest of the antennæ.

This species resembles the Mexican *E. dimidiata* in form, sculpture and size, and differs in the style of coloration and the punctured scutellum. It also resembles the entirely black varieties of *Kernii*, but the latter has more deeply sulcate elytra and the thorax truncate at base.

The males differ from the females by their smaller size, narrower form and more convex pygidium.

Occurs near San Antonio, Texas.

E. sepulcralis Fab.

Body beneath bronzed, shining, distinctly violaceous, above dark bronze, not very shining. Clypeus a little wider than long, anterior angles rounded, apical margin slightly reflexed, not emarginate, surface coarsely punctured, vertex with short erect yellow hairs. Thorax transversely oval, sides arcuate, base emarginate at middle, surface coarsely punctured, not densely at middle, but densely and subconfluently at the sides, pubescence short, erect and very persistent. Scutellum usually smooth, often sparsely punctured at the sides. Elytra distinctly bicostate, intervals with numerous punctures which tend to become ocellate foveæ, at sides the punctures are converted into short, deep transverse strigæ, especially near the apex, surface sparsely pubescent with numerous short, sinuous lines of whitish or ochreous color; tip of elytra distinctly sinuous, the suture slightly prolonged. Pygidium concentrically strigose, often whitish at the sides. Mesosternal umbone transversely oval. Metasternum smooth at middle, strigose, and often coated with white at the sides. Abdomen sparsely punctured at middle, at sides more coarsely and with few hairs, often with whitish coat. Length .44–.60 inch; 11–15 mm.

The club of the male antenna is very little longer than that of the female, the anterior tibiæ tridentate in both sexes.

This species is, next to *inda*, the most common in our fauna. It occurs from the Middle States westward to Kansas, and to Florida and Texas, extending even into Mexico.

The above description, rather detailed for one so common, is given that the specific limits when compared with *melancholica* may be made more evident.

E. melancholica Gory.

Body beneath black, shining, usually with green or dark blue lustre, upper surface equally shining, surface greenish-blue or nearly black. Clypeus as in *sepulcralis*, head not hairy. Thorax formed as in that species, the punctuation coarse, denser at the sides but not confluent, the surface entirely devoid of hairs. Elytra also similar, the punctuation less deep and more sparse, and at the sides very faintly or not at all strigose, surface devoid of hairs, and with whitish lines similar to those of *sepulcralis* but less sinuous. Body beneath as in *sepulcralis*. Length .48–.60 inch; 12–15 mm.

The antennal club of the male is very distinctly longer than that of the female. The anterior tibiæ are tridentate in both sexes, but the upper tooth is smaller in the male.

By a comparison of descriptions it will be seen that this species is more shining, less deeply sculptured, and the upper surface without pubescence. The sculpture of the thorax and sides of elytra is notably different in the two. Here the sides of the thorax are usually margined with cretaceous, but in *sepulcralis* rarely so. The sexual characters here are also better marked.

Occurs in Kansas, Texas and Mexico.

E. fascifera Lec.

Black, shining, glabrous. Clypeus as broad as long, anterior angles rounded, margin reflexed, not emarginate, surface coarsely and densely punctured. Thorax triangular, sides feebly arcuate, base emarginate in front of scutellum, apex truncate, the middle of apical margin slightly elevated in a tubercle, surface sparsely punctate, color reddish-yellow, with a large triangular black space, or with the space replaced by four black spots. Elytra vaguely bicostate, punctures sparse and coarse, on the disc sub-ocellate, color a reddish-yellow, with a basal, median and sub-apical transverse dentate fascial black. Pygidium concentrically strigose. Body beneath very coarsely transversely strigose, and with sparse short pubescence. Abdomen very sparsely punctate, and slightly pubescent at the sides. Mesosternal umbone moderately prominent, rounded at tip. Length .52–.74 inch ; 13–19 mm. Pl. iv, fig. 16.

The club of the male antenna is a little longer than that of the female ; anterior tibiæ tridentate in both sexes.

The specimens before me, six in number, are exactly alike in their elytral markings, scarcely varying in the minutest detail ; in one in my cabinet, from Utah, the thorax has the large black discal space replaced by four smaller spots.

The entirely glabrous surface and the general outline of this species place it in close alliance with *fulgida*.

Occurs in the Peninsula of California, and extends to South-western Utah at St. George (Dr. Palmer).

E. fulgida Fab.

This species, well known from its brilliant green surface, varying to blue, needs but little comment. The upper surface is entirely devoid of pubescence. The head is brilliant green, the thorax similar in color, but margined at the sides with yellow, its surface sparsely punctate. On the elytra the traces of costæ are almost entirely obliterated, the punctuation usually sparse and indistinct, often more or less maculate, with cretaceous spots. The pygidium is concentrically strigose, and with four cretaceous spots more or less confluent. The metasterum is smooth at middle, and at sides deeply strigose. The abdomen is smooth, with but few coarse punctures at the sides, and along the margin of the segments, the sides are usually broadly cretaceous, sometimes with a double row of cretaceous spots. The mesosternal umbone is prominent, oval at tip. The legs are reddish or brownish-yellow, tarsi piceous. Length .52–.80 inch ; 13–20 mm.

The male has a larger antennal club than the female, the tibiæ are tridentate in both.

In the specimens from the Northern States, the elytra have less of the greenish surface lustre, and exhibit a brownish-red ground color ; these have also the fewest whitish spots. In the specimens from the Gulf States, the color is always more brilliant, the punctuation more evident, and the whitish spots more numerous.

Occurs from the Middle States westward to Missouri, and south to Florida and Texas.

E. californica Lec.

Bright green, opaque above, shining beneath, very similar to *fulgida*, upper surface without pubescence. Clypeus longer than wide, slightly narrower in front, apical margin deeply emarginate, feebly reflexed, surface not densely punctured. Thorax transversely oval, sides rather strongly arcuate, base emarginate at middle, disc moderately convex, sparsely obsoletely punctured, a small white spot on each side of middle, lateral margin very narrowly cretaceous. Elytra obsoletely bicostate, the punctures between the costæ very fine and in two rows, sides rather strongly plicate, suture rather strongly elevated, especially near the tip, where it is slightly prolonged, surface opaque green with small cretaceous spots, the first at middle on the inner costa, the second at three fourths, between this costa and the suture, a third behind the second near the apex, two at the margin placed obliquely behind the first two, a very small spot behind the humerus. Pygidium strigose, a white spot each side. Body beneath shining green, sparsely clothed with hair along the sides. Metasternum and abdomen smooth at middle, coarsely punctured at the sides. Meso-metasternal protuberance long, parallel, rounded at tip. Legs bright green, tarsi black. Length .64 inch ; 16 mm.

Of this species I have seen but one specimen, the type. It was given by Baron Osten-Sacken to Dr. Leconte, with the statement that he obtained it in California, but I do not know if it was collected by him. The species seems to me to resemble the East Indian type and to belong to the genus (?) *Glyciphana*, but until an opportunity is afforded for comparison no positive statement can be made, and I leave it with the doubts above given.

E. herbacea Oliv.

Body beneath green, moderately shining, above dull green, changing to opaque brown. Clypeus as broad as long, sides and apex reflexed, the latter not emarginate, surface sparsely punctate. Thorax transversely oval, sides moderately arcuate ♀, or more triangular with sides nearly straight ♂, base emarginate at middle, disc sparsely punctate. Elytra vaguely bicostate, intervals finely punctate, sides with coarse strigæ, surface variable from brownish-green to brown, opaque, with numerous whitish spots of irregular size and shape behind the middle and near the apex and sides. Pygidium concentrically strigose and with short hairs. Body beneath green, shining, abdomen often brownish. Metasternum smooth at middle, strigose and hairy at the sides, abdomen sparsely punctate over the entire surface, pubescent at the sides. Mesosternal button oval, a little broader than long. Length .56–.64 inch ; 14–16 mm.

The male club is very decidedly longer than that of the female, the anterior tibiæ tridentate in both sexes.

This species is entirely devoid of pubescence on the upper surface, except the head and pygidium. It is a well-known species to all collectors, but less common than *inda*.

Occurs in the Middle States region, occasionally found abundantly, but usually not common.

E. inda Linn.

Clypeus broader than long, apex not emarginate, angles rounded, margin reflexed. Mesosternal button more than twice as wide as long.

This species is so well known as to require no further comment.

Occurs everywhere in the United States east of the Rocky Mountains.

E. Schottii Lec.

Black, beneath shining, above opaque, elytra variegated with short transverse luteous spots. Clypeus nearly square, anterior angles rounded, apical margin slightly reflexed, truncate, surface coarsely and moderately densely punctured sparsely clothed with erect yellowish hair. Thorax subtriangular, sides feebly arcuate, base emarginate at middle, surface coarsely punctured, more densely at the sides and very sparsely near the base, pubescence short and sparse, color piceous with three luteous vittæ at middle. Elytra piceous opaque, with irregular, short, transverse and sinuous luteous spots, disc vaguely bicostate, intervals biseriately vaguely punctate, at sides irregularly punctate and posteriorly distinctly plicate. Pygidium indistinctly concentrically strigose. Mesosternal protuberance transverse, arcuate in front. Metasternum smooth at middle, coarsely strigose at the sides, sparsely pubescent. Abdomen very sparsely punctate and with short pubescence. Femora brownish, tibiæ and tarsi piceous. Length .44–.56 inch; 11–14 mm.

The club of the male antenna is very nearly double that of the female, the anterior tibiæ are bidentate ♂, or tridentate ♀.

In form this species bears a considerable resemblance to *herbacea*, being much less robust and more depressed than *inda* and with less distinct pubescence. There is, however, a very close relationship between *inda* and *Schottii*, as shown by a general similarity of appearance, and the form of the mesosternal protuberance.

Occurs in Texas, Eagle Pass.

Bibliography and Synonymy.

EUPHORIA Burm.

Handb. III, 370.

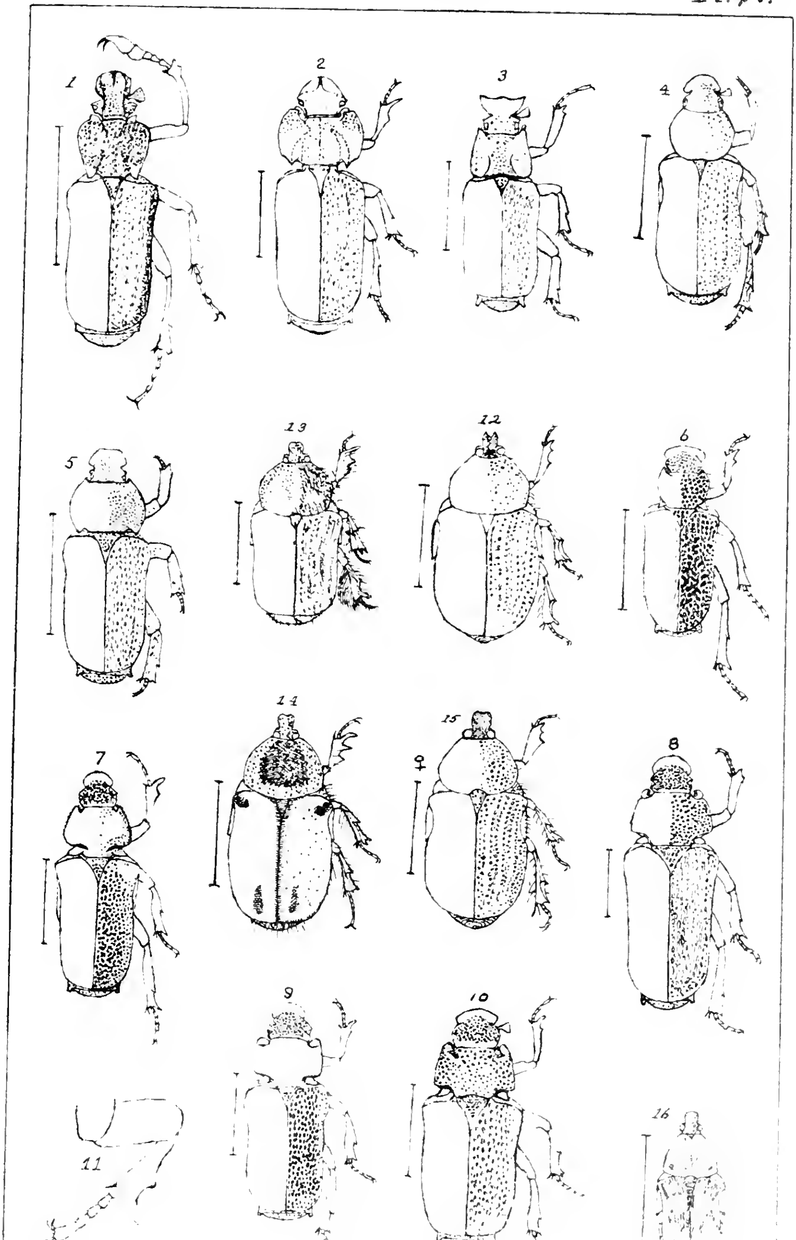
E. areata Fab. Syst. Ent. 1, p. 50; Gory et Perch. Mon. p. 267, pl. 52. fig. 1; Burm. (*Stephanucha*) loc. cit. p. 395.

E. verticalis, n. sp.

E. aestuosa, n. sp.
E. Kernii Hald. Stansb. Expl. p. 374, pl. 9, fig. 10; Lec. Proc. Acad. 1853, p. 440.
Clarki Lec. loc. cit., p. 441.
texana Schauf. Sitz. Ges. Isis, 1863, p. 113.
E. hirtipes, n. sp.
E. devulsa, n. sp.
E. sepulcralis Fab. Syst. El. ii, p. 56; Burm. loc. cit., p. 376.
lurida Oliv. Ent. 1, 6, p. 43. pl. 9, fig. 81; Schaum. Ann. Ent. Soc. Fr. 1849, p. 266.
Reichei Gory et Perch. Mon. p. 210, pl. 38, fig. 3.
E. melancholica Gory et Perch. loc. cit., fig. 4; Schaum. loc. cit.
E. fascifera Lec. Proc. Acad. 1861, p. 336.
E. fulgida Fab. Syst. Ent. p. 48; Gory et Perch. Mon. p. 175, pl. 31, fig. 2; Burm. loc. cit. p. 393.
E. californica Lec. New Species. 1863, p. 80.
E. herbacea Oliv. Ent. 1, 6, p. 35, pl. 11, fig. 101; Schaum. Ann. Ent. Soc. Fr. 1845, p. 375.
antennata Gory et Perch. Mon. p. 177, pl. 31, fig. 4.
pubera Gyll. Schönh. Syn. Ins, 1, 3, App. p. 53; Burm. loc. cit. p. 391.
E. inda Linn. Syst. Nat. Ed. X, p. 352; Oliv. Ent. 1, 6, p. 40, pl. 6, fig. 40; Burm. Hand. iii, p. 389.
barbata Say. Journ. Acad. iii, p. 239.
brunnea Gory et Perch. Mon. p. 267, pl. 51, fig. 6.
marylandica Fröhl. Naturf. 26, p. 116.
E. Schottii Lec. Proc. Acad. 1853, p. 441.

Explanation of Plate IV.

1. **Cremastochilus planatus** Lec.
2. **C. saucius** Lec.
3. **C. Wheeleri** Lec.
4. **C. leucostictus** Burm.
5. **C. Schaumii** Lec.
6. **C. crinitus** Lec.
7. **C. nitens** Lec.
8. **C. variolosus** Kby.
9. **C. Harrisii** Kby.
10. **C. retractus** Lec.
11. Tarsal monstrosity in **C. saucius**.
12. **Euphoria verticalis** Horn.
13. **E. hirtipes** Horn.
14. **E. aestuosa** Horn.
15. **E. devulsa** Horn.
16. **E. fascifera** Lec.



G. H. H. del.

Stated Meeting, January 2, 1880.

Present, 5 members.

President, Mr. Fraley, in the Chair.

A letter accepting his appointment to prepare an obituary notice of the late M. Michel Chevalier, was received from Mr. Moncure Robinson, dated Dec. 22, 1879.

A letter of envoy was received from the London Meteorological office, dated Dec. 1879.

A letter requesting a copy of Proc. No. 100, to complete a set was received from the Central Austalt für Meteorologie, dated Vienna, Dec. 4, 1879.

A letter respecting exchanges of specimens was received from Mr. H. B. Dawson, dated Morisania, N. Y., Dec. 5, 1879.

Donations for the Library were received from the Prussian Academy; Revue Politique; London Astronomical, Geographical and Meteorological Societies, and the Cobden Club; the Royal Geological Society of Ireland; the Massachusetts Historical Society; the Boston Society of Natural History; the American Chemical Society; Mr. A. R. Grote; the Franklin Institute; American Journal of Mathematics; the North American Entomologist; the U. S. Treasury Department; the Botanical Gazette; the Ministerio de Fomento of Mexico, and Mr. S. H. Scudder.

A communication on the Velocity of Light, by P. E. Chase was read.

A paper entitled "An account of an old work on Cosmography, by Mr. Henry Phillips, Jr." was postponed to be read at the next meeting.

A paper on the relation of the crystalline rocks of Southeastern Pennsylvania to the Silurian limestones, and on the Hudson river age of the Hydromica schists (with map and specimens), by Mr. Charles E. Hall, of the Geological Survey, was postponed to be read at the next meeting.

The report of the judges and clerks of the annual election for officers of the Society was read, and the following named persons were declared duly elected to be the officers for the ensuing year:

President.

Frederick Fraley.

Vice-Presidents.

Eli K. Price, E. Otis Kendall, J. L. LeConte.

Secretaries.

P. E. Chase, G. F. Barker, J. P. Lesley, D. G. Brinton.

Councillors for three years.

R. E. Rogers, Robert Bridges, Oswald Seidensticker, Richard Wood.

Curators.

Hector Tyndale, C. M. Cresson, Henry Phillips, Jr.

Treasurer.

J. Sergeant Price.

Pending nominations Nos. 885 to 892 were read.

Mr. Lesley was nominated for Librarian for the ensuing year.

And the meeting was adjourned.

Stated Meeting, January 16, 1880.

Present, 16 members.

President, Mr. FRALEY, in the Chair.

A letter of acknowledgment was received from the R. Academia dei Lincei, Dec. 16, 1879 (102, 103).

Letters of envoy were received from the U. S. Department of the Interior, Jan. 2; the U. S. Naval Observatory, Jan. 16; and Dr. B. A. Gould, Director of the Argentine Observatory at Cordova, S. A.

Donations for the Library were received from the Geological Survey of Japan; the Russian Academy; the Zoologischer Anzeiger; M. Delesse, and the Revue Politique of Paris; London Nature; the Museum of Comparative Zoölogy at Cambridge; the Canadian Naturalist; Harvard Observatory; Silliman's Journal; the Scientific American; the Numismatic Society; the Journal of Pharmacy; the Cincinnati Natural History Society; the Botanical Gazette; the Bureau of Education; the Geological Survey of the Territories; the Fish Commissioners; the Department of the Interior; General Wheeler; and the Mexican Meteorological Bureau.

The death of Dr. Jacob Bigelow, at Boston, Jan. 10, 1879, aged 92, was reported.

Mr. Phillips read an elaborate description of his latin copy of the curious Cosmography of Sebastian Munster, who was born 1489, and died at Basle, *circa* 1552.

Mr. Hall exhibited his provisionally colored map of south-eastern Pennsylvania, from Trenton westward to and across the Susquehanna River, and discussed the age of the Philadelphia rocks on his hypothesis of their metamorphism, considering them Silurian, and perhaps in part Devonian.

Mr. Rand, Prof. Frazer and Mr. Lesley took part in the discussion, the last two dissenting from the view held by Mr. Hall.

A communication was made by Dr. Greene "On a New Synthesis of *Saligenin*."

Mr. Lesley was elected Librarian for the ensuing year.

The President appointed the Standing Committees as follows:—

On Finance.

Mr. Eli K. Price,
Mr. B. V. Marsh,
Mr. Henry Winsor.

On Publication.

Dr. John L. LeConte,
Dr. D. G. Brinton,
Dr. G. H. Horn,
Prof. E. Thomson,
Dr. C. M. Cresson.

On the Hall.

Gen. H. Tyndale,
Mr. S. W. Roberts,
Mr. J. S. Price.

On the Library.

Mr. Eli K. Price,
Rev. C. T. Krauth,
Mr. Henry Phillips, Jr.,
Dr. R. S. Kenderdine,
Prof. E. J. Houston.

Pending nominations Nos. 885 to 892 were read, spoken to, and ballotted for, and on scrutiny of the ballot boxes by the President, the following persons were declared duly elected members of the Society :—

Cav. Damiano Muoni, of Milan.
Mr. Charles Francis Adams, of Boston.
Mr. Henry Wharton, of Philadelphia.
Mr. Charles A. Ashburner, of Philadelphia.
Mr. Robert C. Winthrop, of Boston.
Mr. Archibald Geikie, of Edinburgh.
Dr. Oliver Wendell Holmes, of Boston.
Mr. George Whitney, of Philadelphia.

And the meeting was adjourned.

Stated Meeting, February 6, 1880.

Present, 14 members.

President, Mr. Fraley, in the Chair.

Letters accepting membership were received from Robert C. Winthrop, 90 Marlborough Street, Boston, January 23: Henry Wharton, 2011 Delancey Place, Philadelphia, January 19; Charles A. Ashburner, 9 Woodland Terrace, West Philadelphia, January 28; Charles Francis Adams, Boston, January 22; and Oliver Wendell Holmes, M. D., Boston, January 23.

Letters of acknowledgment and postal cards (Proc. 104), were received from many correspondents and members.

Letters of envoy were received from the London Meteorological Office, December, 1879, and the Royal Society of New South Wales, December 18, 1879.

Letters were received from Prof. S. F. Baird and Miss Mary A. Henry, respecting Prof. Henry's library.

A letter was received from Mr. J. G. Henderson, Winchester, Scott Co., Ill., January 6, respecting mound skulls.

Donations to the Library were received from the Asiatic Society of Japan; the Academies at Berlin and Brussels; the Ludwig Salvator Museum, at Dresden; the Geographical Society and School of Mines, at Paris; the Geographical Commercial Society, at Bordeaux; the R. Astronomical Society and Meteorological Society, in London; the Rev. S. S. Lewis of Cambridge, England; the Museum of Comparative Zoology in Cambridge, Mass.; the Boston Society of Natural History; the American Journal of Science and Arts in New Haven; Prof. W. Carrington Bolton; the Historical Society and American Chemical Society, of New York; the Poughkeepsie Society of Natural History; the Pennsylvania Historical Society; the Franklin Institute; the American Journal of Pharmacy; the American Journal of the Medical Sciences and Medical News; Mr. Henry Phillips, Jr.; and Dr. B. A. Gould, Director of the Observatory at Cordova, South America.

The death of the Hon. Adolph E. Borie, at Philadelphia, on the 5th instant, aged 70, was announced by Mr. Price.

The death of the Rev. Dr. Rudder, at Philadelphia, on the 29th ultimo, aged 58, was announced by Mr. Price.

Prof. Cope exhibited suites of skulls of extinct mammalia (allied to canis, felis and ursus), obtained in the Tertiary deposits on the Pacific Coast, and described their order of evolution. Among them was the skull of a large cave-bear.

He then read a paper "On the Foramina perforating the posterior part of the Squamosal bone of the Mammalia."

New nominations Nos. 893, 894, 895 were read.

Mr. Fraley reported the receipt of the last quarterly interest on the Michaux Legacy, due Jan. 1, amounting to $132.

On motion of Mr. Phillips it was

"*Resolved,* That whereas the Society was incorporated on the 15th day of March, 1780, a fact on which the late Mr. Robert M. Patterson laid great stress in his address before the Society in 1843, as having given 'to this Society for the first time a legal position which it now occupies,' and

"*Whereas*, The 15th day of March, 1880, will mark the hundredth anniversary of such incorporation, therefore be it

"*Resolved*, That the Board of Officers and members in Council be respectfully requested to make suitable arrangements for celebrating this anniversary."

And the meeting was adjourned.

Stated Meeting, February 20, 1880.

Present, 17 members.

President, Mr. FRALEY, in the Chair.

A letter accepting his appointment to prepare a eulogy on Dr. Wood, was received from Dr. Henry Hartshorne, dated on the 9th instant.

A letter of envoy from the Harvard College Observatory was received, dated Jan. 29.

An acknowledgment of the receipt of Proceedings, No. 104, was received from Prof. Wm. P. Blake.

A circular letter of invitation to send delegates to the Centennial Anniversary of the American Academy of Arts and Sciences, on the 26th of May next, in Boston, Mass., was read and its consideration postponed to the next meeting.

A circular letter of invitation to attend the celebration of the two-hundredth anniversary of the discovery of the Falls of St. Anthony, at 10 o'clock, A. M., on the 3d day of July, 1880, on the University Campus, Minneapolis, Minnesota, was read and its consideration postponed to the next meeting.

A circular letter was received from the late Chief of the Statistical Bureau of Sweden, Herr Fr. Th. Berg, and another from his successor, Herr Elis Sidenbladh, desiring a continuance of correspondence.

Donations to the Library were received from the Swedish Bureau of Statistics; the Academia dei Lincei; the Revue Politique; the Bordeaux Geographical Society; London Nature; the American Academy, and Boston Society of Natural History; the Hon. G. C. Winthrop; the Harvard Observatory; the North American Entomologist; the Franklin Institute; the Medical News; the Smithsonian Institution; the U. S. Naval Observatory; the Light House Board; the Department of the Interior, the Cincinnati Society of Natural History, and the Revista Scientifica.

An obituary notice of the late Joseph Henry was read by Mr. Fairman Rogers.

The death of Mr. James Lenox, in New York, on the 18th inst., aged 80, was announced by the Secretary.

The death of Dr. John Neill, in Philadelphia, on the 12th inst., aged 60, was announced by Mr. Price. On motion, Dr. Brinton was appointed to prepare an obituary notice of the deceased.

Dr. König communicated facts respecting his discovery of *Spinel* and *Chondronite* in the crystalline limestone of Chester county, Pennsylvania, and exhibited specimens, comparing them with specimens from Orange county, N. Y., and explaining their analogy with the minerals of Franklin, N. J.

Dr. Brinton communicated a memoir on the Timucua language of Florida, by Albert S. Gatschet, and gave a verbal summary of its contents, manner and value. This is the third important study of this group of languages, the other two having been already published in the Proceedings of the Society.

Prof. Frazer explained by diagrams his new arrangement, by a side-hinged mirror, for illuminating intensely the whole field of the object under a microscope. A strong side light is reflected at a low angle from the *under* surface of a glass plate placed across the front of the objective, on to and again from the side mirror suspended from hinges, on to the object, and so back through the tube to the eye of the observer.

The minutes of the last meeting of the Board of Officers and Council were read.

Pending nominations Nos. 893, 894, 895, and new nominations Nos. 896, 897 were read.

And the meeting was adjourned.

Stated Meeting, March 5, 1880.

Present, 17 members.

President, Mr. Fraley, in the Chair.

A letter accepting membership was received from Mr. Archibald Geikie, dated Geological Survey Office, Edinburgh, Feb. 2.

Letters of acknowledgment were received from the Natural History Society, Emden, dated Nov. 15 (102); the Royal Society of Luxembourg, dated Aug. 20 (102); the Société Hollandaise, dated Harlem, Sept 20 (102, 103); and the Surgeon General's Office, at Washington, dated Feb. 20 (104).

Letters of envoy were received from the Trigonometrical

Survey of India, dated Dehra Dun, Jan. 20; the Natural History Society, dated Emden, Nov. 15; the Royal Saxon Society, dated Leipsig, Oct. 25; the Imperial Academy, dated Vienna, Dec. 1; the Société Hollandaise, dated Harlem, Dec.; the U. S. Naval Observatory, and Department of the Interior, dated Washington, Feb. 19.

A letter respecting Dr. Gabb's memoir was received from Mr. R. S. Swords, acting Librarian of the New Jersey Historical Society, dated Newark, March 3.

Donations for the Library were received from the Mining Bureau at Victoria; the Repertorium für Meteorologie at St. Petersburg; the Academies at Berlin, Vienna, Rome, and Brussels; the Societies at Moscow, Stuttgardt, Halle, Giessen, Emden, Bordeaux, Liège, and Harlem; the Swedish Bureau of Statistics; the German Geological Society at Berlin; the Geological Association at Dresden; the Revue Politique; the Grand Ducal Institute at Luxembourg; the Minister of the Interior at Brussels; the London Astronomical, Geographical and Meteorological Societies; Society of Arts, and London Nature; the Essex Institute; the New York Academy of Sciences; the Brooklyn Entomological Society; the North American Entomologist; Dr. Wm. Elder; Mr. W. B. Taylor; the U. S. Department of the Interior; the Army Bureau; the Journal of Pharmacy, at Philadelphia; the Cincinnati Observatory; the St. Louis Public School Library; the Kansas Historical Society; and the San Francisco Mercantile Library Association.

An obituary notice of the late John W. Harden was read by Mr. Lesley.

The death of Gen'l Clement A. Finley, in West Philadelphia, September, 1879, was announced by the Secretary.

On motion the committee on the paper of X. Y. Z. for the Magellanic premium, was entrusted with the care of the document for examination, to report.

Mr. Ashburner exhibited specimens and photographs of Oil Sands, and read a paper on the constitution of the Bradford Oil Sand of McKean county, Pennsylvania. Remarks were made by Dr. Rogers and Mr. Lesley.

Prof. Frazer exhibited his microscopic reflector, made by Mr. Zentmeyer.

Mr. Frazer then discussed the principles of the problem of the popular 15 number puzzle with Mr. Briggs.

Pending nominations Nos. 893 to 897, and new nominations Nos. 898 to 901 were read.

On motion, the subject (postponed from the last meeting) of appointing delegates to assist at the Centennial Anniversary of the American Academy of Science and Art, at Boston, was referred to the President, Mr. Fraley, with power to act.

And the meeting was adjourned.

On the Constitution of the Bradford Oil Sand. By Chas. A. Ashburner, M.S., Asst. Second Geological Survey of Pennsylvania. (With a plate.)

(Read before the American Philosophical Society, March 5, 1880.)

The constitution of the petroleum sands of Western Pennsylvania, which were discovered in Venango county twenty-one years ago, and which have ever since been producing mineral oil, is no doubt familiar to most of our geologists. The question suggests itself; in what way is the Bradford sand of McKean county, Pennsylvania, and Cattaraugus county, New York, dissimilar?

Before describing the structure of the sands, permit me to give some general facts showing the relative per centage of *dry holes* and the out-put of the *producing wells* in the two districts. At a glance, the comparison will indicate that some essential differences must exist in the sands and mode of occurrence of the oil, to account for the different results which have been obtained.

During the year 1879, there were 475 wells drilled to the Venango oil sands in the counties of Warren, Venango, Clarion and Butler; of this number 122 were *dry holes* or produced no oil; being 25.7 per cent.

In the Bradford or Northern district, there were during the same year, 2536 wells drilled to the Bradford oil sand, of which number but 76 were *dry holes* or only 3 per cent.; being nearly 23 per cent. less than in the Venango or Western district.

The average daily production, for the first month, of the wells drilled in the Bradford sand was about 20 barrels, while for the wells in the Venango sands it did not attain that amount.* When we take these facts into consideration, we can readily understand why there should have been 2536 wells drilled in the Northern district to only 475 in the Western.

Since the beginning of the year 1875, when the Bradford oil horizon was discovered, there have been 6249 wells drilled in the district, of which 236 were dry holes or 3.77 per cent. From the most authentic statistics which I can gather in the Western district, about one-fourth of all the wells which have been drilled in the Venango sands, since their discovery in 1859, have proved dry.

The Bradford sand consists of a gray and white sand, of about the same coarseness as the ordinary beach sand of the Jersey coast; compact, yet loosely cemented. The average thickness of the sand is about 45 feet, and from top to bottom, the sandy strata change but little in their general character. It is only when specimens from the successive layers are placed side by side and closely examined, that any difference in structure can be recognized. The grains of sand are angular, vary but slightly in size, color and the quantity of cementing material which holds them together in their rock bed.

The same homogeneousness, which characterizes the vertical section, is found to exist over a considerable horizontal area. In fact but little change is found to exist in the sand obtained from wells 15 miles apart, or in the sand from the intermediate wells.

The greatest length of the Bradford district is 18 miles north, 30° east; its greatest width is 12 miles in a north and south direction. The area of the territory is between 100 and 110 square miles. In this area the sand is so regular and constant that if wells were drilled at random the number of dry holes, which would be obtained, would hardly exceed 2 in every 100. The percentage of dry holes spoken of as being obtained in the district includes those which were drilled outside of the *probable oil territory* and were genuine *wild-cat wells*.

In the Western district the characteristics of the Venango sands are quite different. The third or bottom sand, which is the most productive of the

* Some of the wells drilled to the Venango third oil sand have produced from 2000 to 3000 barrels of oil per day, while the largest well ever found in the Bradford district has not exceeded as many hundred. The largest individual wells have been located in the Western district; the largest average wells in the Northern district.

group, is sometimes thin, very fine, micaceous and muddy when taken from the sand pump ; in this condition it seldom produces any petroleum. This is the character of the sand at Pleasantville, where it contained only a trace of oil. The black oil of this district came from what was known as the stray or split third, occurring some 25 feet above the regular sand. Where the Venango sands are formed in thin layers, fine grained and clayey the driller views the territory with suspicion.

NOTE.—It must be remembered in comparing the sands of the two districts that they belong to different geologic formations. Based on lithological and stratigraphical facts, I make the Venango oil sand group the equivalent of the Red Catskill, No. IX (Old Red Sandstone), while the Bradford sand is of Chemung age.

The following general section shows their relative positions :

Venango group, Catskill, No. IX.	First sand..................	40 feet.
	Interval....................	105 "
	Second sand................	25 "
	Interval....................	110 "
	Third sand.................	35 "
Chemung, No. VIII.	Interval............................	1000±
	Bradford sand.	45′ "

See "Oil Sands of Penna.," Franklin Institute Journal, April 1878, also "Bradford Oil District," Transactions American Institute Mining Engineers, Vol. VII ; by the Author.

The accompanying illustration shows a typical specimen of a good producing third sand in the Venango group and a specimen of Bradford sand, such as might be taken from any of the producing wells in the Northern district. A productive Venango sand consists of a white, gray or yellow pebble rock ; the pebbles being loosely cemented together and generally bedded in fine sand. The rock is open and porous. The interstices between the pebbles and sand grains are extensive and capable of containing a large bulk of oil ; but this character does not maintain itself over any extended area. Areas of such sand are small and scattered and are separated by sand beds, possessing a character belonging to the unproductive sands.

The Venango sands are not homogeneous over any considerable area and are frequently very heterogeneous in section. The thickness of the sand varies ; in one locality the upper part of the sand may be pebbly and of productive character and the lower part fine and contain no oil, while but a short distance away the conditions may be reversed.

Such then are the principal features of the two great oil producing rocks of Pennsylvania.

Résumé. The Bradford sand is fine but porous; constant in thickness; homogeneous in section; the character of the sections remaining the same over a very wide area.

The Venango sands are sometimes coarse, pebbly and porous, and sometimes fine, compact and clayey; variable in thickness; heterogeneous in section and subject to sudden changes in very short distances.

The difference in the structure of the sands, when considered in connection with their relative productiveness, is a strong argument in support of the view which has been accepted by the *best informed* of our geologists that the sands are only reservoirs or sponges which serve to hold the oil, coming almost entirely from an inferior formation to which it is indigenous.

The conditions under which these two sands were deposited must have been essentially different. The Venango sands were undoubtedly shore and shallow water deposits. The currents, by which the sediments forming the group were transported, were evidentiy rapid and shifting. It has been suggested that the sands may have been laid down in a river bed. This would necessitate dry land at the time, on either side of the territory where the sands are at present found.

The Bradford sand was possibly deposited in deeper water, by a slower and more constant current. It does not bear any evidences of being a shore deposit, but was probably formed in a bay or estuary.

An Obituary Notice of the Late John W. Harden. By J. P. Lesley.

(*Read before the American Philosophical Society, March* 5, 1880.)

John W. Harden was born at Leicester, England, June 19th, 1816, and died at Philadelphia, November 8th, 1879.

He was versed in the arts of Horticulture and Floriculture, and for a number of years followed them professionally. Was especially successful in designing, ornamenting and laying out estates, notably those of Hon. Capt. Cust, Wormleybury, Hertfordshire and Sir Ralph Howard, Bart., Craven Cottage on the Thames.

He commenced practice as a Mining Engineer in 1846, and in that year took the management of the Hawkesbury Colliery, near Coventry, England. He was the means of introducing into the Warwickshire coal field most of the modern improvements at that time only in use at the best collieries in the North of England. Wire ropes took the place of hemp ropes and chains, guides and carriages were introduced, high speed direct acting hoisting engines replacing the slow, geared machine of the condensing type. These improvements required corresponding facilities, and extended operations underground, so that much larger areas of mineral were by these means won through one shaft.

He left this colliery in 1857 for the purpose of sinking the New Shafts for the Exhall Coal Company, for winning the coal and ironstone underlying the Blakeslee estate, to the dip of the Hawkesbury Colliery. He succeeded in passing the waterbearing strata and reaching coal, although a former attempt by others had failed. He here met with an accident from which it was thought he could not recover. In descending the shaft he was caught between the carriage and surface plate; receiving injuries about the head and face which disfigured him, and no doubt shortened his life many years. After his recovery he made a professional trip to this country, from which he derived so much benefit that he determined to settle in America, and did so in 1865, and for a time had charge of the Anthracite Mines of the Plymouth Coal Company, in Luzerne county, Pennsylvania.

In 1866, he with his sons, established and maintained a large professional practice in Wilkesbarre until 1870, when he removed to Philadelphia, continuing practice until physical disability confined him to the house. His last report was made in August, 1874, for the Cameron Coal Company. He retained all his faculties, and continued to give advice up to within two weeks of his death.

He was married three times, and leaves a widow and two children, besides four grown sons by his first marriages.

He was a member of the North of England Institute of Mining and Mechanical Engineers, the American Philosophical Society, and the American Institute of Mining Engineers.

My acquaintance with Mr. Harden commenced on board the Liverpool steamer in the autumn of 1863. I was going to make a special investigation of the alleged success of a new process for hardening the heads of rails, which led me on to an examination of the Bessemer experiments in various parts of Europe; and he was returning from the journey to which I have already alluded.

His face was disfigured by the terrible injuries it had received; but that could not conceal the dignity and amiability which was natural to it. He was attractive in all respects, and I soon found the utmost satisfaction in our intercourse. Sir Henry Holland was our constant companion in our walks on deck, and it would be hard to say which of the two, unlike as they were, inspired one with more pleasure.

No one could long know Mr. Harden without loving him and confiding in him. His judgments of men's motives were kind; his criticisms of their acts tempered by justice and guided by a long experience; his opinions were liberal and manly; his business decisions were gravely and concisely expressed, after a close and systematic statement of all the facts of the case after personal examination. He impressed every one with the feeling that they were dealing with a man who professed to know only certain things, and to know these because he had used or made opportunities for learning them well, before he spoke of them. His uprightness was so evidently ingrained that it seemed to hold no relations with either an educated sense of duty, public opinion, or business interests; and the perfect straightforwardness with which he treated everything and everybody gave to his carriage and demeanor the air of nobility.

These traits of character with which I could not help being greatly impressed during our voyage, and which merely made me at that time look upon my companion of a week as one of the finest specimens of man I would be likely to encounter, became in after years the basis of a warm friendship between us.

In the following year I was called upon to designate the Superintendent of an extensive colliery near Wilkesbarre, to equip which it was necessary to make both sinkings and buildings, lay railways and throw a large bridge across the Susquehanna river. I was fortunate enough to induce Mr. Harden to accept the responsible position, and he took this opportunity to settle with his sons in America. Had his accident of 1863 not implanted the seeds of paralysis in his brain, we should not now be lamenting the long sufferings and death of a remarkable man; for, during a number of years he acquired a reputation among our coal and iron men, which would have placed him foremost among professional experts of Mining Engineering in Pennsylvania.

His physical energy and endurance so well supported his intellectual ability; his long experience was so completely at the command of a good judgment; the warmth of his heart colored so charmingly his inflexible and proud integrity; while natural force of will and earnestness of purpose made his executive plans rapid and direct, and his methods so thoroughgoing as to be the reverse of that penny-wise pound-foolish, hand to mouth manner so common with Americans,—that life alone failed to the establishment of his fame among us.

Such was the man whose name stands worthily on the list of members of our Society.

Astronomical Approximations. II, III. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(Read before the American Philosophical Society, Jan. 2, 1880.)

II. Velocity of Light, and Kirkwood's Analogy.

The cosmical undulations should produce effects at every centre of inertial reaction, which would furnish data for approximate determinations of the velocity of light. We have seen that the favorable central position of the Earth, in the belt of greatest condensation, leads to a simple equation for Sun's apparent diameter and, therefore, for finding the quotient of Earth's distance from Sun by Sun's semi-diameter. The accuracy of the result is confirmed by other inferences which may be drawn from the same data.

Kirkwood's Analogy may be formulated thus:

$$\left(\frac{\rho_n}{\rho_0}\right)^3 \times \left(\frac{\nu_0}{\nu_n}\right)^2 = \text{a constant} \ldots\ldots\ldots\ldots\ldots (1.)$$

Let ρ_0 denote Sun's semi-diameter; ρ_1, ρ_2, etc., the mean vector-radii of the several planets (Mercury$_1$, Venus$_2$, etc.); μ, mass; t, time of rotation synchronous with revolution at Laplace's limit; ν_n, number of rotations in ν_0 orbital revolutions synchronous with primitive solar rotation; v_λ, velocity of light; v_n, velocity of revolution $(\sqrt{gr})$ at the surface of planet$_n$; r, planetary radius; the subscript figures being applicable to μ, t, ν, v, and r. The actions and reactions of light-waves, between the nucleal centre (Sun) and the principal centre of primitive condensation (Earth), lead to the equation, similar to Kirkwood's:

$$\left(\frac{\rho_n}{\rho_0}\right)^3 \times \left(\frac{\nu_0}{\nu_n}\right)^2 = \left(\frac{v_n}{v_\lambda}\right)^2 \frac{\mu_0^2}{\mu_n \mu_3} \times \left(\frac{t_n}{t_3}\right)^2 \frac{r_n}{r_3} \ldots\ldots\ldots (2.)$$

For Earth, $\rho_n = \rho_3 = 214.54\rho_0$; $\nu_n = \nu_3 = 366.256\nu_0$; $v_n = v_3 = .0012383 r_3$; $v_\lambda = 214.54\rho_0 \div 497.83 = .43096\rho_0$. Substituting, and taking the square root of equation (2), we get:

$$\frac{214.54^{\frac{3}{2}}}{366.256} = \frac{.0012383 r_3}{.43096\rho_0} \times \frac{\mu_0}{\mu_3} \ldots\ldots\ldots\ldots\ldots\ldots (3.)$$

If we designate density by δ, mass varies as $r^3\delta$, or as the square of $\frac{r}{v}$. Therefore $\frac{\delta_3}{\delta_0} = \left(\frac{r_0}{g_0} \div \frac{r_3}{g_3}\right) = \left(\frac{1 \text{ year}}{214.54^{\frac{3}{2}}} \div 5074 \textit{ sec.}\right)^2 = 3.9175.$

Substituting in (3), dividing and reducing:

$$\left.\begin{array}{l} \frac{214.54^{\frac{3}{2}}}{366.256} \times \frac{.43096}{.0012383} \times 3.9175 = \left(\frac{\rho_0}{r_3}\right)^2 \\ 108.155 r_3 = \rho_0 = 428,600 \text{ miles.} \\ \rho_3 = 214.54 \rho_0 = 91,950,000 \text{ miles.} \\ v_\lambda = \rho_3 \div 497.83 = 184,710 \text{ miles.} \end{array}\right\} \ldots\ldots\ldots\ldots (4.)$$

If we suppose Sun to contract till Laplace's limit would correspond with Sun's present equatorial radius, the foregoing equations would all be deducible from the following:

$$\left.\begin{array}{l} \frac{\rho_3 t_3}{\rho_0 t_0} = \frac{v_3}{v_\lambda} \\ \frac{\rho_3}{\rho_0} \times \frac{1 \text{ dy}}{.11624 \text{ dy}} = \frac{4.907}{184,710} \\ \rho_0 = 323,350 \rho_3 \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots (5.)$$

In these first approximations no allowance has been made for orbital eccentricities, or for disturbances by the principal planets. I am, therefore, inclined to attach more importance to the following methods.

The equivalence of luminous action and reaction, between the nucleal centre (c_0) and the principal centre of primitive condensation (c_3), is shown by Earth's still retaining one-half of the original rupturing force. According to Stockwell, Earth's mean eccentricity is .0338676. If the rupturing locus is represented by mean perihelion, since the superficial velocity of rotation in a condensing nebula varies inversely as radius, the rupturing velocity was $\frac{1}{.9661324}$ times the mean velocity. The constant solar equation $\frac{g_0 t_0}{2} = v_\lambda$, would be satisfied in $.9661324 \times \frac{1}{2}$ yr., if we look only to solar gravity at the corresponding nucleal surface, or in .9661324 yr., if we look to initial terrestrial gravity as one-half of corresponding solar gravity.

$$\left.\begin{array}{l} v_\lambda = .9661324 \times 365.256 \times 86400 \times \frac{32.0874}{5280} = 185,287 \text{ miles.} \\ \rho_3 = 497.83 v_\lambda = 92,242,000 \text{ miles.} \end{array}\right\} (6.)$$

In equation (4), if we substitute Earth's mean solar day for the sidereal day, we get:

$$\rho_0 = \left(\frac{366.256}{365.256}\right)^{\frac{1}{2}} \times 428,600 = 429,200 \text{ miles.}$$

$$\left.\begin{array}{l} \rho_3 = 92,070,000 \text{ miles.} \\ v_\lambda = 184,970 \text{ miles.} \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.)$$

By the well-known laws of elasticity, M, the solar *modulus* of light, or the height of a homogeneous æthereal atmosphere, at Sun's surface, which would transmit undulations with the velocity of light, is $\left(\frac{v_\lambda}{v_0}\right)^2 \rho_0$. This is equivalent to $\left(\frac{.43096}{.00062563}\right)^2 \rho_0 = 474{,}500\rho_0$. For v_λ, as we have already seen, is $.43096\rho_0$, and v_0 is $\frac{2\pi\rho_3 \times (214.54)^{\frac{1}{2}}}{365.256 \times 86400} \times \frac{214.54\rho_0}{\rho_3} = .00062563\rho_0$. If the cyclical variations of alternately increasing and diminishing stress, to which every particle of the Sun is exposed during each half-rotation, are due to the velocity of light, the equations, $\frac{g_0 t_0}{2} = v_\lambda$, and $\sqrt{g_0 \rho_0} = .00062563\rho_0$, give:

$$\left.\begin{aligned} g_0 &= .00000039142\rho_0 \\ t_0 &= \frac{2 \times .43096\rho_0}{g_0} = 2{,}202{,}050 \text{ sec.} = 25.486 \text{ dy.} \end{aligned}\right\} \quad \ldots\ldots(8.)$$

The continual disturbances at Sun's surface, and the combined influences to rotation and revolution upon spots near the solar equator, make it impossible to find the exact value of t_0 by direct observation. Laplace's estimate was $25\frac{1}{2}$ days; Carrington's 25.38 days. According to his observations, "near the equator the period was about 25.3 days, while it was a day longer in 30° latitude. Moreover, the period of rotation seems to be different at different times, and to vary with the frequency of the spots. But the laws of these variations are not yet established. In consequence of their existence, we cannot fix any definite time of rotation for the Sun, as we can for the Earth and for some of the planets. It varies at different times, and under different circumstances, from 25 to $26\frac{1}{2}$ days." *

It is, therefore, impossible now to assign any more probable value to t_0 than the one which I have deduced theoretically from the stress of luminous waves. If future observations should lead to the acceptance of a period which is either slightly less or slightly greater, the discrepancy can be easily accounted for, either by orbital acceleration or by inertial resistance and retardation.

If ρ_a represents Stockwell's determination of the centre of the belt of greatest condensation ($1.016878\rho_3 = 218.16\rho_0$) and if we suppose a similarity of action and reaction at the nucleal centre (Sun's centre $= c_0$) and at the dense-belt centre (c_a), we find:

$$\left.\begin{aligned} &\left(\frac{M}{\rho_0}\right)^{\frac{1}{2}} \times \left(\frac{\rho_a}{\rho_0}\right)^{\frac{1}{2}} = \frac{1\ yr.}{1\ dy.} \times \frac{g_0}{g_3} \\ &(474500 \times 1.016878 \times 214.54)^{\frac{1}{2}} = 366.256\frac{g_0}{g_3} \\ &g_0 = 27.78g_3. \\ &\rho_0 = \frac{g_0\,\delta_3}{g_3\,\delta_0} r_3 = 27.783 \times .9175 \times 3962.8 = 431{,}250 \text{ miles.} \\ &\rho_3 = 214.54\rho_0 = 92{,}520{,}000 \text{ miles.} \\ &v_\lambda = 185{,}850 \text{ miles.} \end{aligned}\right\} \quad \ldots(9.)$$

*Newcomb: *Popular Astronomy*, p. 250.

The influence of luminous undulation is also shown by the principal planet of the light belt (Jupiter), which is also the controlling planet of the system. For the time required by light, to traverse the linear orbit ($4\rho_5$) which would be synchronous with Jupiter's orbit, is equivalent to the time of satellite revolution at Jupiter's surface $\left(2\pi\sqrt{\frac{r_5}{g_5}}\right)$.

$$\left.\begin{array}{l}
4 \times 5.2028 \times 497.829 = 10360.24 = 2\pi\sqrt{\frac{r_5}{g_5}} \\
\frac{\delta_0}{\delta_5} = \left(\frac{10360}{10043}\right)^2 = 1.0642 \\
\frac{r_0}{r_5} = (1047.875 \div 1.0642)^{\frac{1}{3}} = 9.9485 \\
\frac{g_0}{g_5} = 1047.875 \div (9.9485)^2 = 10.587. \\
\frac{\nu_5}{\nu_0} = 11.86 \times 365.256 \times 24^h \div 9^h\ 55^m\ 26^s.5^* = 10477.56. \\
\frac{c_\lambda}{r_5} = (10.587 \times 9.9485)^{\frac{1}{2}} \times 688.84 = 7069.5 \\
\frac{t_3}{t_5} = 24^h \div 9^h\ 55^m\ 26^s.5 = 2.4183. \\
\text{Substituting in (2); } (5.2028 \times 214.54)^3 \div (10477.56)^2 = \frac{1047.88}{7069.5^2} \times \\
\quad \left(\frac{1}{2.4183}\right) \times \frac{\rho_0\ r_5}{\rho_3\ r_3} \\
\text{Multiplying by } \frac{r_0}{r_5} = 9.9485, \text{ and reducing; } 137718750 = \left(\frac{r_0}{r_3}\right)^4 \\
\rho_0 = 108.33 r_3 = 429,300 \text{ miles.} \\
\rho_3 = 214.54 \rho_0 = 92,100,000 \text{ miles.} \\
c_\lambda = .43096 \rho_0 = 185,000 \text{ miles.}
\end{array}\right\} \quad (10.)$$

The experiments which are now in progress, for measuring the velocity of light, may lend interest to the following comparative tabulation, in kilometers, of some of the most important approximations to the velocity.

	By Measurement.		
Maxwell	(Electricity),	288,000	kil.
Ayrton and Perry	"	298,000	"
Foucault,		298,360	"
Michelson,		299,820	"
Cornu,		300,000	"
	By the Nebular Hypothesis.		
From Kirkwood's Analogy,		(4) 297,254	kil.
" " "		(7) 297,672	"
" Jupiter's density,		(10) 297,720	"
" Earth's mean perihelion		(6) 298,182	"
" Primitive condensation		(9) 299,088	"

*This is the time of Jupiter's rotation, as given by Professor Asaph Hall.

All the elements for the foregoing calculations can be measured with much greater accuracy than the solar parallax, the position of the moon's centre, cometary disturbance, or any other similar astronomical data. The identification of luminous and electro-magnetic action, by Weber, Kohlrausch, Thomson, Maxwell, and Perry and Ayrton, together with Peirce's investigations of the influence of repulsive force in the miniature world-building of cometary nuclei,* lead me to hope that further research will show what modifications are needed in order to secure exact astronomical measurements, by means of the equal action and reaction of opposing forces.

III. Controlling Centres.

The principal centre of gravity in the solar system (Jupiter–Sun), is at $5.2028 \times 214.54\rho_0 \div 1047.88 = 1.06522\rho_0$. The ratio of synchronous lineal and circular orbits $= \frac{2}{\pi}$. The wave-velocity which counteracts Earth's semi-diurnal variations of stress, is $v_\beta = \frac{32.08 \times 43082}{5280} = 261.76$ miles. Equating radial (numerator) and tangential (denominator) influences, we find:

$$\left.\begin{aligned} \frac{v_\lambda}{v_\beta} &= \frac{2}{\pi} \times \frac{1.065\rho_0}{\rho_5} \\ v_\lambda &= 186,025 \text{ miles.} \\ \rho_3 &= 92,606,000 \text{ miles.} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1.)$$

At any given distance from cosmical centres the orbital influence is proportioned to the mass. Hence the equation:

$$\left.\begin{aligned} &\frac{v_\lambda}{v_\beta} \times \frac{v_5}{v_3} = \frac{\mu_5}{\mu_3} \\ &\frac{186,025}{261.76} \times \sqrt{\frac{1}{5.2028}} = 311.56 \\ &\frac{\mu_0}{\mu_3} = 311.56 \times 1047.88 = 326,500 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (2.)$$

A similar reciprocity, introducing some further interesting considerations, may be found by looking to the centre of reciprocal nebular rupture, Neptune's secular perihelion. Adopting Stockwell's value of Neptune's greatest eccentricity (.0145066), and taking the mean between Stockwell's (30.03386) and Newcomb's (30.05437) estimates of Neptune's mean radius-vector, Neptune's secular perihelion (ω) is at $3\pi^2\rho_3$. Both the linear centre of oscillation and the collisions of subsiding particles† tend to produce cosmi-

*Trans. Amer. Acad., 1859.

†*Ante*, xvii, 100.

cal aggregations at $\frac{2}{3}r$. This tendency, considering ω as a centre, would fix the boundary of the belt of retrogradely rotating planets at $\frac{1}{3}\omega = \pi^2\rho_3 = 9.8695\rho_3$, or between Saturn's mean and aphelion positions, so that Saturn well represents the surface of the belt of directly rotating planets. When the rotating wave-velocity (w) was operating in Saturn's orbit $\left(\text{at } \frac{\omega}{3}\right)$ the orbital velocity $\left(\frac{w}{\pi}\right)$ was found at $\left(\frac{\omega}{3\pi} = \pi\right)\rho_3$, or in the asteroidal belt (3.142), nearly midway between the mean perihelion of Mars (1.403), and the secular perihelion of Jupiter (4.886), and also nearly midway between Earth's secular aphelion (1.068), and Jupiter's mean distance (5.203), as well as between the mean aphelia of Venus (.774), and Jupiter (5.519). The next change of wave-rotating to orbital velocity brings us to Earth, the central and greatest mass in the belt of greatest condensation. If we start from 2ρ, the surface of early subsidence which would give orbital velocity at ω, all these relations may be embodied in the equation:

$$\left.\begin{array}{l} \left(\dfrac{v_\lambda w_3}{g_0 \; r_0 \; r_3}\right)^2 = 6\,\pi^2. \\ \left(\dfrac{688.84}{16.982}\right)^2 \times \dfrac{g_3}{g_0} = 59.217 \\ 27.785 g_3 = g_0 \\ \text{By Eq. II., (9); } \rho_3 = 92{,}540{,}000 \text{ miles.} \\ \mu_0 = 329{,}200 \mu_3 \end{array}\right\} \quad \ldots\ldots\ldots (3.)$$

The action and reaction between the reciprocal centre (Neptune) and the centre of condensation (Earth), are also shown in the ratio between v_3 and the velocity of terrestrial rotation (w_3):

$$\left.\begin{array}{l} \dfrac{v_3}{w_3} = \dfrac{4.907}{.289} = 16.982 \\ \dfrac{\mu_3}{\mu_8} = \dfrac{w_3}{v_3} \\ \dfrac{\mu_0}{\mu_8} = \dfrac{329{,}200}{16.982} = 19{,}385 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4.)$$

Newcomb's estimate for $\frac{\mu_0}{\mu_8}$, as deduced from observations on Neptune's satellite, is 19,380 ± 70. By combining (4) with Eq. (11) in "Further Confirmations of Prediction," * we find the equation between moments of reciprocal rotation $\left(\frac{\mu}{\rho^2}\right)$ and times of synchronous rotation and revolution $\left(2\,\pi\sqrt{\frac{r}{g}}\right)$:

* Ib. xviii, 231.

$$\left.\begin{array}{l} \dfrac{\mu^3\,\rho_8^{\,2}}{\mu_8\,\rho_3^{\,2}} = \dfrac{\mu_0\,t_3}{\mu_3\,t_0} \\ \dfrac{19{,}385\rho_8^{\,2}}{329{,}200\rho_3^{\,2}} = \dfrac{329200 \times 5074 \text{ sec.}}{1 \times 31558150 \text{ sec.}} \\ \rho_8 = 29.9936\rho_3 \end{array}\right\} \dots\dots\dots\dots (5.)$$

The Saturnian orbit embraces the primitive centre of rotating inertia; Saturn's mean position having been influenced by the locus of reciprocal rupture (Neptune's *m. p.**), the two chief points of incipient condensation (Jupiter's *s. a.* and Saturn's *s. a.*), and the mean positions of the other planets, as will be seen by the following table, in which Sun's mass = 10,000,000,000 :

	μ_n	Authority.	$\rho_n \div \rho_3$	Authority.	$\mu\,\rho^2$
1. Mercury,	2,055	Encke,	.3871 *m.*	Leverrier,	308
2. Venus,	23,406	Hill,	.7233 *m.*	Leverrier,	12,246
3. Earth,	30,600	Newcomb,	1.0000 *m.*	Leverrier,	30,600
4. Mars,	3,233	Hall,	1.5237 *m.*	Leverrier,	7,506
5. Jupiter,	9,543,087	Bessel,	5.5193 *s. a.*	Stockwell,	290,693,300
6. Saturn,	2,855,837	Bessel,	10.3433 *s. a.*	Stockwell,	305,528,600
7. Uranus,	442,478	Newcomb,	19.1834 *m.*	Newcomb,	162,837,000
8. Neptune,	515,996	Newcomb,	29.7322 *m. p.*	Stockwell,	456,140,000

$$\left.\begin{array}{l} \sqrt{\Sigma\mu\rho^2 \div \Sigma\mu} = \rho_6 \\ \Sigma\mu = 13{,}416{,}692 \\ \Sigma\mu\rho^2 = 1{,}215{,}247{,}560 \\ \sqrt{\Sigma\mu\rho^2 \div \Sigma\mu} = 9.517 \end{array}\right\} \dots\dots\dots\dots\dots\dots (6.)$$

Saturn's mean radius-vector is $9.539\rho_3$. The above result, therefore, indicates a slight preponderance, beyond the orbit of Neptune, of the unknown cosmical matter in our system. If the influence of all this unknown preponderance is equivalent to that of a mass about $\frac{3}{4}$ as great as Earth, at the locus of incipient subsidence ($2\omega = 6\pi^2\rho_3$), the mean moment of nebular rotation of each planet is represented by Saturn's mean position.

μ	$m(\rho_n \div \rho_3)$	$\mu\rho^2$
1	.3871	308
2	.7233	12,246
3	1.0000	30,600
4	1.5237	7,506
5	5.2028	258,317,647
6	9.5388	259,852,941
7	19.1834	162,837,000
8	30.0339	465,444,000
x	59.2170	76,446,000

**a*, aphelion; *p*, perihelion; *m*, mean; *s*, secular.

$$\left.\begin{aligned}\Sigma\mu &= 13,440,100\\ \Sigma\mu\rho^2 &= 1,222,948,248\\ \sqrt{\Sigma\mu\rho^2 \div \Sigma\mu} &= 9.539\end{aligned}\right\}\quad\ldots\ldots\ldots\ldots(7.)$$

The ratio of Uranus to Neptune appears to have been determined by the incipient condensation of the system. For orbital velocity is proportioned to $\left(\frac{\mu}{\rho}\right)^{\frac{1}{2}}$; therefore, for any constant initiatory velocity, like v_λ, mass is proportioned to the radius of equal orbital velocity, or inversely to the $\frac{2}{3}$ power of the velocity of reciprocal orbital revolution, or to the cube root of the distance from the Sun. Designating the locus of incipient condensation (Neptune's secular aphelion) by ρ_γ, we find

$$\left.\begin{aligned}\mu_7(\rho_\gamma)^{\frac{1}{3}} &= \mu_8(\rho_7)^{\frac{1}{3}}\\ \mu_7(30.4696)^{\frac{1}{3}} &= \mu_0\frac{(19.1834)^{\frac{1}{3}}}{19385}\\ \frac{\mu_0}{\mu_7} &= 22618.\end{aligned}\right\}\quad\ldots\ldots\ldots\ldots(8.)$$

Newcomb's estimate of $\frac{\mu_0}{\mu_7}$ is 22600 ± 100.

The inner retrogradely-rotating planet (Uranus) is connected with the belt of directly-rotating planets by the two proportions :

$$\left.\begin{aligned}\mu_7 : \mu_5 &: : \rho_{3(2)} : \rho_{7(4)}\\ \mu_7 : \frac{\mu_0}{1047.88} &: : .9661 : 20.044\\ \frac{\mu_0}{\mu_7} &= \frac{20.044 \times 1047.88}{.9661} = 22530\end{aligned}\right\}\quad\ldots\ldots\ldots\ldots(9.)$$

$$\left.\begin{aligned}\mu_7 : \mu_3 &: : v_{0(a)} : v_{0(3)}\\ \frac{\mu_0}{22530} : \mu_3 &: : \sqrt{214.54} : \sqrt{1.019256}\\ \frac{\mu_0}{\mu_3} &= \sqrt{\frac{214.54}{1.019256}} \times 22530 = 326,900\end{aligned}\right\}\quad\ldots\ldots\ldots\ldots(10.)$$

In equation (9), $\rho_{3(2)}$ = Earth's mean perihelion ; $\rho_{7(4)}$ = mean aphelion of Uranus. In equation (10), $v_{0(a)}$ = velocity of projection at the mean perihelion centre of gravity of Sun and Jupiter (5.2028 × 214.54 × .95684 ÷ 1047.88 = 1.019256); $v_{0(3)}$ = Earth's mean orbital velocity. The influence of Jupiter's mean perihelion position will be further shown in the following comparisons (13, 14).

In the early ellipsoidal or truncately paraboloidal nucleus indicated by Peirce's cometary and meteoric researches, of which Uranus (19.1836) represents the perihelion, and Neptune (30.034) represents the aphelion, Jupiter's mean aphelion (5.4274) was central.

The centre of reciprocal rupture (Neptune's secular aphelion = 30.47), the paraboloidal centre (Jupiter's secular aphelion = 5.52), and the centre of the dense belt (Earth = 1), are connected by the geometrical proportion

$$1 : 5.52 : : 5.52 : 30.47 \quad \ldots\ldots\ldots\ldots (11.)$$

The masses at the centres of rotary inertia (Saturn), and of early nebulosity (Jupiter), are proportioned to their respective gravitating tendencies towards the nucleal centre (Sun), or inversely proportioned to the squares of their vector-radii, so that their primitive moments of rotary inertia were equal.

$$\left.\begin{array}{l} \mu_5\rho_5^2 = \mu_6\rho_6^2 \\ \dfrac{5.2028^2\mu_0}{1047.88} = \mu_6 \times 9.5388^2 \\ \dfrac{\mu_0}{\mu_6} = 3522.3 \end{array}\right\} \quad \ldots\ldots\ldots\ldots (12.)$$

Bessel's value is 3501.6, so that the theoretical mass is about .006 too small. This approximation, which was first pointed out by Professor Stephen Alexander, convinced me that all the cosmical masses must be determined by ascertainable laws, and thus led me to the results which are embodied in the present and previous communications.

The ratio between the masses at the centre of rotary inertia (Saturn), and at the centre of greatest condensation (Earth), appears to have been determined by Jupiter's perihelion influence and by centrifugal force, since the masses vary nearly inversely as their gravitating tendencies towards the Sun, or directly as the squares of their vector radii.

$$\left.\begin{array}{l} \dfrac{\mu_6\rho_3^2}{\rho_a} = \dfrac{\mu_3\rho_6^2}{\rho_0} \\ \dfrac{\mu_0}{3522.3 \times 1.019256} = \mu_3 \times 9.5388^2 \\ \dfrac{\mu_0}{\mu_3} = 326{,}661 \end{array}\right\} \quad \ldots\ldots\ldots\ldots (13.)$$

The ratio between the masses at the nucleal centre (Sun), and at the centre of primitive nebulosity (Jupiter), combines the projectile, the centrifugal, and the square of the centripetal ratios, thus illustrating the thermodynamic law that equal quantities of heat correspond to equal increments of *vis viva* in simple gases.

$$\left.\begin{array}{l} \dfrac{\mu_0}{\mu_5} = \left(\dfrac{\mu_5}{\mu_6}\right)^2 \times \dfrac{\mu_5}{\mu_3} = \left(\dfrac{\rho_6}{\rho_5}\right)^4 \left(\dfrac{\rho_6}{\rho_3}\right)^2 \times \dfrac{\rho_a}{\rho_0} \\ \dfrac{\mu_0}{\mu_5} = \dfrac{9.5388^6 \times 1.019256}{5.2028^4} \end{array}\right\} \quad \ldots\ldots (14.)$$

The centrifugal ratios between Saturn and Earth (13), and the centripetal ratios between Saturn and Jupiter (12), are further illustrated by the vector-radii of the centre of inertia and the centre of nebulosity. For, if we take a locus at $\frac{9}{11}$ of ρ_6, ρ_5 is at $\frac{2}{3}$ of the locus, or at the centre of subsidence collision and the centre of linear oscillation, while the locus itself is at the centre of projection due to Saturn's spherical *vis viva* $\left(.4 \text{ of } \frac{5}{11} = \frac{2}{11}\right)$.

$\frac{6}{11}$ of 9.5388 = 5.20298....... ....(15.)

This approximation gives a value for Jupiter's mean radius-vector which is only about $\frac{1}{290}$ of one per cent. too large.

In the dense belt, the moment of rotary inertia ($m\rho^2$) of Mars (7,506) is $\frac{1}{4}$ of Earth's (30,600), while that of Venus (12,246) is .4 of Earth's, thus indicating the influence of Sun's mean spherical moment of inertia, when expanded to Earth's orbit. The uncertainty with regard to Mercury's mass is too great to warrant any present speculation as to its origin, or its influence on the stability of the system.

The principal considerations, involved in these approximations, are:

1. Fourier's theorem. that every periodic vibratory motion can always be regarded as the sum of a certain number of pendulum vibrations.

2. The natural alternation of radial and tangential oscillations, in elastic media surrounding centres of inertia.

3. Maxwell's theorem of equality between *vires vivæ* of translation and *vires vivæ* of rotation.

4. Equality of action and reaction, especially in centripetal and centrifugal tendencies.

5. Perihelion indications of primitive centrifugal or rupturing force, and aphelion indications of primitive centripetal "subsidence."

6. Synchronism of rectilinear ($4r$) and circular ($2\pi r$) orbits.

7. The tendency of nodes in elastic media to establish harmonic nodes.

8. The laws of elasticity which connect arithmetical ratios of distance, with geometric and harmonic ratios of density.

9. The different variability, in condensing nebulæ, of times of rotation ($\propto r^2$) and times of revolution ($\propto r^{\frac{3}{2}}$).

10. Laplace's limitation of rotating elastic stress, by the radius of equal times of rotation and revolution.

11. The counteraction of the cyclical variations of stress, during each half-rotation, by the central force (g), after the analogy of projectiles from the Earth's surface.

12. The constancy, at the nucleal surface of any expanding or contracting nebula, of the stress-opposing value $\frac{gt}{2}$.

13. The tendency, in the primitive rupture of a nebula, to rotations in opposite directions.

14. The continual reciprocal action, between attracting centres, $\left(g \propto \frac{\mu}{d^2}\right)$ of disturbances proportional to mass.

15. The limiting influence of parabolic velocities, upon tendencies to dissociation and to aggregation.

16. The ratio of stress-opposing force, at Laplace's limit, to parabolic $\left(\frac{\pi}{\sqrt{2}}\right)$ and to orbital (π) velocity.

17. The influence of centres of linear and of spherical oscillation.

18. The conjoint influence of centres of nucleation, of density, of nebulosity, of rotary inertia, and of reciprocity.

19. The equations of relation between oscillatory and orbital motion.

20. The interesting and suggestive FACT, important in chemistry and general physics as well as in astronomy, that the central stress-opposing value in the solar system $\left(\frac{gt}{2}\right)$ is the velocity of light.

The Relations of the Crystalline Rocks of Eastern Pennsylvania to the Silurian Limestones and the Hudson River Age of the Hydromice Schists. By Charles E. Hall. With a Plate.

(Read before the American Philosophical Society, January 2, 1880.)

Recently Prof. Frazer called the attention of the Academy of Natural Sciences to the fact of the occurrence of the fossil *Buthotrephis flexuosa* in the Peach Bottom roofing slates of York county, Pennsylvania. As Prof. Lesquereux admits that this fossil does not extend below the Trenton limestone, it is in all probability within the Hudson river group. Dr. Emmons assigned this fossil to the Taconic System. Since Dr. Emmons' time, I think the fossiliferous bed of the Taconic system have been pretty well proven to be of the Cambrian series, which would place this Taconic fossil of Emmons somewhere about the Hudson river group.

I embrace this opportunity to state some facts from which I have drawn conclusions concerning the relative positions of the rocks forming the crystalline series of Eastern Pennsylvania.

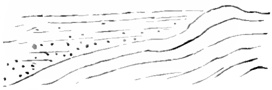
I shall endeavor to make my statements concise, and I think my reasoning will be understood.

We have the following series of rocks:

First. A series of granitoid, syenitic, quartzose, and micaceous schistose rocks, to be seen on the Delaware river above the city bridge at Trenton, and extending in a south-easterly belt across Bucks and Montgomery counties, as far west as Chestnut Hill, Philadelphia.

Second. A series of syenitic, hornblendic and quartzose rocks extending from the neighborhood of Chestnut Hill westward across the Schuylkill river, and covering a greater part of the northern portion of Delaware county. Fine exposures of this rock are to be seen on the Schuylkill river below Spring Mill, Montgomery county. This series may be the upper members of the first, or that extending from the Delaware river to Chestnut Hill.

Third. Potsdam sandstone, conglomerate, quartzite, and occasional schistose beds. In this group is included the Edge Hill rock which extends in an unbroken ridge from the Delaware river at Trenton to Huntingdon Valley in Montgomery county, and another ridge of the same rock from a point south of Willow Grove to Spring Mill, Montgomery county, near the Schuylkill river. The Edge Hill sandstone is identical with the quartzites flanking the north side of the limestone valley of Montgomery and Chester counties, and merges into them about Willow Grove. This,



the Potsdam sandstone, rests unconformably upon the preceding two groups. The unconformity is seen at points east of Willow Grove, where the lower conglomerates contain fragments of the syenitic rocks.

Fourth. Dolomites, schistose or slaty micaceous beds, limestone, marble, hydromica schists and bastard marble. This group of limestones and schists rest upon the above group, and are the equivalent of the Cambrian limestones of the Great Valley. Trenton fossils have been found in the upper part of this group at Buckingham, Bucks county, by Mr. Ash. This Bucks county belt of limestone is cut off from the limestones of Chester Valley by the New Red Sandstone. There is no apparent unconformity throughout the limestone group. The lower beds are Dolomites; there are occasional alternations of shale throughout the mass. The marbles are all confined to the upper horizon and are followed by alternations of shale and shaly limestone.

Fifth. Hydromica schists, quartzose schists, chloritic schists, and occasional beds of quartzites and sandy beds and serpentines. It is difficult to draw a line between this group and the limestones, which pass into it by alternations exactly as the Trenton limestone passes into the shales of the Hudson river group in Central Pennsylvania. These are the Hudson river shales and flank the Chester Valley on the south from some point not far east of the Schuylkill river throughout the entire length of the valley. They extend south to the syenitic rocks of the second group, and west of the Schuylkill to the neighborhood of the Brandywine creek in Chester county, and gradually widening out to the south-west.

Sixth. Micaceous, garnetiferous schists, limestone in beds which rapidly thin out to the eastward, mica schists, and sandstones. The area of this group I have not determined, but it is principally confined to the southern central portion of Chester county. resting upon the Hydromica schists of the group above-mentioned. The eastern boundary is about the line of the Brandywine creek, although a tongue extends east of the creek to the neighborhood of Dillworthtown. This group rests unconformably upon the western extension of the *second* group.

Seventh. The mica schists of Philadelphia, mica schists, hornblendic, garnetiferous, talcose schists with soapstone and serpentine. These rocks lie to the south of the first and second groups of rocks, and are cut off on the west and south by the rocks of the second group from any connection with the rocks of Chester county. They rest unconformably upon the first, second, third and fourth groups and are somewhat different in character from the fifth group, though they resemble portions of the sixth group.

There are besides these groups probably two serpentine horizons, which are undoubtedly unconformable deposits above the second group. I think the northern belt of serpentine may be considered as altered Hudson river rock; while the southern belts are doubtful.

The *first* and *second* groups are the oldest rocks, overlaid by the Potsdam sandstone unconformably. The Potsdam is flanked on the south by the *first* from Willow Grove to Chestnut Hill, where this group seems to be succeeded by the *second*. It may be only the upper part of the first, however, the sandstone rests on both. The *first* group is flanked on the south by the Edge Hill rock or Potsdam S. S. from the Delaware river to the Pennepack creek in Montgomery county. To the north the upturned edges of these rocks are overlaid by the New Red Sandstone. West of the Pennepack creek the structure is plainly a synclinal, the axis of which would be just south of Willow Grove; and an anticlinal, the axis being about on a line from Abington to Attleboro.

The syenitic rocks flank the Potsdam on the north of the synclinal north of Willow Grove, encircle the end of the synclinal and are exposed along the anticlinal to a point near Chestnut Hill. The Potsdam sandstone is not found between Huntingdon Valley on the Pennepack and Waverly Heights, south-west of Edge Hill P. O., along the south side of the anticlinal.

The overlying limestone occurs just south of Huntingdon Valley, overlying the sandstone, and extends westward beyond the Pennepack creek some distance, lying *immediately above* the gneisses of the first group.

The unconformity is evident between the gneisses of the first group and the limestones, and inasmuch as the limestone occurs almost on the line of strike of the sandstone which again appears at Waverly Heights, it would seem to be sufficient proof of its unconformity to the sandstone.

Resting on the Potsdam sandstone from the neighborhood of the Delaware river to a point near Huntingdon Valley, and on the limestones between Huntingdon Valley and Waverly Heights, and also on the Gneisses of the first group, we have the micaceous, garnetiferous schists of the Philadelphia group. These are unconformable, resting upon and against these lower rocks.

The sandstone along the south margin of the synclinal, which I spoke of as extending from Willow Grove to the Schuylkill is, most of it, very different in character to that along the north side. The difference in character on the north and south sides of the valley may be due to the infiltration of ferruginous matter derived from the New Red sandstones which flank the group and overlap it on the north.

The dips are high, the rocks are sandy, light colored and very free from iron as a rule; the ridge is known as Edge Hill. Towards the Schuylkill it dies down rapidly, and disappears below the limestones at Spring Mill, not only swallowed up by a fault, but unconformably overlapped as well.

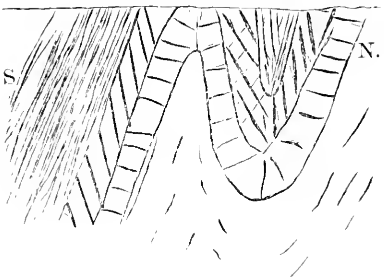
On the north side of this synclinal valley, we find the quartzites and sandstones forming prominent ridges, having a much less dip and covering greater areas. There are several cynclinals and anticlinals, the axes of which form an obtuse angle to the line of strike of Edge Hill. These folds die down very rapidly to the eastward, but are marked by slight irregularities in the line of strike of Edge Hill.

I have been long inclined to consider the elevations of sandstone along the north flank of the limestone valley, as having been caused by folds and faults, but I do not see any proofs of faulting. But there is evidence of unconformity between the two groups, as at Spring Mill, where the limestone overrides the upturned Potsdam; at a point west of the second crossing of Sandy Run by the North Penn. R. R., just south of Fort Washington, the limestone occurs in a bay in the sandstone, having a slighter dip. Just south of Mogeetown, east of the Schuylkill river, near Norristown, the limestones rest unconformably upon the Potsdam, to all appearances.

The anticlinal ridges of Potsdam extending diagonally into the valley, are flanked on both sides by limestone, and, in some cases, disappear below the limestone which encircles it; but in the most eastern fold I doubt whether the limestone is connected.

The marble is confined to the south side of the valley. The dip of the limestone being to the south, it would place them at or near the top. Marble quarries are found in Chester county, close along the southern margin of the limestone valley, and in close proximity to the slates. In Montgomery county the same rule holds good, and very shortly after the disappearance of the slates to the east of the Schuylkill, we find the marble is missing as well.

The rocks rise rapidly to the eastward. The slates of the South Valley Hill are in regular succession upon the limestone. This may be seen where the South Valley Hill ends at Gulf Mills. The structure is clearly proven by the succession of rocks, which is marble, bastard marble, shale, on the north side of the synclinal and a double repetition on the anticlinal at Gulf Mills. The cove made by the erosion of the anticlinal is just west of Gulf Mills, west of Conshohocken. The transition shaly limestones are repeated several times by minor contortions, and extend over a wide area from Gulf Mills to the Schuylkill river.



The alternations from the limestone into the slates is everywhere visible along the southern margin of the Chester valley.

The slates are traversed by a trap dyke, which crosses the Schuylkill at Conshohocken. I do not think it marks the line of any disturbance of importance. The synclinal and anticlinal of the slates do not cross the Schuylkill river. The slates flanking the marbles east of the Schuylkill lie in a monoclinal, pitching to the south against the Potsdam, which was upturned along the line from Spring Mill to Edge Hill P. O., probably prior to their deposition. This is evident from the fact that the limestones lap over the rocks of the second group at West Conshohocken.

It may be that the great unconformity of the measures west of the Schuylkill river cannot be explained without a fault along the line of junction.

The southern margin of the slates of the South Valley Hill is somewhat irregular, they come in contact with the rocks of the *second* group as far west as the east branch of the Brandywine creek, or that neighborhood, where they are succeeded and overlaid by micaceous garnetiferous rocks with limestone of the *sixth group*.

The southern boundary of the South Valley Hill slates or Lower Hudson river slates, is about on a line from West Conshohocken to a point about four miles north-west of West Chester, and gradually diverges from the line of the Chester valley as we proceed westward. This divergence is caused partially by the flattening of the measures, and partially by their increased thickness.

The sixth group which flanks the South Valley Hill rocks on the south and overlies them, increase rapidly in thickness to the west of the Brandywine creek. This group lies upon the rocks of the *second* group and encircles the western end of that area. The East Branch of the Brandywine creek cuts along close to the line of junction, between these groups. The schists in places are found on both sides of the creek, while at other points the syenitic rocks of the *second* group extend west of the line. The limestones of this group are well exposed in the neighborhood of Doe Run. The most easterly exposures are at Caleb Cope's and Copesville on the Brandywine; also at Brinton's Bridge on the Brandywine, and two localities east of Brandywine creek, one in Birmingham and the other in Thornbury township.

The locality at Caleb Cope's place, north-west of West Chester, is a similar deposit to the one at Brinton's Bridge, a thin bed of impure crystalline limestone between beds of schistose rock.

The first locality is on a line with the locality at Cope's Mill, and as can be seen by the map, is also on a line with a number of limestone quarries west of it. I have satisfied myself by walking over the ground that they all belong to one horizon, and if not absolutely continuous they are only broken by the thinning out of the limestone itself. The locality at Brinton's Bridge is on a line with the quarries of East Marlborough and London Grove townships, and although it is a small bed, it is flanked on both sides by the same rocks which flank the heavier beds further west. The fact of it being a thin bed bears me out in the assertion that all these beds thin rapidly towards the east.

I am not prepared to say whether or not there is more than one horizon of limestone in this portion of Chester county. I am forced to the conclusion as to its superposition to the South Valley Hill slates, as the succession is clearly seen along the East Branch of the Brandywine Creek.

The rocks of this group seem to vary considerably, and it is not improbable that they may have to be subdivided, as I have included all the schistose rocks with limestone from the South Valley Hill slates along the East Branch of the Brandywine to Chadd's Ford or the Maryland line, and west at least as far as Avondale, Chester county. From their position above the slates of the South Valley Hill, which are Hudson river, they belong to a limestone group above the Hudson river group. Inasmuch as no fossils have been found as yet, it is difficult to assign them to any particular age, but I am inclined to think that they may be Silurian and possibly Helderberg.

There may be an unconformity between these schists and sandstones and the slates below, but as yet I have not been able to determine the area of the upper group accurately, and before this is done it is impossible to state decidedly what the relation is.

In Eastern New York, south-west of Albany, we find the Hudson river shales and sandstones overlaid by the Niagara in thin beds of concretionary limestone, often not recognizable, followed by the Helderberg limestone, the Oneida conglomerate, Medina sandstone, the Clinton group, and Onondaga shales, all having died out east and north before reaching the Helderberg escarpment. May we not have similar structure here?

The limestones of the Chester Valley extend in an almost straight line from the Schuylkill river to the neighborhood of Quarryville, in Lancaster county, where the straight valley ends and connects with the great limestone valley of Lancaster county at Camargo P. O.

At Camargo P. O., according to Prof. Frazer's map, a tongue of slates connects across the limestone and is colored the same as an area of rock north of the limestone valley, extending to the county line south and east of the Gap P. O.

The limestone valley from the Schuylkill to Quarryville or thereabouts is a monoclinal, the beds all pitching to the southward, followed by Chloritic schists, Hydromica schists and Mica schists, which overlie the limestones. This is clearly demonstrated at the eastern end of the South Valley Hill, which is formed by these slates. The marbles, which are always confined to the southern edge of the valley, mark the horizon of the Trenton limestone with its alternations of slate and slaty limestone, passing by alternations into shale and slate of the South Valley Hill or Hudson river group. Just north of Gulf Mill a synclinal of the slates dies out, and at Gulf Mill we have a double repetition of the alternations of impure limestone and slate found flanking the synclinal on the north, which proves Gulf Mill to be on an anticlinal axis. (See wood cut.)

The dips, as a rule, are pretty high towards the Schuylkill river, varying from 50° to 85°. But as we proceed westward they become somewhat less, which may in part account for the widening of the slate area before spoken of, but there is a marked thickening in the beds to the southwestward, which also must be taken into consideration.

Owing to the short time I have for the preparation of this paper, I will proceed to carry these determinations of horizons south-westward.

At Camargo P. O., we would have an anticlinal of slates overlying the limestones, which anticlinal would be on a line of the axis of the Tocquan creek anticlinal recognized by Prof. Frazer on the Susquehanna.

The lower portion of Pequea creek flows along an anticlinal in which the limestone is exposed along the creek to the neighborhood of Marticville P. O. A tongue of slates extends eastward between the Pequea and Conestoga creeks as far as Willow Street P. O., which is on a line of a synclinal axis shown to end at Compassville, and along which the Pequea creek flows from Compassville to Wheatland Mills P. O. An anticlinal having its axis about on a line between Petersville P. O. and the mouth of Conestoga creek. A synclinal of Chloritic slates ending somewhere near Indian town. An anticlinal exposing the limestone, extending from Prospect Furnace P. O., in York county, to Lancaster.

A synclinal of slates extending from a point south-east of Montville P. O. to Washington Manor P. O., and crossing the river, is evident from the distribution of slates in York county, beyond the line of the Peach Bottom R. R. Lastly, we have a monoclinal flanking the Chickis Potsdam, extending from Hempfield, which is at the extreme eastern end of the Potsdam anticlinal through Columbia in Lancaster county, and Wrightsville, York, Springforge to Hanover in York county. North of York the limestone is not continuous across to the northern arm of the anticlinal, which is principally covered by the Trias, but has a considerable exposure in Lancaster county. The slates, therefore, south-east of the limestones of Chester county, are of Hudson river age.

The slates of York and Lancaster counties, which includes the roofing slates of Peach Bottom, are a continuation of those of Chester county, which flank the limestone on the south, and are referable to the same group.

The serpentines of Radnor township, Delaware county, and those of Easttown, Willistown, East and West Goshen, are undoubtedly altered beds of the South Valley Hill slates, or Hudson river slates. They lie unconformably upon the syenitic rocks of the second group.

The probability is that all the serpentines of Chester county will be found to belong to the Hudson river group, and are possibly pretty nearly on the same horizon as the limestones of West Bradford, Merlin, east and west Marlborough, London Grove, Kennet, and other townships of southern Chester county, although I have spoken of this limestone group as being possibly of Helderberg age. The serpentines of southern Lancaster county are undoubtedly altered beds of the Hudson river group, and from their relative position to the roofing slates of Peach Bottom, would be in their proper place.

Dr. T. Sterry Hunt insists that the serpentines of the Schuylkill are below the Philadelphia schists. If they are, the structure would be even more simple than otherwise. Placing them below the Philadelphia schists they would be on a horizon with the serpentine beds of Chester county, and these Philadelphia rocks equivalent to those which they resemble in southern Chester county; but if the serpentines of Montgomery and Delaware counties are above the Philadelphia series, they necessarily belong to a later age than those of the Hudson river group.

At present I am inclined to place these serpentines above the Philadelphia rocks, and, by so doing, assign the Philadelphia series to a higher group than the Hudson river.

The relation of the Philadelphia schists to the schists of the *sixth* group is not fully determined, but they bear a great resemblance to them, and in many respects are identical. The syenitic rocks of Delaware county which belong to the *second* group, cut off the connection between them.

To all appearances the serpentine belts, which are visible on the Schuylkill river at Lafayette station, Montgomery county, and at a point just north of them, are above the mica schists of Philadelphia. The southern belt extends in an almost unbroken line from Chestnut Hill, Philadelphia, to Bryn Mawr, in Montgomery county. A less prominent belt extends from the Schuylkill river to the neighborhood of Rosemont station, on the Pennsylvania R. R., in a parallel line to the first belt.

The serpentines of Delaware county are on a general line of strike with these belts, and without doubt represent the same horizons.

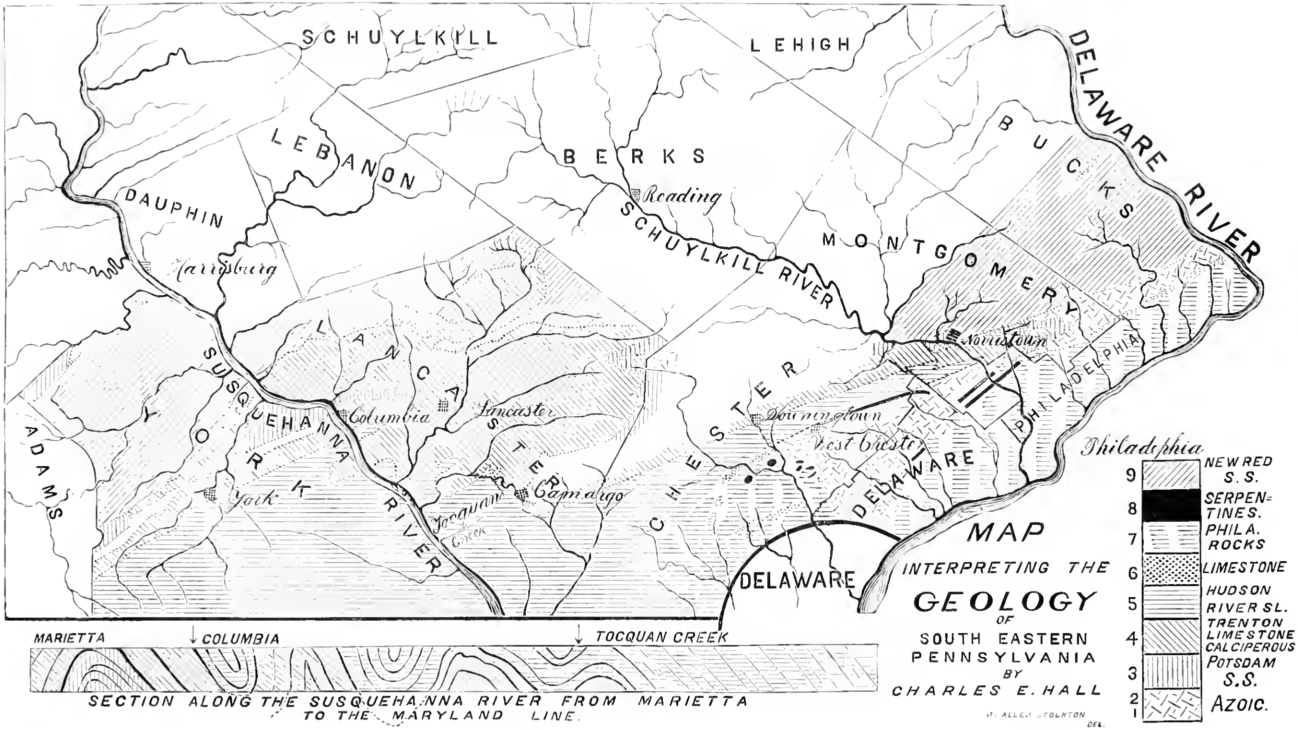
There is no evidence in this section of the Oneida conglomerate or Medina sandstone, as far as I can observe, but there are sandstones in the south-eastern portion of Chester county I have classified with the sixth group, which may prove to belong to a sandstone formation succeeding the Hudson river slates.

	LIMESTONE.
	MICA SCHISTS.
III.	SERPENTINES. GARNETIFEROUS SCHISTS. HYDROMICA SLATES. CHLORITIC SLATES. ALTERNATIONS OF SLATE AND LIMESTONE.
II.	MARBLE. SLATE. DOLOMITES.
I.	POTSDAM SANDSTONE. QUARTZITE.
	SYENITIC AND GRANITIC ROCKS.

There is no doubt that magnesian beds may be altered into serpentines wherever they may be, and the mere fact of serpentine existing at any place is not proof of a given horizon, but it is in all probability confined to definite horizons within limited areas.

The whole question of structure would be easily solved could we prove what is everywhere indicated, viz, a gradual subsidence of the formations north-west of the line of junction between the South Valley Hill slates and the syenitic rock of the *second* group, which change in level, at the close of the Hudson river group, allowed the upper magnesian beds of that group to be deposited over the edges of and encircle the *second* group.

The evident nonconformity between the Philadelphia schists and the


SCHUYLKILL
LEHIGH
DELAWARE RIVER
BUCKS
LEBANON
BERKS
DAUPHIN
Reading
SCHUYLKILL RIVER
MONTGOMERY
Harrisburg
Norristown
LANCASTER
PHILADELPHIA
SUSQUEHANNA
Columbia
Lancaster
CHESTER
Downingtown
West Chester
YORK
ADAMS
York
Camargo
DELAWARE
Tocquan Creek
RIVER
DELAWARE
MAP
INTERPRETING THE
GEOLOGY
OF
SOUTH EASTERN
PENNSYLVANIA
BY
CHARLES E. HALL
Philadelphia
9 NEW RED S. S.
8 SERPENTINES.
7 PHILA. ROCKS
6 LIMESTONE
5 HUDSON RIVER SL.
4 TRENTON LIMESTONE CALCIPEROUS
3 POTSDAM S.S.
2 1 AZOIC.
MARIETTA
COLUMBIA
TOCQUAN CREEK
SECTION ALONG THE SUSQUEHANNA RIVER FROM MARIETTA TO THE MARYLAND LINE.

rocks of the *first, second, third* and *fourth* groups may be due to subsequent faulting, but they are nevertheless more recent.

The accompanying map gives the general outline of the groups. I have used Prof. Frazer's section along the Susquehanna river for illustration with my interpretation. He produced the section through *Chickis* in his report C. C. of the Second Geological Survey. The changes I have made are on structural grounds.

An Account of an Old Work on Cosmography. By Henry Phillips, Jr., A.M.

(Read before the American Philosophical Society, January 16, 1880.)

It has occurred to me that as all knowledge is within the scope of our pursuits, an analysis of a work on Cosmography, the production of a once famous author, might not prove unacceptable. The errors among which men once blindly groped, the silly tales of wonderment with which returned travelers were wont to astonish their stay-at-home friends, the absurd statements once received as absolute facts, but later exploded by the Ithuriel-touch of truth, now at these later days, when we are entirely freed from superstition, folly and ignorance, and a blind reliance upon the *ipse dixit* of anyone, may afford us a lesson pregnant with instruction. It is, therefore, with this view that I venture, this evening, to present to our Society an account of a book which bears for its title :

"Cosmographia Universalis Libri VI. in quibus juxta certioris fidei scriptorum traditionum describuntur omnium habitabilis orbis partium situs propriæque dotes, regionum topographicæ effigies. Terræ ingenia quibus fit ut tam differentes et varias specie res et animatas et inanimatas ferat. Animalium peregrinorum naturæ et picturæ. Nobiliorum civitatum icones et descriptiones, Regnorum initia, incrementa et translationes. Regum et principium Genealogiæ. Item omnium gentium mores, leges, religio, mutationes; atque memorabilium in hunc usque ad annum 1559 gestarum rerum Historia. Autore SEBAST. MUNSTERO."

On the recto of the title-page appears the portrait of the author, an elderly, hard-featured man, beneath which are two Latin poems, laudatory of that distinguished person and his work. The preface is dated at Basle, March, 1550.

Sebastian Munster may serve us as an example of the scholars of the olden time. He was born at Ingelheim, in 1489, and became a Cordelier monk, but, having adopted the opinions of Luther, he renounced the robes and the yoke of a cloister and took to himself a wife. Such was the usual course in those days which the converted clergy took to show their hatred to the tenets of the church of Rome, where enforced celibacy was of primary importance, and weighed so heavily upon them.

For several years Munster taught at Basle, where he gave to the public many valuable works, having rendered himself so very learned in geographical and mathematical science, and in the Hebrew language, that he was known as the Esdras and the Strabo of Germany. The mere enumeration of his writings in Gesner's *Bibliotheca* occupies several folio pages. He died at Basle, of a prevailing pestilence, on the twenty-third day of May, 1552, in the sixty-third year of his age.

This book was one that became very popular and ran through many editions. It was published at Basle originally in 1550, then successively in 1569, 1574, 1578, 1592, 1598 and 1614. All these editions were in German. The Cosmography was issued in Latin in 1550 and 1554, having been translated by Munster himself. It was issued in French at Basle in 1552, and at Paris in 1575; in Italian at Bale, 1558. A selection from its contents, entitled "A treatise on the New India with other newe founde lande and islandes as well eastwarde as westwarde by Sebastian Munster, translated into English by Richard Eden," was published at London in 1553, and another translation, "A brief collection of strange and memorable things gathered out the Cosmography of Sebastian Munster," was published at London in 1574.*

The book, which is crowded with quaint and rude wood-cuts, begins with a number of full-page maps, among which are the world on the Ptolemæan system (America, of course, not shown), surrounded by a border representing the various winds, Europe and its various divisions (embracing the kingdoms of Bohemia, Hungary, Poland), Africa, Asia and the New World. The British Islands were not of sufficient importance to warrant a special map and are crowded up towards the top of a general map of Europe in such a manner that very little of Scotland is shown. England was at this time under the dominion of Edward VI. (1547–1553), and the influence exercised by it upon the politics of Continental Europe was very inconsiderable; it was looked on, in fact, only as a semi-barbarian island in the far-off northern seas.

Naturally the author begins with the beginning and starts with the creation of the world, drawn from Biblical sources. To this chapter is prefixed a wood-cut representing the world as a plain from whose bounds arise lofty mountains, inhabited solely by animals. In the background is a circle of flames; in the foreground is an ocean with fishes and an old-fashioned high-pooped Dutch galliot, navigating apparently by its own instinct (for not a living being is anywhere to be seen upon it) the new-made waters. Sea monsters raise their heads from the billows and gaze with rapt amazement at the ship, taking it, doubtless, for some novel marine creation. Overhead are shining the sun, moon and stars, while God, represented as an old man with a papal tiara upon his head, is seated between the heavenly bodies upon a cloud. At each of the upper corners of the plate is an angel; at each of the lower corners a very satyr-looking demon.

Then follow chapters upon land, sea, islands, the earth with its vegetable and mineral wealth, earthquakes, hot springs and baths, fires existing

* Brunet.

in the bosom of the ground, natural phenomena, metals and their mode of being mined, the mines and the spirits and devils who rule in them, and the localities where metals are found.

On page 9 is represented a man using the divining rod (*Glueck-ruth*) of forked witch hazel, that is turning in his hands as he steps over a place where mining operations are being conducted. A section of a hill is shown with men at work breaking ore and loading a rail car upon a tramway which leads to an elevator running up to a level with the opening of the mine.

On page 11 we find a machine in use for crushing the crude ore, represented as somewhat similar to a modern quartz crusher, the motive power of which is furnished by an overshot-wheel.

In speaking of the earth and its dimensions, the author says it is hollow in the centre; that this opening or void space is full of flames, and is hell; that it is of sufficient capacity to contain all the millions of damned souls that it will be required to hold. That the earth itself is round, about 5400 (German) miles in circumference, and about 1718 (German) miles in diameter.

There are accounts given of early sea navigation, the deluge, and the terrestrial paradise, of which latter there is an illustration exhibiting the Garden of Eden with a fountain in the centre, walled around with crenated battlements, a lofty tower rising from the middle of the enclosure, and we are also favored with a view of the trees of life and knowledge.

On page 37 we find a picture representing the migration of some early tribe, every one of whom, male and female, is dressed in the fashions prevalent among the Germans of the sixteenth century; before them is drawn a low truck containing standard stores for the journey, in which are several barrels distinctly suggesting to the mind of the observer the idea of *beer*. The parade is passing an old castle.

On page 42 occurs a description of the British Islands, accompanied by a map of the same. England has only three towns represented, viz: London, Dover, and what the engraver is pleased to call *Ochsenfürt* (Oxford). Scotland has only Edinburgh, and Ireland a large city in the extreme south, called *Vatford*. The shape of the British Islands is simply atrocious. It must be a mortification to an Englishman to consider of how little importance his country was but three hundred years ago, while kingdoms that now have sunk into oblivion and their names even lost, were then potent, flourishing, and even objects of dread.

The description of England is short, and contains nothing of interest. Speaking of Ireland, reference is made to the rebellion of 1534, and the great slaughter that followed in its wake. The manners of the Scotch are condemned, but their mental and moral qualities much praised; a statement is made that the use of coal for burning is so common, that in Scotland the beggars supplicate it for alms. In this kingdom is found the very wonderful stone known as *Gagates* (p. 45):

"A stone which, although of a rough and common appearance, yet partakes somewhat of a Divine essence, for it kindles fire in running streams which nothing but oil can extinguish. If any one should drink the water in which this stone has been steeped, if there has been any stain upon the chastity of such a one, he (or she) will immediately be compelled to micturate, nor can he (or she) possibly avoid it; but if it is drunk by one who is pure, no such evil effects will result."*

The English language is thus spoken of: "It is a mixture of many tongues, especially German and Gallic. Formerly, as we learn from Bede, it was entirely Germanic, who thus writes: 'The ancient inhabitants of England were accustomed to reckon their months according to the course of the moon, calling the moon *Mona* (which the Germans call Mon), and a month, *Montha*. December was called *Haleg monath* (*i. e.*, Holy month), and April, *Eoster monath*, from a goddess named *Eostre*, to whom the Teutonic tribes were wont to sacrifice in this month in Pagan times. May was called *Thri melci* (thrice milked), because in that month they usually milked their cattle so often.' This passage," continues Munster, "is not to be in the printed copies of Bede's works, but I found it in a manuscript which Glareanus ex Nigra Silva in 1545 sent here to Basle."

Scotland possesses yet another wonder (p. 49):

"Here there are trees which produce a fruit enveloped in leaves; this when the proper time arrives falls down into the water below and is turned into a living bird which is called the *Tree Goose*. This tree grows in the island of Pomonia which lies to the north of Scotland at a short distance therefrom. This tree is mentioned by all the old Cosmographers, especially Saxo Grammaticus, so you must not think we have made up this account. Æneas Sylvius writes in this manner concerning it: 'We have formerly heard that there was a tree in Scotland growing on a river's bank, whose fruit was in the form of aniseed, which when it had come to maturity fell of its own accord, some on the land and some into the water; and those which fell on the land petrified, but those that alighted in the water soon receiving life began to swim and afterwards on their wings and pinions took to flight. When we were in Scotland in the reign of King James hearing of these things we endeavored to investigate them, all persons uniting in affirming the marvel, but the further to the north we traveled the further was removed the place of the miracle so that it was finally said not to exist in Scotland at all but in the Orcades Islands.'"

The description is accompanied by a wood-cut representing the tree with its fruit in various stages of development. Some are entirely closed, some are a crack open, some have the heads of the birds peeping out of them. At the base of the tree is water within whose vivifying influences a number of these rare exotics may be seen disporting themselves. Owing to the favorable position of the tree, only two of its fruits are threatened with premature extinction by falling upon the dry land.

There is a map and metrical description of the city of Paris, dated 1548, and on page 185 is a large two page plate representing the theatre at Verona, in its perfect state as it formerly appeared, but of which "only ruins now remain." It is a huge edifice built upon arcades and around it

*The Venerable Bede speaks of a stone called *gagates*, and says: "it (Britain) hath much and excellent jet, which is black and sparkling, glittering in the fire, and, when heated, driveth away serpents."

a river is flowing. It was ascribed to Octavius and is said to have furnished seats for 23,184 persons.

At page 249 is a description of the dialect formerly spoken in the island of Sardinia.

At page 408 is given a description of two terrible earthquakes which occurred at Basle in 1346 and 1356, accompanied by a wood-cut representing the overthrow of the city; the church steeples, palaces and houses being raised in the air and cast upon the ground.

At page 431 mention is made of curiosities found in the mines of Alsatia, as follows:

"There is in this region a lake extremely long and broad and deep, which contains many kinds of living animals and reptiles reproduceed by nature in pure copper on the neighboring rocks so that they can be most easily recognized and known. That most learned man John Hobensack sent me a specimen of one of these stones which figure I have reproduced here."

According to the picture it is a very ugly looking fish, with a large head and fins close behind the junction of the head and body, and a single fin lower down; the body seems coated with plates like a crocodile, with a dividing line running up the back.

At page 488 occurs a description of the town of Mayence, in which is found a description of the invention of the art of printing, which is attributed to John Guttenberg.

At page 489 is a long description of the invention of cannon and gunpowder, which latter is ascribed to Bernhard Schwarz. A picture of the very rude artillery in use in those days accompanies the letter-press.

At page 493 occurs an account of the tradition of Bishop Hatto and the Mouse-tower, where it is stated that a similar tale is told of a king and queen of Poland (names not given) who, with their children, were devoured by mice. A woodcut shows the tower on an island in the Rhine, with the mice swarming up the walls, climbing into the windows, and gnawing at the foundations.*

A monster born in the Palatinate is thus described on page 625:

"In the year 1495, in the month of September, a woman at Bierstadt gave birth to a monster in the form of two girls, whose bodies were joined together at the forehead, so that they always looked into each other's eyes, but in all other respects were entirely distinct and separate. I (Munster) saw them myself at Mayence, in the year 1501, when they were about six years old. They were forced to have a common will, to walk together, to sleep and rise together; and when one went forward the other went backward. Their noses almost touched each other, and their eyes, instead of being straight to the front, were crooked to one side. They lived to be almost ten years old, at which time one of them dying, it was necessary from the decay of the corpse to cut them apart; but the wound mortified, and the survivor quickly followed her sister to the grave. The explanation given for this prodigy was that as a pregnant woman was conversing with another, a third suddenly coming up from behind knocked their heads together, and the impression of the fright was communicated from the mother to the fetus."

*Vide also Camerarius, Vol. II, p. 45.

There is a wood cut representing these girls as joined at the forehead, and looking into each other's eyes.

A representation of the manner of coining money in vogue at that time, is found at page 692, and at page 703, men and women are represented bathing together, entirely nude, in one of the mineral bath resorts. The Vehm Gericht is described on page 718, the animals of Prussia at 784, and the martyrdom of John and Hieronymus Huss at page 801.

At page 820 is an engraving which recurs very frequently throughout the book. The subject is, "A great contention between two kings." Two men in regal paraphernalia are represented as hauling and mauling and pulling and tugging at each other, in a tremendous state of excitement, clutching at each other's beards and hair and garments. This probably conveyed to the readers, better than the mere force of words, the close and violent nature of a combat between sovereigns.

On page 832 is a description of Norway, and of the monsters that abound therein. Among these the whale stands pre-eminent with a head shaped somewhat like that of a dog, with huge projecting tusks like those of a boar, and is shown in the act of swallowing a man, who is all out of sight except his head and arms. His comrade, more fortunate, appears on the mainland, naked and in full flight A vessel is being sucked down into a whirlpool, of which the text states that there are many on the Norwegian coast. The ocean is seen swarming with fishes, and a man is portrayed following the sport of angling with a bait that resembles a bundle of hay.

The Lord's Prayer in the language of the Lapps and Finns is given at page 847, and on the same page a description of Iceland occurs, with a representation of Mount Hecla in full eruption.

A short description is given of *Greenland*, at page 850, as follows:

"Grünland means Green Land (*virens terra*), so called on account of the luxuriant herbage found there Of which, as well as of cattle, there is exceeding abundance, as may be seen from the reports brought back by those who have voyaged thither that they make great amounts of butter and cheese, from which we may conjecture that that country is not rough with mountains. It contains two Bishopries, whose Bishops are ordained by the Archbishop of Nidross. The people, through the negligence of their spiritual pastors, have almost relapsed into heathenism, being of fickle disposition, and greatly given to magic arts. By means of incantations and spells, they are reputed to be able to raise, at will tempestuous storms, and to cause the shipwreck of foreign vessels whose remains they desire to plunder. Their own vessels being of *skins*, and very light, are quite safe from collisións against their rocks."

An odd two-page illustration occurs at page 852 of the monsters which are to be found in the Northern Regions. So laughably absurd, so ridiculous and so diverse in their representations that no pen could ever attempt to describe them with the slightest approach to justice. On examining them one feels tempted to exclaim with Bottom, when he awoke from his asinine hallucination, "The eye of man hath not heard, the ear of man hath not seen, man's hand is not able to taste, his tongue to conceive, nor his heart to report" what these remarkable figures were intended to convey.

Monsters of every conceivable age, shape, size, appearance and color; fish with the heads of owls; whales with crocodile's scaly backs and the heads and tusks of wild boars; pig-headed animals with fish's tails and elephants' bodies; fish with cats' faces and ruffles around their bodies; fish that look like turnips and carrots; fish swallowing young pigs; fish with leopards' heads and claws; fish with wolves' heads; fish with oxen's heads; griffin-headed fish; fish with heads of birds and bodies like dock leaves; fish attacking men; gigantic lobsters and crawfish; wonderful fish that look like crows; a sea serpent swallowing a vessel; and many other objects which the credulity and superstition of our ancestors accepted in good faith. A whale is represented as attacking a vessel whose mariners are vainly endeavoring in accordance with the established custom to divert its attention from their ship by throwing overboard a number of small barrels or tubs; a usage from whence arose the saying of *casting a tub to the whale*, meaning to divert one by means of a lesser matter from a greater one. In one corner of the plate occurs the barnacle tree, already described, with its fruit.

At page 905 is the portrait of a monster who was born at Cracow in February, 1547, and lived three hours. It is a boy whose feet and hands terminate in four duck-like webs instead of fingers and toes. There grows out of each knee and out of each elbow a dog's head, being four in all, while from each of his breasts protrudes the head of a ram. At the bottom of the breast bone in his belly is an extra pair of eyes; a forked tail waves up to his head. He has a long and flexible elephant's proboscis in place of an ordinary nose; large and round, saucer-shaped eyes, and an extra pair of ears growing out of the corners of his eyes, which, as well as the ears in their usual position, are formed like those of a rabbit.

At page 1025 occurs the history of the Tower of Babel, apropos of which Munster gives the word bread in fourteen languages, and speaks of Noah as being identical with *Janus*.

The Phœnix is described on page 1034, and at page 1045 the Hyrcanian Tiger; the latter as follows:

"It is a large animal of various colors, which is quite tame when its hunger is appeased. It sleeps three days at a time and upon awakening it washes itself and raises a cry and emits a peculiar scent that attracts to it all sorts of wild animals, for with all such does it preserve friendly relations save with the dragon and with the asp."

The Tartars are described at page 1060 as being anthropophagi, and one of them is delineated as superintending the process of roasting a human body impaled upon a spit over a fire, in the act of turning the viand carefully so as to cook it evenly on all sides.

At page 1066 is a description of India and its customs, one of which is represented by a woodcut of an elephant attached to a plough and serving as a tiller of the soil.

Dragons are seen on page 1069 with all their usual fabulous horrors of scales and wings and jaws; duels between these animals are pictured as of frequent occurrence. Nor is the griffin forgotten among the prodigies which nature is supposed to have lavished upon the lands of the Orient.

At page 1073 a hippopotamus is figured as a horned horse with huge fangs, whose body is half concealed in the river. Snakes are also represented with several heads, each of which bears a regal crown. Still further on (at page 1080) we find the Cynocephali, "the men whose heads do grow beneath their shoulders," the people who have but one eye and that in the centre of their forehead, a race of double-headed dwarfs and a nation whose feet are more than twice the size of the rest of their bodies. These last are represented as taking their ease on their backs under the shadow of their own feet, which they are holding propped in the air supported by their hands. The pygmies and their incessant warfare with their hereditary enemies the cranes, are not forgotten.

At page 1410 occurs a woodcut illustrative of the customs of Cathay which *modestiæ gratia* is transcribed in the German of the edition of 1563:

> "Wan einer sein tochter nie kan aussteürn, nimpt er trumen und pfeyffen, und zeucht mit seine töchtern uff den marckt, und so jederman herzu laufft als zu einem offentlichen spectakel oder schawspil, hebt die tochter ire kleider dahinden auff biss an die schultern, und lasse sich dahinden besehen, darnach hebt sie sich dafornen auch auff biss über die brust, und lasst ihre leib daforne auch sehen, und so etwann einer do ist dem sie gefalt, der nimpt sie zu der eh, und thut kein blinden kauff."

The foregoing extracts will give a general idea of the work and its contents. To transcribe at greater length would be profitless, as the remaining matter for the most part presents no novelty either of subject or treatment. There are narrations of the voyages of Columbus and Vespucius, but differing in no wise from the generally received accounts.

There is a very remarkable map of the New World, which, however, I pass over for the present, intending in the hereafter to make it a study by itself.

It is needless to dilate upon the pleasure to be derived from the perusal of old books. Cardan says with much truth:

> "That as in traveling the rest go forward and look before them, an antiquarian looks around about him, seeing all things, both the past, present and future, and so he alone hath a complete horizon." "Such studies allure the mind by their agreeable attraction on account of the incredible variety and pleasantness of their subjects and excite to further steps toward knowledge. What greater pleasure can there be than to peruse those books of cities put out by Braunus and Hogenbergius? To read those exquisite descriptions of Magnius, *Munster*, Herrera, Laet, Merula, Boterus, Leander, &c.? These famous expeditions of Christoph. Columbus, Americus Vespucius? These hodœporicons to remote and fabulous places of the world? To see birds, beasts, and fishes of the sea, spiders, gnats flies, serpents, &c., all creatures set out and truly represented?"*

The book itself is one of those huge folios in which our ancestors so greatly had their delight; books with broad margins, heavy linen paper, good black ink, large type, bound in ponderous oak boards covered with stamped hogskin, and weighing several pounds. †"Scholars of a former

* Burton.
† Disraeli.

age regarded with contempt small books and a common reproach against a man was that he was the author of such." But the very magnitude of a work has often been the occasion of its neglect, as but very few persons have either leisure or inclination to wade through long series of ponderous tomes ; a fact only apparent to book publishers within the last one hundred and fifty years. Such sized volumes tempt the reader to cry out as Macaulay did in his celebrated criticism upon Dr. Nares' life of Lord Burleigh.

The learning which gave rise to such works was as weighty, as solid, and as substantial as the volumes themselves. The period in which it flourished was before the day of easy paths to knowledge, compends, abridgments and short cuts; the royal road had not yet been discovered, the quagmires filled up, nor the forests leveled that obstructed the pathway. The consequence was that those who were scholars were more thoroughly and deeply learned than those of the present day. The diffusion of knowledge has seemingly resulted in sciolism ; where once the few were educated, the many now are smatterers.

Knowledge is like a powerful stream, whose currents while checked within its banks flows deeply and strongly although silently; but when the obstructions which hem it on each side are removed, when the obstacles to its free dispersion are leveled, it spreads itself over the adjacent country, so that where once a noble river ran, naught now remains except a shallow babbling brook.

Diffusion of knowledge, as it is fashionable to call it in the cant of our day, is unfortunately frequently only a diffusion of ignorance.

On a New Synthesis of Saligenin. By Wm. H. Greene, M.D.

(*Read before the American Philosophical Society, January* 16, 1880.)

The method by which I have obtained saligenin synthetically is an application of a general method for the preparation of phenolic derivatives, made known by Reimer and Tiemann. Indeed, since by the reaction of chloroform or of carbon tetrachloride on an alkaline solution of sodium phenate salicylic aldehyde or salicylic acid may be obtained, it may naturally be expected that, under the same circumstances, methylene chloride would yield saligenin, the latter being an oxybenzylic alcohol.

A mixture of 30 grammes of methylene chloride, 30 grammes of phenol, and 40 grammes of sodium hydrate dissolved in 50 grammes of water, was heated in a sealed matrass in a water-bath. The reaction is complete in about six hours, after which the contents of the matrass is neutralized with hydrochloric acid, and agitated with ether, which takes up the saligenin and the excess of phenol. The ethereal solution is decanted, and the ether distilled off; the residue is repeatedly exhausted with boiling water, which takes up the saligenin and leaves the greater part of the phenol undissolved. The aqueous solution is concentrated to a small volume, and the drops of phenol which separate on cooling are removed. After exposing the residue for some time over sulphuric acid, a crystalline mass is obtained, which is pressed, and recrystallized from boiling water or from alcohol. Pure saligenin is thus obtained.

The quantity of saligenin is by no means in proportion to the quantity of phenol employed, and an alcoholic solution of sodium hydrate was found to yield no better results than an aqueous solution, although the reaction took place more promptly.

Isomeric oxybenzylic alcohols may be, and probably are, formed at the same time, but I have not yet been able to isolate such compounds.

On the Foramina Perforating the Posterior Part of the Squamosal Bone of the Mammalia. By E. D. Cope.

(*Read before the American Philosophical Society, February* 6, 1880.)

The number of perforations of the posterior part of the squamosal bone in the *Mammalia* is considerable, and they have not attracted that attention from anatomists which their importance deserves. As I have found them to be especially valuable in diagnosis, I have thought it might be useful to place on record the manner of their occurrence in various recent genera with whose structure we are more or less familiar in other respects.

The one of these foramina of which some notice has been taken, is the *postglenoid*, which is mentioned by Flower (Osteology of Mammalia) as occurring in the dog and bear, and as absent in the cat. I find five other foramina which usually form the outlets of canals which are connected with the lateral venous sinus. The principal canal extends from the postglenoid foramen upwards and backwards between the os petrosum and the squamosal, and enters the cranial cavity at the superior border of the former. At a point in the parietal bone, often on or very near the squamoso-parietal suture, it issues on the surface again, in the foramen which may be called the *postparietal*. A branch of the canal may take a posterior direction and issue on the occipital face of the skull in the suture between the *ossa petrosum* and *exoccipitale*, forming the *mastoid* foramen. Or a posterior branch may issue in the posterior part of the squamosal bone in a lateral foramen, the *postsquamosal*. In certain Mammals a large foramen perforates the base of the zygomatic process of the squamosal from above, entering the canal after a short course of its own; this I call the *supraglenoid* foramen. Still another inlet to the canal is found in some Mammals, perforating the squamosal below the crest which connects the zygoma with the inion, occupying a position posterior and exterior to the postglenoid, and generally looking more downwards than outwards. I call this the *subsquamosal*. These foramina may be arranged in four sets, as follows :

I. Looking downwards ;
Postglenoid.
Subsquamosal.
II. Looking outwards ;
Postsquamosal.
Postparietal.
III. Looking upwards ;
Supraglenoid.
IV. Looking backwards ;
Mastoid.

Some foramina of the same region are not necessarily connected with the *sinus lateralis*. Hyrtl, in his essay* on the arterial system of the *Edentata*, shows that a foramen near to the postsquamosal of the *Tamandua tetradactyla*, gives passage to an "*arteria diploëtica*," which is formed by the junction of the occipital branch of the carotid with an ascending branch of the *temporo-maxillaris* division of the carotid. The *a. diploëtica* issues in a foramen which perforates the parietal bone on the orbital border. These two foramina may be called the *f. diploëticum posterior* and *f. d. anterior*, respectively. The former enters from the fundus of the same small fossa, which is also perforated in its superior portion by the *f. postsquamosale*, the canal from the latter foramen taking the usual vertical direction.

Still another foramen exists, which is, so far as my present knowledge goes, confined to the *Monotremata* and *Marsupialia*. It enters the posterior base of the zygomatic portion of the squamosal, and is directed forwards. In *Tachyglossus* it passes through the base of the zygoma, issuing in the base of the zygomatic fossa. In the *Marsupialia* it enters a fossa of the squamosal bone, which may or may not be partially filled with cancellous tissue. I call this the *foramen postzygomaticum*.

I now give the results of my observations on the crania of the most important genera which I have observed, one hundred and sixteen in number.†

Monotremata.

Tachyglossus. The only foramina are the *f.f. diploëtica anterior* and *posterior*, and the *postzygomaticum*. The anterior half of the canal connecting the former two has no external wall.

Ornithorhynchus. Postzygomatic large and passing through the zygoma ; postsquamosal large ; no other foramina.

Marsupialia.

The types of this order generally have the postglenoid, and hardly ever have the supraglenoid or postparietal. They are generally distinguished

* Denkschriften Wiener Akademie, 1851, T. III, pl. I.

† Most of these are preserved in my private collection ; for a few I am indebted to the Museum of the Philadelphia Academy.

by the presence of the subsquamosal, but in *Hypsiprymnus* and *Macropus* this foramen becomes the postsquamosal, through the failure of the post-zygomatic crest. It need not be confounded with another foramen also found in these genera, which enters above the *meatus auditorius externus*, and communicates with the tympanic chamber, and which I call the *supratympanic foramen*. The subsquamosal enters the sinous canal, and in *Phascolarctos*, where the postglenoid is wanting, constitutes its only external outlet. The order is further characterized by the presence of the postzygomatic foramen.

Phascolomys; postzygomatic chamber enormous, extending above meatus. No foramina below, except supratympanic; above, a supraglenoid and one or two postglenoids.

Phascolarctos; subsquamosal and postzygomatic only; the latter communicating with an empty chamber.

Macropus and *Hypsiprymnus;* postglenoid, postzygomatic, supratympanic and postsquamosal; the second communicating with a chamber filled with cancelli.

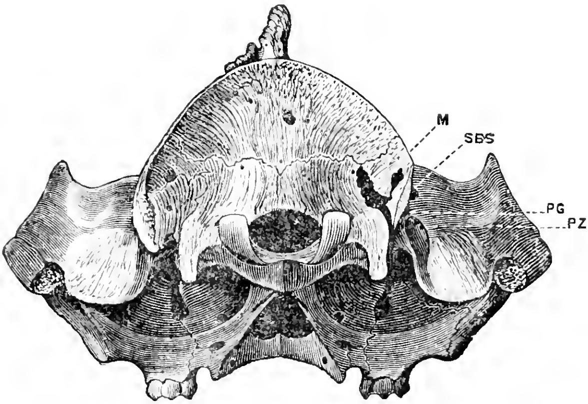


FIG. 1.—Skull of opossum (*Didelphys virginiana*) natural size, posterior view, parts of the right mastoid and squamosal bones removed. M, mastoid foramen; SBS, subsquamosal; PG, postglenoid; PZ, postzygomatic foramen.

Didelphys; postglenoid, postzygomatic, subsquamosal and mastoid; postzygomatic small.

Dasyurus; postglenoid, subsquamosal and probably mastoid. I cannot find a postzygomatic.

Phalangista; postsquamosal and postparietal only; no postzygomatic nor supratympanic.

EDENTATA.

Tamandua; F. f. diploëtica anterior and *posterior,* and postsquamosal only.

Dasypus (6-*cinctus*); postglenoid (large), postsquamosal, mastoid, several postparietals, and a small subsquamosal.

Chlamydophorus; a postglenoid only.

Manis; postzygomatic only.

Megalonyx; postsquamosal and supratympanic; a closed fissure at position of postglenoid. A large foramen below the usual position of mastoid.

Bradypus and *Cholœpus;* no foramina.

Rodentia.

In this order, so far as yet observed, the supraglenoid and postparietal foramina are never present, while the mastoid is rarely, and the subsquamosal is generally, represented. The ridge connecting the zygoma with the inion being weak, the difference between this foramen and the postsquamosal is less marked in this order than in the *Marsupialia.* It is, however, always on the inferior border of the squamosal bone.

Lepus and *Lagomys;* no foramina.

Lagidium; no foramina.

Cercolabes; no foramina.

Lagostomus, Geomys and *Erithizon;* an enormous postglenoid without internal canal.

Capromys, Cœlogenys, Sciurus, Haplodontia, Hesperomys, Mus; postglenoid and postsquamosal only.

Hystrix, Hydrochœrus, Neotoma and *Arvicola;* postglenoid and postsquamosal foramina confluent; no others.

Castor, Cynomys and *Spermophilus;* postglenoid, postsquamosal and mastoid.

Insectivora.

The foramina are very much as in the *Rodentia* in the smaller forms, and as in the *Carnivora* in the larger.

Blarina, Condylura and *Scalops;* postsquamosal only.

Erinaceus; postglenoid and postsquamosal only. *Mystomys* the same, according to Allman's figures.

Centetes; postglenoid, postparietal and mastoid.

Solenodon (from Peters' figures); postglenoid and postparietal.

Chiroptera.

In some members of this order the foramina are, as in many Carnivora, limited to the postglenoid and postparietal.

Scotophilus (*fuscus*)*;* postglenoid, postparietal and mastoid.

Pteropus; postglenoid, subsquamosal and postsquamosal.

Carnivora.

In this order the foramina are few in number, and are very well defined. None of them possess more than three, while the specialized forms, both terrestrial and aquatic, do not possess them.

Trichecus and *Arctocephalus;* no foramina.

Phoca; a rudimental postglenoid.

Ursus, *Arctotherium* and *Hyænodon*; postglenoid, mastoid and postparietal.

Enhydrocyon and *Temnocyon*; postglenoid and postparietal only.

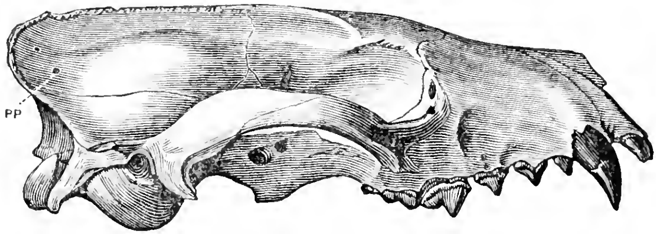


FIG. 2.—*Temnocyon coryphæus* Cope, Lower Miocene of Oregon; one-half natural size. PP, postparietal foramen.

Archælurus, *Dinictis*, *Pogonodon*, *Hoplophoneus* and *Machærodus* (*cerebralis*); postglenoid and postparietal only.

Procyon, *Nasua* and *Bassaris*; postglenoid only.

Canis, *Vulpes* and *Urocyon*; postglenoid only.

Viverra, *Mustela*, *Putorius* and *Mephitis*; postglenoid only.

Felis (*domestica*); sometimes a minute postglenoid only; sometimes none.

Hyæna, *Uncia*, *Cynælurus*; no foramina.

PROSIMIÆ.

Lemur, *Chirogaleus* and *Tarsius*; a postglenoid only.

QUADRUMANA.

Hapale; postglenoid and postsquamosal.

Cebus; postglenoid and postparietal. The latter is on the suture of the parietal and squamosal bones; in *Hapale penicillata* it is entirely within the squamosal bones.

Ateles, *Callithrix*, *Mycetes*, *Semnopithecus* and *Cynocephalus*; no foramina.

Macacus; a small postglenoid.

Troglodytes niger, *gorilla*; a closed fissure, but no foramen postglenoideum.

Homo; no foramina in sixteen North American Indians examined of the Klamath, Bannock, Crow, Sioux and Cheyenne tribes. One postglenoid on one side in a South Australian. One or two mastoids are more usual, being found in a good many specimens of all races. They are rarest in Hottentot negroes.

CETACEA.

Balæna, *Beluga* and *Monodon*; no foramina.

SIRENIA.

Halicore and *Manatus*; a huge mastoid only.

HYRACOIDEA.

Hyrax; no foramina.

PROBOSCIDIA.

Elephas; no foramina.

PERISSODACTYLA.

In this order the number of the foramina ranges from very few to many.

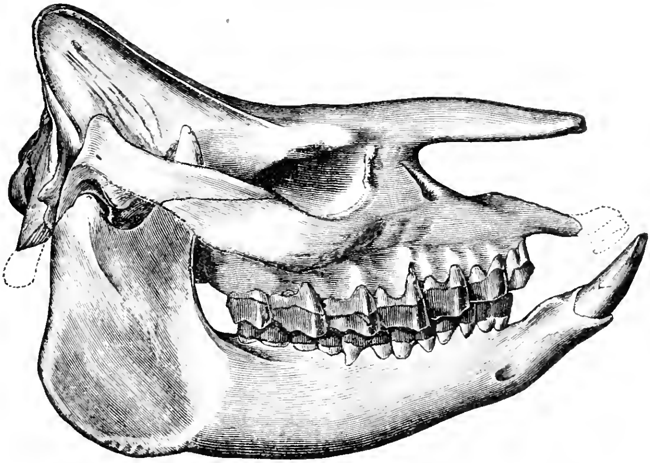


FIG. 3.—*Aphelops megalodus* Cope, Loup Fork of Colorado; one-sixth natural size; showing postparietal foramen.

Rhinocerus, Aphelops; postparietal only

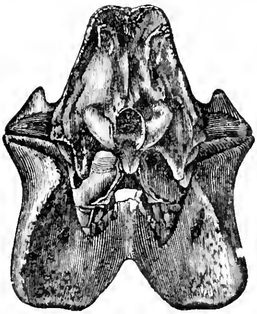


FIG. 4.

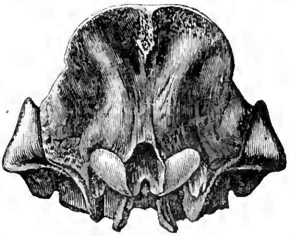


FIG. 5.

Skulls of *Aphelops megalodus* (Fig. 4) and *A. fossiger* (Fig. 5) from behind; one-sixth natural size; showing absence of mastoid foramen.

Tapirus; postparietal and a huge mastoid.

Anchitherium, Hippotherium, Protohippus and *Equus;* postparietal, postsquamosal, postglenoid and supraglenoid. In the last three genera the vessel issuing from the postsquamosal, grooves the petrous bone, leaving it at a point near that usually occupied by the mastoid foramen. In the second and last genera, and probably in the third, the sinous canal is protected by a bony crest in front, throughout its entire length.

Artiodactyla.

Great diversities are found in this order, especially between the suilline and ruminant divisions. In the former, with the exception of the *Hippopotamidæ*, there are no foramina; in the *Ruminantia* they are more numerous than in any other order of the class. The *Ruminantia* are, like the equine *Perissodactyla*, characterized by the presence of the supraglenoid foramen; to this the *Camelidæ* and some others add the mastoid. The *Tragulina* must be excepted from this rule, for they have nothing but the postglenoid.

Omnivora.

Sus, *Dicotyles* and *Phacochœrus*; no foramina.

Hippopotamus and *Chœropsis*; postglenoid, postsquamosal, mastoid and a rudimental supraglenoid.

Ruminantia.

Tragulus; postglenoid only.

Oreodon; postparietal and mastoid. In one specimen of *O. culbertsoni* from Colorado, I find a minute supraglenoid on each side; in other specimens it is wanting.

Poëbrotherium; postparietal, postglenoid; mastoid; a small supraglenoid.

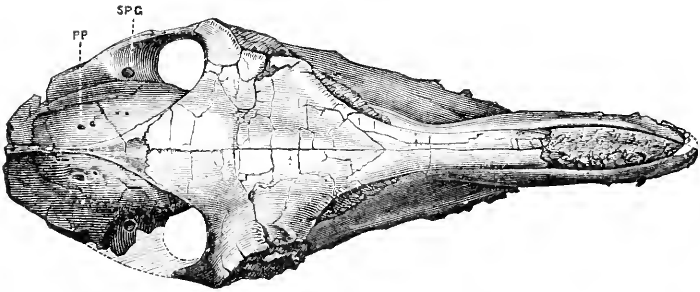


Fig. 6.—Skull of *Procamelus occidentalis* Leidy, Loup Fork of New Mexico; one-fourth natural size; showing supraglenoid foramen, SPG.

Procamelus, *Camelus*, *Auchenia*; postglenoid, supraglenoid and mastoid.

Bos; postglenoid and supraglenoid only.

Antilocapra; postparietal, postglenoid, mastoid, and a large supraglenoid.

Giraffa; postglenoid, supraglenoid, postsquamosal and mastoid.

Oreas, *Ovis*, *Cervus*; postglenoid, supraglenoid, postsquamosal, postparietal and mastoid.

From the preceding the following conclusions may be derived :

(1) The sinous foramina furnish valuable diagnostic characters, and may, with proper limitation, be used in systematic definition.

(2) The primitive condition of the various mammalian orders appears to have been the possession of a limited number of these foramina.

(3) The monotreme-marsupial line have developed a number of foramina in their own special way.

(4) The *Rodentia* have chiefly developed those of the inferior part of the squamosal bone, if any.

(5) The *Carnivora* commenced with but few foramina, and have obliterated these on attaining their highest development.

(6) The history of the *Quadrumana* is identical with that of the *Carnivora*.

(7) The *Perissodactyla* present very few foramina in the lowest forms, and did not increase them in the line of the *Rhinoceridæ*. In the line of the horses an increase in their number appeared early in geologic time, and is fully maintained in the existing species.

(8) In the Omnivorous division of the *Artiodactyla*, time has obliterated all the sinous foramina. In the Camels an increased number was apparent at the same geologic period as in the history of the horses (White River or Lowest Miocene), and has been maintained ever since ; while the existing *Pecora* present a larger number of the foramina than any of the class of *Mammalia*.

The only relation between these structures and the habits of the species concerned that can now be traced is, that the largest number of the foramina is found in the specialized vegetable feeders, while the smallest number is found in omnivorous forms.

I now give a synopsis of the distribution of the sinous foramina according to the foramina themselves. The *f. f. diploëtica*, *postzygomatica* and *supratympanicum* are not included, as their existence is restricted to the few types already mentioned.

I. No foramina.

Homo, Troglodytes, Cynocephalus, Semnopithecus, Mycetes, Callithrix, Ateles.

Uncia, Hyæna, Arctocephalus, Trichecus.

Elephas, Hyrax ;

Sus, Phacochœrus, Dicotyles.

Lepus, Lagidium, Cercolabes.

Cholæpus, Bradypus.

II. Postglenoid only.

a. Rudimental.

Felis ; Phoca.

aa. Developed.

Chlamydophorus.

Lemur, Chirogaleus, Tarsius ;

Macacus.

Mustela, Putorius, Mephitis; Canis. Vulpes, Urocyon; Viverra.
Procyon, Nasua, Bassaris.
Tragulus.

aaa. Enormous.
Lagostomus and *Geomys.*

III. Subsquamosal only.
Phascolarctos.

IV. Postsquamosal only.
Ornithorhyncus, Tamandua, Blarina, Condylura, Scalops.

V. Postparietal only.
Rhinocerus, Aphelops.

VI. Mastoid only.
Halicore, Manatus.

VII. Postglenoid and subsquamosal only.
Hystrix, Hydrochœrus, Capromys, Cœlogenys, Sciurus, Haplodontia, Neotoma, Hesperomys, Mus, Arvicola.

VIII. Postglenoid and postsquamosal only.
Erinaceus.
Macropus, Hypsiprymnus.
Hapale.

IX. Postglenoid and postparietal.
Chiroptera sp.
Temnocyon, Enhydrocyon;
Archælurus, Dinictis, Pogonodon, Hoplophoneus, Machærodus.
Cebus.

X. Mastoid and postparietal.
a. Mastoid small.
Oreodon.
aa. Mastoid enormous.
Tapirus.

XI. Mastoid, postglenoid and postsquamosal.
Castor, Cynomys, Spermophilus.

XII. Mastoid, postglenoid and subsquamosal.
Dasyurus, Didelphys.

XIII. Mastoid, postglenoid and postparietal.
Scotophilus (*fuscus*).
Centetes.
Hyænodon, Ursus, Arctotherium;

XIV. Supraglenoid and postsquamosal only.
Phascolomys.

XV. Supraglenoid and postglenoid only.
Bos.

XVI. Supraglenoid, postglenoid and mastoid.
Procamelus, Camelus, Auchenia.

XVII. Supraglenoid, postglenoid, mastoid, postparietal.
a. Supraglenoid small.
Poëbrotherium.

aa. Supraglenoid large.
Antilocapra.

XVIII. Supraglenoid, postglenoid, mastoid and postsquamosal.
a. Supraglenoid small.
Hippopotamus, Chœropsis.
aa. Supraglenoid large.
Giraffa.

XIX. Supraglenoid, postglenoid, postparietal and postsquamosal.
a. Supraglenoid small; mastoid not grooved.
Anchitherium.
β. Supraglenoid large, mastoid grooved.
Hippotherium, Protohippus, Equus.

XX. Supraglenoid, postglenoid, postparietal, postsquamosal and mastoid.
Cervus, Oreas, Ovis.

Biographical Notice of Professor Joseph Henry. By Fairman Rogers.

(*Read before the American Philosophical Society, February* 20, 1880.)

The admirable memoir of Prof. Joseph Henry, prepared by Mr. William B. Taylor, and read before the Philosophical Society of Washington, October 26, 1878, is so exhaustive both as to his scientific labors and the incidents of his life that little can be added to it until at some future time a biographer will undertake the preparation of a more voluminous life and letters.

As to his scientific career, the memoir deals principally with his earlier work as being more directly personal, and the results of his own manipulation and experiment, while his later days were devoted to the direction and coördination of the work of others.

Regret has frequently been expressed by the scientific friends of Prof. Henry, that his acceptance of the Secretaryship of the Smithsonian, and his devotion to the interests of that Institution had withdrawn him from those lines of original research, in which he shone so conspicuously, and while these regrets are perhaps well-founded, it is a question whether he could possibly have been of more value to science under any circumstances other than those in which this later part of his life was passed.

In his position his influence upon American Science was great and varied. He was a constant and shining example before the eyes of the younger scientific men of an unselfish devotion to the interests of science for itself, and not for self aggrandizement. Honest in the widest and deepest sense of the word, he never permitted expediency, self-interest or passion to interfere with the search for truth, and his clear and simple expressions on such subjects put it out of the power of those who consulted him to do otherwise than follow the example which he set them.

Filling for years a position in which, without violating any of the principles which many, nay, most men consider quite sufficient for their moral guidance, he might have used his knowledge for the furtherance of his own selfish ends, he never swerved for an instant from his determination to examine and decide all matters from the purely scientific point of view, unbiassed by any considerations as to how his decisions might affect the interests of any one, and the hosts of inventors and projectors who are constantly hovering around Government headquarters found him a sentinel whom it was impossible to cajole or to pass without that countersign of true worthiness which his trained mind was quick to recognize.

While he no doubt, had he remained in his laboratory, would have added year after year to the knowledge of the world by original research, he did so much in his prominent position to encourage and assist such work by others, that it may be fairly presumed that the results were equally good. While there are many men who in the solitude of the laboratory can carry on important investigations, there are few who join to an accurate scientific training the ability to impress and to direct men who are their scientific equals, the lofty incorruptibility of character, and the clear-sighted power of grasping a subject which he possessed.

In this respect as well as by his official position he much resembled his friend Alexander Dallas Bache with whom he was intimately associated for the many years during which they both lived in Washington.

Brought into continual personal contact with the active scientific men of the day, they exerted an incalculable effect upon what we might call the scientific morals of the younger generation, and always trod themselves, the paths which alone lead to honor.

Single minded and steadfast in their purposes, they would listen to no projects which had about them the taint of selfishness or corruption, and the man who met them with any project which would not bear the full light of day soon felt that he had made a grievous mistake, and retreated in confusion.

In writing thus, I do not mean that Prof. Henry frowned only on those projects which the average sentiment characterizes as dishonest, that was his clear and evident duty, but he also taught that scientific work had for its object the development of truth, and that all the petty considerations of claims of priority, and the jealousies which so often embitter the relations of scientific men were unreal and unimportant, purely secondary matters.

It is somewhat doubtful whether any one can occupy again a position in the American scientific world exactly similar to his. Commencing his scientific career at a time when it was quite possible for a great man to know the whole range of the physical sciences in a way more or less complete, he was looked up to by all men working in those fields as an acknowledged authority, and his influence was thus very extensive. Now these fields have become so large and varied that it is hardly possible for any one to become more than a specialist, and the power of coördination which Prof. Henry in common with Bache and Agassiz, exercised is gone with them, and must perhaps now be concentrated in Academies and Societies.

Prof. Henry's closest connection with the American Philosophical Society was during his residence at Princeton, from the year 1832 to 1846, during which period he made constant communications to the Society, and attended its meetings regularly, forming and cementing those friendships with many Philadelphians which lasted through his life. This was the time of his greatest activity in original work, and as Faraday, in England, Biot and Becquerel, in France, and Riess, in Germany, were engaged in parallel investigations of the greatest importance, the period was one of the most interesting in the annals of science.

Upon his election, in 1846, as head of the Smithsonian Institution, his opportunities for direct private investigation in his own laboratory ceased, but he had improved facilities for controlling extensive investigations through correspondents, which added largely to scientific knowledge, and some of his later personal researches, such as those relating to lighthouse oils and to sound signals, were of the greatest importance.

Elected President of the National Academy of Sciences, in 1868, after the death of its first President, Prof. Bache, he exercised in its affairs the same strong, sensible, quiet influence that characterized his usual action, and his last formal connection with it, only a few weeks before his death, was marked by two incidents, in themselves of much interest.

His waning powers and several sharp attacks of illness had warned him that his life was drawing towards its close, and one of his intimate friends, with whom he sometimes took counsel about his family affairs, found that he was troubled by the fear that his family might suffer from straightened circumstances after his death. Without giving him the least intimation of what was intended, a fund of forty thousand dollars, in one thousand dollar subscriptions, was quickly made up among his friends and admirers in several Eastern cities, principally in Philadelphia, and placed in trust for the benefit of his wife and children during their lives, with the proviso that after their death it should go to the National Academy of Sciences, and form "The Joseph Henry Fund," the interest to be applied to assisting investigators in original research.

Nothing could have been more pleasant than the way in which Prof. Henry took this compliment. He appreciated exactly the spirit in which the movement was made, and said that the only source of trouble in his mind was now removed. He frequently referred to it, and enjoyed drawing a parallel between his life and that of his intimate friend, Bache, remarking that they had worked together, had occupied high scientific positions under government together, had both been Presidents of the Academy, and that now the chain would be unbroken, for he would leave behind him, in the hands of that Academy "The Joseph Henry Fund," as Bache had left "The Bache Fund."

The presentation of this fund to the Academy formed a conspicuous part of the business proceedings of the Session of April, 1878, and the President's address, which was his last formal communication to that body, touched in the most feeling manner upon the compliment paid to him.

The other incident was the exhibition to the Academy, by Mr. Edison, through special invitation, of the phonograph, and of a number of improvements upon the telephone and kindred instruments. A private exhibition of them was made in Prof. Henry's private rooms in the Smithsonian Institution, and nothing could have been more interesting than the spectacle of the famous old physicist studying with the most intense interest and the clearest appreciation, the very latest developments of the sciences to which he had devoted his life, and the application of those investigations, in many of which he had led the world fifty years before.

He felt, and those about him felt, that it was probably the last time that he would have any direct connection with the active science of the world, and so it proved ; for, within less than four weeks, his friends were called upon to mourn his death.

The funeral services of Prof. Henry were the occasion of a large gathering of the scientific men of the country, and of others who, prominent in their respective offices, admired the pure spirit which had passed for so many years unscathed by the breath of scandal, through the temptations of official life ; and, on a sunny May afternoon, his remains were deposited in the beautiful cemetery which overlooks the city of Washington, in which he spent so many years, full of honor.

Within a year of his death, the Congress of the United States paid to the memory of Prof. Henry its highest compliment. Both Houses passed on the 10th of December, 1878, the following resolution : "That the Congress of the United States will take part in the services to be observed on Thursday evening, January 16, 1879, in honor of the memory of Joseph Henry, late Secretary of the Smithsonian Institution, under the auspices of the Regents thereof, and for that purpose the Senators and Members will assemble on that evening in the Hall of the House of Representatives, the Vice-President of the United States, supported by the Speaker of the House, to preside on that occasion."

The exercises which were held in a crowded auditorium, consisted in an opening prayer by Dr. McCosh, of Princeton College, and addresses by Senator Hannibal Hamlin, Senator R. E. Withers, Prof. Asa Gray, Prof. William B. Rogers, Representative James A. Garfield, Representative S. S. Cox, and General W. T. Sherman with the concluding prayer by the Rev. Dr. Sunderland, Chaplain of the Senate.

With this mention of such a fitting tribute to his worth, and to the estimation in which he was held by his fellow-men, our short memoir of Prof. Joseph Henry ends.

THE TIMUCUA LANGUAGE.

By Albert S. Gatschet.

(*Read before the American Philosophical Society, February* 20, 1880, *as a third sequel to the articles on this subject read April* 6, 1877, *and April* 5, 1878.)

This third article on the Floridian language once spoken by the Timucua or Atimoke people is herewith presented to those interested in linguistics, with the remark of the author, that all his attempts to connect it by its radical elements with some other language spoken in the neighborhood of its native soil have proved infructuous, and that therefore he regards it as constituting a linguistic family for itself. The position of the author as a linguist of Prof. J. W. Powell's U. S. Bureau of Ethnology, Washington, D. C., has materially facilitated his researches upon the idiom, and any further notice bearing upon the history, ethnography and language of this remarkable nation, the last remnants of which are perhaps not yet extinct, will be received with thanks by the author.

This article subdivides itself into the following portions: Historic Remarks, Ethnographic Remarks, Bibliography, Radical Affinities, Dialects, Grammatic Notes and Selected Texts. Among the texts a missive sent in 1688 by the Timucua chiefs to the King of Spain will be read with much interest.

Historic Remarks.

Our historic information about the Indians of Florida *speaking the Timucua language* is very fragmentary up to the period of the publication of René de Laudonnière's report on his expeditions to that country, or, as he calls them rather unassumingly, "Voyages." His account treats of no other American people but of this, for Florida was the only portion of this continent of which he possessed a special knowledge. From the reports of the chroniclers of the expedition of De Soto (1539–43) we can gather the fact that this race extended across the whole northern part of the Floridian peninsula, for they mention proper names of persons and places on its western coast, which can be explained through no other language but that of the Timucua.

Modern research has proved that the dialects of the Indians inhabiting the northern part of the Floridian peninsula belong to a linguistic family *differing radically* from that of the Maskoki, Yuchi, Cheroki and Algónkin. But the early explorers were not aware of this fact, or at least they did not put it in evidence. In those times not even instructed people could appreciate the enormous ethnologic importance of the difference of linguistic stocks, and had only a vague idea of linguistic classification. The disparateness of linguistic families means early *local* distance of the tribes or nations speaking them, and those who have paid some attention to these studies, know that these linguistic differences must go back into an epoch remote from ours by fifty or by a hundred thousand years. Thus the difference of linguistic families proves, and is associated with racial difference. But racial difference is not always associated with a disparateness of linguistic family, for it is recorded that certain individuals, tribes and nations have, in the course of time, been prevailed upon to adopt the idioms of neighboring populations, especially when conquered by them.

Although the method, how to infer a difference of race from a thorough, radical disparateness of language was above the conception even of the most learned men of the sixteenth century, we see that these as well as the common adventurers who flooded the islands and coasts of America were close observers of the ethnographic peculiarities of the tribes they visited. Their records leave us in the dark concerning the languages spoken by the Teqestas and Calos on the southern extremity of Florida; we cannot gather from them whether Caribs, Western or Northern Indians were settled in the peninsula at the time of their visit. But they transmit us many peculiar traits and customs, from which they seem to have inferred that all Southern Indians of the Gulf States belonged to one stock.

Our present knowledge of Timucua shows that it stands in no radical connection with the *Galibi dialects* of South America (Arowak, Cumanagota, Chaymas, etc.), nor with the extinct Galibi idioms of the West Indies (Eyeri, Taino, Lucayo, etc.), nor with the Carib on the coast of Honduras. We must therefore discountenance, in some degree, the far-going speculations concerning Carib colonies, and their influence on the Indians in the Apalache country, indulged in by Hervas, Catalogo I, pag. 386 &c., though seafaring men of this nation may have temporarily settled on that coast. Hervas quotes the following terms from Bristock: "Palabras de los Apalachinos que tienen de los caribes: buottou *maza*, taumalí *guisado*, banaré *amigo familiar*, etotou *enemigo*, allouha *arco*, allouani *flechas*, taonabo *lago*, *estanque*, mabouya *espiritu maligno*, akarnboue *alma humana* y innumerables palabras de cosas curiosas y raras, comunes á los caribes de las Antillas."* Pag. 386: "Las provincias (apalaches) de Amana y Matibue, en donde hay muchas familias de caribes, tienen muchas palabras del antiguo idioma *caribe*."

René de Laudonnière's report, from which Hakluyt made his English and Théodore de Bry his Latin translation, is dated 1586, and bears the following title:

L'HISTOIRE | NOTABLE DE LA FLO | RIDE SITUEE ES INDES | Occidentales, contenant les trois voyages faits en icelle par certains Capitaines & Pilotes Françis, descrits par le Capitaine Laudonniere, qui y a commandé l'espace d'vn an trois moys: à laquelle a esté adiousté vn quatriesme voyage fait par le Capitaine Gourgues.

Mise en lumiere par M. Basanier, gentil-homme François Mathematicien.

(Vignette: Bellerophon and the chimera.)

* Most of these terms can be identified with Carib words once in use on the island of Guadeloupe, etc. cf. Breton, Dict.; Brinton, Notes on the Fl. peninsula, pag. 96–98.

A Paris, Chez Guillaume Auuray, ruë sainct Iean de Beauuais, au Bellerophon couronné. MDLXXXVI. AVEC PRIVILEGE DV ROY.

gr. 12mo, 124 leaves, numbered recto only.

To give a historic sketch of the various vicissitudes of the French adventuring soldiers who arrived in Northeastern Florida on June 22, 1564, and established Charlefort or Fort St. Charles (arx Carolana) on the southern shore of the St. John's River, is a task quite foreign to my purpose. My inquiries on the Timucua have prevailingly linguistic tendencies; hence our attention will be solely occupied by gathering from the above, and other sources, notices on the social status, in which the explorers found the people of the Atimoqua, and by the information which can be made available for linguistic science.

In the countries drained by the St. John's River and its tributaries René de Laudonnière heard of the existence of *five paracusi*, and some of them ruled over a considerable number of Indian chiefs and their towns. These five paracusi were called Saturiwa, Holata Utina, Potanu, Onethcaqua and Hostaqua.

Saturiwa and his son Athore resided on the Atlantic coast, south of the outlet of St. John's River, and controlled thirty sub-chiefs, while the Holata Utina, or as De Laudonnière calls him in French orthography, "Olata Ouae Utina," ruled over forty chiefs and their towns further inland. The map added by Theodor de Bry to his pictorial description of these "Voyages" places the seat of the Utina east of some large inland forest, west of the St. John's River, and there are reasons for locating his seat near Lake St. George, a sheet of water formed by the St. John's River in its middle course. That map locates the town of Timoga, which belonged to the domain of this head chief, upon the eastern shore of the St. John, and De Laudonnière's text places it twenty leagues from Saturiwa's seat. The Timagoa people were the most inveterate and implacable enemies of Saturiwa's warriors; and when a war was impending between Saturiwa and the Timagoa, because the former had obtained some silver by force from the latter, De Laudonnière offered his military assistance to Saturiwa. He thereby hoped to obtain trustworthy information on the countries, where the silver, as well as the gold of which some of their ornaments were made, was obtained; constant rumors pointed to the "Apalatci mountains" as to the source of these precious commodities. Both sexes wore various ornaments made of gold, and most conspicuous were the disk-shaped gold pieces worn around their loins at dances and on other solemn occasions.

Potanu, written Potauou by De Laudonnière, was twenty-five leagues from Utina; he gives this name to a chief, Pareja gives it to a province in the interior.* This chief controlled an upland tract of country; in this tract was found the hard slate stone, from which the people made wedges to cleave wood and to finish their canoes after they had burnt out a cavity

* Personal names are frequently confounded in De Laudonnière's and other narratives with local Timucua names, and vice versa.

in the logs beforehand. To deprive Potanu of his slate quarries, the Olata Utina warred against him, and an officer of De Laudonnière assisted him in putting his antagonist to flight.

The home of Onethcaqua is located "near the high mountains"; the map reads: Onathcaqua. Hostaqua, Houstaqua is a settlement located by the map a short distance from Onathcaqua, and we are told that the people of these two communities (De Laudonnière calls head-chiefs by these names) painted their faces black, while the people of Molloua (Mulua) used red paint for this purpose.

It is probable that these five paracusi were nothing but *head-chiefs* of tribal confederacies, and that the real power was not in their hands, but in those of their sub-chiefs or holata. Head-chiefs and chiefs surrounded themselves with considerable ceremonial and pomp, and probably on this account the chroniclers call them *kings*; but some kind of etiquette surrounded all chiefs throughout the territories near the Gulf of Mexico, and that the Timucua people enjoyed a sort of democratic rule is shown by the election of a new chief by the warriors. From Pareja's writings alone, which were composed fifty years later, we would certainly be led to assume that the Timucua people was ruled rather despotically. On many points the narrative of the French captain is neither precise nor satisfactory; we learn nothing positive about the territorial extent of the settlements of the Timucua race, nor about the national name by which they called themselves. His book goes to show that Timoga, Timagoa was the name of *one* town, village or chieftaincy only; in later times it was extended over several chieftaincies only by the circumstance that the Indians of this place were among the first christianized, and that missionaries composed books in *their* dialect only. The same thing has occurred with the Mutsun of San Juan Bautista, California.

Some of the French explorers seem to have reached the locality where *gold* was obtained in the sand of the rivers and brooks, but the result being not satisfactory, they soon returned to Fort St. Charles.* When they began to suffer of famine, the Indians showed to them their natural treacherous disposition and scoffed them for their misery, but never attacked them, protected as they were by an insular fort armed with cannons. Two Spaniards were liberated by them, who told them about the existence of the Calos "kingdom" at the southern extremity of the peninsula; one of them had been despatched as a messenger by the Calos chief to chief Oathchaqua, a four or five days' journey north of Calos. Half way he saw the island Serropé in a fresh water lake of the same name.

Fontanedo mentions forty towns or settlements of the *Calos*, or *Callos*

* Gold was called by them sieroa pira (pira, *red, yellow*). The chronicler Fontanedo speaks of the "mines of Onogatano, situated in the snow-clad mountains of Onogatano, the most distant possessions of Abolachi;" Mem. p. 32. Cf.: "The precious metals possessed by the early Floridian Indians," pag. 199-202 (Appendix III) of *Brinton*, Notes on the Flor. Peninsula. Brinton thinks that the Timucua were probably acquainted with the auriferous gulches of the Apalachian ridge in Georgia and the Carolinas.

Indians, who held the south-western portion of the peninsula (Brinton, *Notes*, p. 113). Among twenty of their number, Comachica and Cala-obe are probably belonging to the Timucua language (hica, land, country; kála-abo, fruit-stalk or fruit-tree); the town of Tampa has a Maskoki name: itímpi *near, close to it*. Some of these towns were located on Lucayo Islands (the Keys?), and four in the land of the Tocobayo, on Lake Mayaimi. Near Manatee, Brinton found a small lake called Lake Mayaco, a name not altogether unlike Mayaimi; but Lake Mayaimi is described by the chroniclers as being of huge proportions. Sarasota Bay and Island, Manatee Co., on the western coast, seems to be a Timucua name, but the majority of the present Indian names of localities found on maps of the peninsular part of the State are Seminole, an idiom differing but very little from the Creek, of the Maskoki family. Thus Welaka, a town on St. John's River, Putnam Co., is the "great water," o íwa thláko, contracted into withláko; this was or is still the Seminole name for the St. John's River, and is interpreted by some writer: "river of many lakes." The French called the St. John's River la Rivière Mai, because entered on May 1st by their vessels; the Spaniards named it Rio de San Mateo, Rio Picolata, Rio de San Juan.

South of Cape Cañaveral, the country along the Atlantic Coast was called by the Spaniards, who had a post there, the "Province of Tequesta." The northern portion of this section of land was called in later epochs Ais, Ays, Is, and Santa Lucia by the Spaniards. *Ais* is interpreted by aïsa, *deer*, a term not belonging to the Timucua language, but identifiable with itcho, *deer*, in Seminole, or itchi, itche in Hitchiti and Mikasuke.

The *work of christianizing* the Florida Indians began with the establishment of a permanent Spanish garrison at St. Augustine by Adelantado Pedro Menendez de Aviles, in 1564. The padres mostly went to the southern portions of the land; two were sent to the "Calusas" in 1567, and 1568 ten others arrived, who dispersed themselves in various directions. Padre Antonio Sedeño settled in the island of Guale (Mary's, Santa Maria, now Amelia Island) and was the first to compose there a catechism and a grammar of some North American language not specified.

After Menendez had returned to Spain in 1567, the French Huguenot leader De Gourgues, allied with the paracusi Saturiwa, demolished the most important Spanish forts in the same year, and the Spanish missionaries met with the most cruel reverses. Padre Rogel returned from the Calos country, disgusted with his ill-success, and went to San Felipe, a Spanish coast settlement in the "Province of Orista," north of the Savannah River, but did not remain long. Coava, chief of an inland country named Axacán, one hundred and fifty leagues from San Augustine, put to death all the apostolic missionaries sent among his people. The English captain Francis Drake destroyed San Augustine in 1586.

In 1592 twelve Franciscan padres were sent to this bloody field of Catholic martyrdom, and two years after this, twenty "mission houses" were in existence. But the indomitable spirit of the aborigines could not tolerate any priestly interference with their own customs and traditions. They murdered in cold blood Pedro de Corpa, missionary at Tolemaro, near the mouth of St. Mary's river, killed the missionaries at Topiqui, Asao, Ospo and Assopo, all on Guale island, and destroyed their churches and other mission establishments.

In 1612, the "Custodia" of the eleven convents of Florida was erected into an independent ecclesiastic "Provincia de Santa Elena," the principal house being at Havana; thirty-two Franciscan priests were sent there (1612–13) to found missions, and in 1616 their number was increased by twelve others.

In 1638 a war took place against the Apalache Indians. The civil administration of the province was from 1655 to 1675 in the hands of Governor Don Diego de Rebollado, "Capitan-General." His successor from 1675 to 168) was Don Juan Hita de Salaçar, who was followed by Don Juan Marquez Cabrera. Twenty-four Franciscans were disembarked in 1676 to christianize the natives. A town Timucua is, not long after this, recorded at New Smyrna, Volusia Co, on the Atlantic coast, about ninety miles south of San Augustine.

In 1687, Governor Juan Marquez attempted to remove some Indian tribes of Florida, Apalachis, etc., to the West Indian Islands. Upon this a revolt broke out in San Felipe, San Simon, Santa Catalina, Sapala, Tupichihasao, Obaldaquini and some other towns; the natives emigrated to Georgia, or took refuge in the forests. This revolt does not seem to have extended over those pueblos or towns who sent the letter, printed below, to King Charles II, of Spain († 1700), and they were evidently well satisfied with their present governor.

It was perhaps a consequence of this revolt that, in 1687, some Yamassi Indians, living under Spanish rule, left their country for the South, invaded the mission of Santa Catalina, in the province of Timucua, pillaged the church and convent of San Francisco by removing its plate and vestments, burnt the town of Timucua, killed many converted Indians, while others were brought as slaves to Santa Elena. The reason given by the Yamassis for this unprecedented massacre was that they were disgusted with the rule of the Franciscans, and tried to put an end to it. English instigations were supposed to be at the bottom.

The English colonists of Georgia and the Carolinas, jealous of the Spanish and their power, began from 1702 a series of inroads into Florida, which lasted for half a century, and entailed much misery on the Spanish Indians. Col. Daniels, who led the land force of Governor Moore's army in 1702, took St. Augustine, and met, as far as known, with no resistance. These incursions lasted until 1706, and an inroad of the Alibamu Indians occurred in 1705. Further English inroads are recorded for the years 1719, 1727, 1736, 1740 and 1745.

It is not altogether impossible that some Timucua Indians survive at the present time, for the Pueblo de los Atimucas, on the Muskito lagoon, Volusia Co., has subsisted long after the beginning of the English raids.

Either the Atlantic coast or the borders of the interior fresh-water lakes, or the Seminole settlements, Fla., might still harbor some of the race, though little hope is to be entertained that their ancient vocalic language may still be heard among them.

Ethnographic Remarks Concerning the Timucua People.

Not only for the history of the Floridians, but also for their ethnography the report of René de Laudonnière is of the greatest value. In the small extent of territory which he saw, the manners and customs were probably the same everywhere, on the coast and in the interior; but further to the west, among the Apalache, Hitchiti and Creeks, they must have differed not inconsiderably. The artist Jacques le Moyne de Morgues accompanied the captain on his expeditions inland, and with his skilful pencil reproduced most tastefully what he had observed among the red men of the plains and forests. These sketches do not seem to be historically faithful in every respect, for striking pictorial effect often seems more desirable to artists than historic truth; but taken as a whole, they give us a vivid picture of the reality of life among the Timucua. They were published in Theodor de Bry's collection of pictorial voyages, vol. II, with *Latin* text at the lower margin (Brevis Narratio; Francofurti ad Moenum, 1598, fol.). Alb. J. Pickett, History of Alabama, Charleston, 1851 (2 vols., 12mo.), has reproduced several of these drawings, together with extracts from De Laudonnière; but he wrongly supposes that LeMoyne's pictures represent the appearance and customs of the Southern Indians in general. Neither he nor Fairbanks, nor any other southern writer speaks of the Timucua as a *distinct* race.

Condensed from De Laudonnière, Pareja and other sources, I present the following short sketch of what appeared to me the most characteristic of all the Timucua customs and peculiarities:

Men and women generally went nude. Their *bodies* were well proportioned, the men were of a brown-olive color, tall stature and without apparent deformities. The majority of men tattooed themselves in very artistic devices on the arms and thighs, and to judge from Le Moyne's pictures, the chiefs at least were tattooed over the whole body. They trussed up their long black hair in a bunch resting on their head, and covered their privates with a well-dressed deerskin. Women wore the hair long, reaching down to the hips, but on losing their husbands they cut their hair off to its root, and did not remarry before it had grown again to reach the shoulders. Both sexes were in the habit of wearing their finger nails long. The custom of pressing the heads of infants is not mentioned.*

*This custom prevailed largely among the Chá'hta, who were called Flatheads on that account. The German anatomist, A. Ecker, has lately examined twenty skulls excavated on the western coast of Florida, and published the result in the Brunswick "*Archiv für Anthropologie*," vol. X (1878), page 201-14, under the heading: "Zur Kenntniss des Körperbaues früherer Einwohner der Halbinsel Florida." He thinks that a portion of them was artificially altered and deformed, but that they belonged to a race similar or identical to that encountered by the first Spanish explorers; he further believes, that the people which accumulated the shell-heaps which are so frequent on the Floridian shore-line differed from the above, and perhaps belonged to the Carib stock.

Women were seen to climb the highest trees with agility, and to swim over broad rivers with children on their backs. When they became pregnant, they (and the Creek women) kept away from their husbands, and during their periods were careful to eat certain kinds of nutriment only; they drank blood to render their sucking children stronger and healthier. Chiefs had one legitimate wife, whose children alone could inherit them, and one or two concubines. The first-born males in the tribe were sacrificed to the chief, under solemn ceremonies.

Most Indians were found to be diseased by the "pox," for they were exceedingly fond of the other sex, calling their female friends "daughters of the sun." Pederasty was not unfrequent, and the French noticed quite a number of "hermaphrodites," who were very strong in body, and used as load-carriers, especially on war expeditions. The Indians showed a feeling of repugnance towards them.

The Timucua declared *war* by sticking a number of arrows into the ground, fliers up, in close vicinity to the enemy's camp. This was done with the utmost secrecy the night before the attack, and locks of human hair were seen dangling from the end of the arrows. The chiefs led the warriors on the war-path, club, arrows and bow in hand; when the fight had begun, they placed themselves in the centre of the combatants, and their usual mode of attack was to surprise the enemy, as is done by all Indians. They fought valiantly and impetuously, when compelled to fight openly; their weapons were spears, clubs, bow and arrows, and a small target hung on the chest. Their arrows were headed with stones and fish-bones, both being worked quite handsomely and carefully. The warriors put to death all men captured (though exceptions to this are recorded), cut off their arms above the elbow, and their legs above the knee, took their scalps, and ran an arrow into their anus, leaving them in this condition on the battle-field. The scalps and sometimes the cut-off limbs were brought to camp, stuck on poles which they connected with garlands, and during the scalp dance, which lasted three days and nights, the most revolting orgies were gone through. The oldest of their women were compelled to join hands in the maddening dance; the scalps of the slain were smoked over a fire, while praises were sung to the sun for the victory obtained. Women and children of the enemy were kept as slaves. Warriors ornamented their heads with all kinds of feathers, leaves and plants, like the Aztecs and Mayas, or drew the head or skin of some wild animal over their foreheads, to protect the head.

When *hunting game* they hid themselves in deer skins, and thus shot their game by decoy. The various superstitions of hunters are contained in Pareja's queries. He also speaks of their barbacoas or provision houses, and Le Moyne's picture shows that these were low palisade huts, roofed over, and having only one issue. In the maize gathering season, the whole crop was carried to these *barns*, and subsequently it was portioned out to every man according to his quality. The watchmen of these barns, when found to be neglectful of their duties, were executed by a heavy blow on the head with a war-club.

As one of the pastimes of their young men is mentioned the throwing of balls against a square mat made of bulrush reeds, hanging from a pole 8–9 fathoms high; the one who succeeded in making the mat come down, was winner in the game.

At the *death* of a holata or *chief*, men and women cut their hair off to half length, and a thorough abstention from food was ordered for three days; the deceased was buried ceremoniously, on the top of a terrace-mound, a smaller mound erected over his grave, and a large conch or marine shell, which had been his drinking cup, placed over this monticule. The conch was then surrounded by a circle of arrows stuck perpendicularly into the soil, at two or three feet distance from the conch.

In a people which believes in the power of *conjurers* over ghosts and spirits, the influence of the bewitcher or shaman must be necessarily immense. From Pareja's queries we gather the fact that mostly old men, *naribua*, were acting as conjurers; they consecrated the arrows before a hunting party left for the woods, and when the game did not expire from the first shots, they prayed over another arrow which would certainly finish it; they produced rain, restored lost objects to their owners, spoke their benedictions over corn-cribs and new fish weirs, over a catch of fish and over baskets of recently gathered fruits. They treated the sick with incantations and physicked them with herbs; they sometimes cured them half-ways only to exact more reward from them. They predicted future events, especially at a time when everybody was interested in what they might reveal: during war-expeditions. Before going to war, the chief sitting amidst his warriors, consulted one of the oldest and smartest conjurers (who had to be also an accomplished contortionist), concerning the result of the war, the force and the whereabouts of the enemy. In their midst the magician knelt down on his small round target in such a manner as not to come in contact with the soil; after various incantations he derived inspiration from demoniac powers, and while grimacing, drew a magic circle in the sand around his shield. After contorting himself in the most terrific manner for about twenty minutes, while singing incantations and uttering imprecations against the enemy, he finally stood up, and after getting cooler, he revealed to the "King" the number of the hostiles and their hiding places or whereabouts and the best moment to attack them.

Although we find no direct mention of *solar* and *lunar worship* in Pareja's writings, both prevailed among the Timucua, and solar worship throughout the Southern territories. The term acuhiba, *moon*, really means *indicator* (of time), literally: "the one who tells." The Timucua worshiped the sun under the image of a deer; they raised a stuffed deer skin on a high pole and testified their reverence for it by singing and dancing rites.* The sun was invoked before a battle and praised after a victory gained; the natives once refused to accept meat from the French and

* This is perhaps the origin of the tribal name *Aïsa*, *Ais*, *Ays*, previously mentioned.

made them understand that they were accustomed to wash their faces and not to eat before the sun had gone down.

Another object closely connected with their beliefs was the *sacred* number *three*. While the Maskoki tribes had a traditional reverence for the number *four* on account of the four points of the compass and the winds coming from each of these four quarters, and while they assigned a particular color to each of these four points, we find over a dozen references in De Laudonnière to a worship of the number *three* among the Timucua. They fasted three days at the death of a chief, their scalp-dances lasted three days and three nights ; at the toya festivity, which probably represents the green-corn festivity of other Indians, men ran into the woods, as if crazed, and stayed there three days, while the women cut themselves and their daughters, crying "*he toya !*" Even in Pareja this number is alluded to, for he mentions that chiefs just coming into power ordered a new fire to be made in their cabins to burn during six days, and at sowing time the chiefs caused six old men (*ano miso*) to eat a pot of fritters. Six is the double of *three*. The holy fire in the temple of the sun, among the Naktche, was fed by *three* logs only ; and a Peruvian creation myth pretends that *three* eggs fell from the skies ; from the golden egg issued the royal family, from the silver egg the nobility, and from the copper egg the commoners.

Concerning their mode of *sustenance* the Timucua stood high above the northern savages, for they tilled the soil and were not altogether at the mercy of nature, when an inclement summer season had deprived them of food. A hoe, made of a heavy fish bone or shell adjusted to the end of a stick, served in loosening the compact soil ; the women made grooves in the ground by hand and carefully deposited maize-seeds in each of them. Here the agricultural work did not devolve entirely on the women for the males turned the soil with their hoes. They made artificial ponds to let fish, eels, turtles, etc., come in, and afterwards caught them when needed. They were drinking the black drink, an exhilarating beverage made from the cassine-plant (also known among the Creeks), and to this, probably, refers the charge of drunkenness made by Pareja. They ate alligators, snakes, dogs, and almost every kind of quadrupeds and fruits, and were seen mixing coals and sand in their food ; their main staple, however, was maize, and the French saw them kissing the "baskets of mill," tapaga tapola, standing before them.

During the three or four months of the rainy season they retired to the woods and lived there in huts covered with palmetto leaves. They did so evidently to avoid the burning rays of the subtropical sun.

About their *arts and domestic life* not much is transmitted to us. The term taca ni timutema, "my fire is out" (Proc. of 1878, page 496), shows that they kept up the fire in the lodge all day. The description of the town, with the chief's house on a mound, as seen by Hernando de Soto on Tampa Bay, is too well known to need repetition here. The ordinary settlements of the Timucua were a conglomerate of huts surrounded by strong palisade fences, not unlike the *kraals* (from Span. corral, medieval

Latin: curtinale) of the Kaffirs. They must have been very fond of personal ornaments as Le Moyne's pictures tend to show, and tattooing with some indelible color was carried to a high pitch of artistic development. They seated themselves on coarse benches made of nine poles or canes running parallel, the benches forming half circles; there they held their councils of war and peace, while the women prepared food for them, or let the cassine drink make the round of the assembled warriors. They were adepts in the art of manufacturing fans, hats and other tissues from palmetto leaves, and also moulded large *earthen* vessels, in which water was carried. Not less were they acquainted with ideographic writing, for each of the two head-chiefs Olata Utina and Hostaqua sent five painted skins as presents to Captain René de Laudonnière.

A study of Pareja's *totemic list* goes to show that two kinds of descendencies existed among the Timucua. The names of the first refer simply to the relations which the men of the tribe or tribes entertained to their chief, as councillors, etc.; but the second list contains the ancient names of the gentes or clans, as given to them through their totem. The majority of these totems are names of animals, and herein the Timucua do not differ from other North American Indians east of the Rocky Mountains. The two lists of Pareja seem to stand in no reciprocal connection, and hence it is to be presumed that a man who belonged, *f. i.*, to the Anacotima could belong at the same time to the Apahola or some other clan mentioned in the second list.

Bibliography.

The following are the titles of Pareja's works consulted by me in the library of the Historical Society of New York:

I.

Cathecismo en lengua Castellana, y Timuquana. En el qual se contiene lo que se les puede enseñar a los adultos que an de ser baptizados. Compuesto por el P. F. Francisco Pareja, Religioso de la Orden del seraphico P. S. Francisco, guardian del Conuento de la purisima Cõcepcion de N. Señora de S. Augustin, y Padre de la Custodia de sancta Elena de la Florida. (Woodcut.) EN MEXICO, en la imprẽta de la Viuda de Pedro Balli. Por C. Adriano Cesar M. DC. XII.

In 16mo., eighty leaves or 160 pages, not numbered, but every quire marked with a letter of the alphabet running from A to K inclusive, at lower right hand margin, the leaves being marked with Roman figures: Biii, Biiii, Gii, Iv etc.

II.

In the copy consulted by me the following "Doctrina" is bound into same volume as part of a second Catechism:

Catechismo y breve exposicion de la doctrina Christiana muy util y necessaria, asi para los Españoles como para los Naturales, en Lengua Castellana y Timuquana, en modo de preguntas, y respuestas. Compuesto por el P. F. Francisco Pareja de la Orden de N. Seraphico P. S. Francisco, Padre de la Custodia de S. Elena de la Florida.

Follows a woodcut extending over more than half the page.

Back of title: Woodcut representing the infant Jesus with the cross, and Spanish verses to its praise. 176 leaves, paged only recto; the last three leaves 171–76 not numbered. Profusely illustrated with rough woodcuts. The colophon reads as follows:

Con Licencia de los superiores, en Mexico, en casa de la viuda de Pedro Balli. Año de 1612. Por C. A. Cesar.

III.

Confessionario En lengua Castellana y Timuquana. Con algunos consejos para animar al penitente. (*) ¶ Y assi mismo van declarados algunos effectos y prerrogatiuas deste sancto sacramento, etc. Ordenado por el Padre Fr. Francisco Pareja, Padre de la Custodia de Santa Elena de la Florida. Religioso de la Orden de nuestro Seraphico Padre San Francisco. Impresso con licencia en Mexico, en la Emprenta de la Viuda de Diego Lopez Daualos. Año de 1613.

Colophon: Aquino van puestos los Canones, hallarsean en el libro llamado segundo mandamiento.

LAUS DEO DEIPARÆQUE
o MARIÆ o

The book is in 16mo and the title is followed by seven unpaged leaves, containing testimonials and documents of the press authorities concerning Pareja's books. Follow eight unpaged leaves containing errata and list of contents. Follow leaves, the numbers of which run from 9 to 239, some set up in one, others in two columns, the former being more frequent. The volume is illustrated with many coarse woodcuts. The star, as marked in the title, occupies the middle of the page.

Note.—In the official preface to the Confessionario (leaf 3) the President and auditors of the royal "Audiencia" of New Spain mention the following writings composed by Father Pareja: "Fray Francisco Pareja de la Orden . . . . . a compuesto, traduzido y declarado la Doctrina Christiana, tres Cathecismos, Confessionario, Arte, y Vocabulario, y otro tratado de las penas del Purgatorio, y de las penas del infierno: y gozos de la Gloria, y el Rosario de la Virgen con otras cosas de deuocion, en lengua Castellana y Floridana, y gastado en esto mas de diez y seys años." It is possible that some of these writings have never appeared in print.

To the above I add the titles of two works by Gregorio de Mouilla, as copied from Icazbalceta's *Apuntes*:*

IV.

Explicacion de la Doctrina que compuso el cardenal Belarmino, por mandado del Señor Papa Clemente 8. ¶ Traducida en Lengua Floridana: por el Padre Fr. Gregorio de Mouilla Diffinidor de la Prouincia de santa Elena, de la Orden de S. Francisco, natural de la Villa de Carrion de los Condes

*Joaq. Garcia Icazbalceta, Apuntes para un catálogo de escritores en lenguas indígenas de América. Mexico, 1866, 12 mo, pag. 116–118.

hijo de la Prouincia de la Concepcion, y del Conuento recolecto de ñra Señora de Calahorra. Corregida, enmendada y añadida en esta segunda impression por el mesmo Autor. En Mexico Impressa con licencia en la Imprenta de Iuan Ruyz. Año de 1635.

(En 8°, 12 fojas preliminares. Fojas 1 à 197. 2 fojas de indice, sin numerar. Al fin :)

Acabose à 9. de Enero de 1636. con licencia en Mexico, por Iuan Ruyz.

V.

(A continuacion se halla este otro opúsculo):

Forma breve de administrar los Sacramentos à los Indios, y Españoles que viuen entre ellos. ¶ Aprobado por Autoridad Apostolica, y sacado del Manual Mexicano, que se vsa en toda la nueua España y Pirù, mutatis mutandis, esto es, lo que estaua en lẽgua Mexicana traducido en lengua Floridana. Para vso de los Religiosos de ñro Padre S. Francisco, que son los ministros de las Prouincias de la Florida. ¶ Por el Padre Fr. Gregorio de Mouilla. ¶ Con licencia del señor Don Lope Altamirano Comissario general de la santa Cruzada. Impresso en Mexico. Por Iuan Ruyz. Año de 1635.

(En 8°, 32 fojas. En la biblioteca del Señor D. J. F. Ramirez, México.) La primera edicion de este libro es de Madrid, 1631, en 8°; pero habiendo resultado con muchas erratas, volvió el autor á imprimirlo en México, corregido y aumentado. Así lo dice en su prólogo.

Radical Affinities of Language.

My attempt to compare the Timucua language with other linguistic families in regard to lexical affinity may be called premature, for we do not know over two hundred vocables of it with some degree of certitude. There are no two languages in the world which will not yield many real or fancied resemblances when confronted with each other, and to build aircastles on these has been a frequent mistake of many unexperienced investigators. Linguistic families, which are ancient neighbors of Timucua, are the Yuchi, Cherokee, Maskoki and Carib, but none of them seem to give any chances for fruitful radical comparisons, and Yuchi and Maskoki differ widely from it phonetically. The Carib or Galibi dialects, anciently spoken in the West Indies, are quite fluctuating in the pronunciation of their vowels as well as of their consonants, like some Polynesian dialects, and since we observe the same peculiarity in Timucua, an additional difficulty springs up in the way of arriving at a result.

A. *Timucua-Maskoki affinities.*

Holata *chief.* This Timucua term is evidently *loaned* from the Eastern Maskoki dialects, for in Creek holá'hta is a ceremonial title of men officiating in annual festivals and busks, and is often connected with the war-title hadjo, hádsu, which corresponds to our *bold, reckless* (holá'hta hádsu). In rank the holá'hta, hulá'ta stands below the tustĕnóki, who is himself inferior to the míko or chief. Holá'hta is the word holáti, with prefix ok-: oγoláti *blue, sky blue,* the blue color having become in some way or other the emblem of these titled warriors. In the cognate Hitchiti dialect blue is holatle. Among the Creeks *blue* was the color symbol of the *south.*

Aba, abo stick, club; *stalk, plant;* maize-stalk; abopaha corn-crib; aboto to beat with a stick; abara maize field. In the Maskoki dialects this term appears as ápi in Creek: stalk, stem; adshim api stalk of maize or Indian corn; ádshi-intal-ápi cob of Indian corn. The Hitchiti dialect pronounces the a longer than Creek: āpi stem, handle; nofāpi beech, lit. beech-stalk. In Chá'hta this word may be traced in: nusápi oak-tree, and in haksh-ap bark.

B. *Timucua-Carib affinities.*

Piro *red;* ano pira *red man, Indian.* In Galibi ta-piré is red and yellow; in Tupi piranga is red; pira piranga red fish, name of some fish species (Martius); in Taino pu, bu meant scarlet.

Paha *house, lodge, wigwam.* In Arowak we find bahü (and: baacheh) house; boharque in Taino: bohio, buhü, ubanna: *tugurium,* in the same dialect (Martius).

Ele *young, fresh, recent.* In Eyeri el is *son,* in Taino el, ili, gua-ili (with demonstrat. prefix gua-, wa-) young, offspring, infant; in Arowak elunchy: boy.

Ichali *weir, fish-pond.* Raymond Breton (Dictionn. Caraïbe français, 1665) page 282, has ichali: garden for raising vegetables. p. 468: tona icali (or áriche), fish-weir: "réservoir de poisson," tona meaning river. The word oubacali he also translates by *garden;* oúbao island, icali garden. Ibid. p. 111: chaláali he was drowned; na chálaroyem I am drowning, I go to the bottom. These two words are evidently representing different linguistic roots, and the first has to be pronounced ishali, according to the French pronunciation. Pareja expressly states that ichali was used for *weir* on the coast, puye in the interior, and I think it may be a loan word from the south incorporated into the language after suppressing the tona, which alone qualifies the Carib word (as spoken on the island of Guadeloupe) as a fish-pond. In Eyeri, as spoken on Porto Rico, chali meant a garden also.

The terms pointed out certainly agree in both languages, but they may be loan words; even if they rested on a common origin, their number is too small to prove identity of ethnic origin of the two peoples.

Other resemblances may be traced, but they are too doubtful for being relied on:

hapu *three:* kabbuin, kabuin Arowak.

maca, moca *sea, ocean:* bagua in Taino; cf. pa in paraná, the Tupi term for *sea.*

iyorona *eel:* ihiri in Arowak. The Timucua word is derived from the verb yuru to shake, tremble.

Dialects of the Timucua Language.

This is a topic on which very few indications were transmitted to us by the authors. But we are told by Pareja that dialects spoken by one tribe were intelligible to tribes speaking other dialects. He mentions several dialectic differences, f. i., that between ichali and puyu *fish-weir*, yame and yamanchu *brother-in-law*, amitina and chirima *my younger sister*.

The dialects to which he refers, are :

1. The dialect of Timoga or Timagoa, on Lower St. John's River.
2. That of Potano, west of St. John's River.
3. That of Itafi.
4. That of the Fresh-water District.
5. The dialect of Tucururu, on the Atlantic coast.
6. The dialect of Santa Lucia de Acuera, a short distance south of Cape Cañaveral.
7. The dialect of Mocama, a term which means : "on the coast."

Many other dialects and sub-dialects must have been spoken throughout the vast interior of the peninsula, of which we have no knowledge. The most instructive passage on this subject is found in Hervas, Catalogo de las Lenguas conocidas, I, p. 388, who quotes Pareja, of whose writings he had seen none but the catechism of 1627 : "Los indios que tienen mas diferencia de vocables y mas toscos que son los de Tucururu y Santa Lucia de Acuera, por participar de la costa del Sur, que es otra lengua, entienden á los de Mocama, que es la lengua mas politica, y á los de Timuqua, como lo he experimentado, pues me han entendido predicandoles."

Thus Pareja declares the coast dialect of Mocama (which latitude?) to be the most polished of all and a medium of inter-communication with the southernmost dialect with its rude pronunciation. *Otra lengua* does not necessarily mean "a language of a different stock," but only *an idiom differing from ours.*

Grammatic Notes.

On account of the unsatisfactory state of the Timucua texts at hand, our grammatic and lexical knowledge of this idiom can increase but slowly. Pareja's "Arte" or grammar would considerably help our investigations, but no trace could as yet be discovered of its manuscript or of the book itself, if it has ever been printed.

The following remarks contain the result of my studies on the grammatic part of the idiom. Many of them may be revoked in doubt or corrected by further research, for the state of the texts often admits several interpretations of the wording. For this reason I have even hesitated for a while, whether it would be justifiable to publish them or not.

In *phonetics* the most prominent feature is the alternation of some vocalic sounds among themselves, and of the consonants pronounced with the same phonic organ of the vocal tube.

Other changes are very frequent also, especially those produced by contraction, viz.: synizesis, syncope, ekthlipsis.

Thus, the article (or pronoun) na frequently combines with the following word, whether this begins with a vowel or not :

na ucuta : nacuta, ucuta ; nacunu : na acu ano.

na uquostano : naquostano, uquostano.

iti-aye : itaye ; iti ayaqe : itayaqe; isaye isa : isayesa ; isaye nate : isayente.

soba hebi : sobaebi ; piaha : pia.

chuqua cosa : chuquosa ; chi iquila : chiquila.

aya-lacota : yalacota ; ano eyo : anoya.

The Verb.

The *verb* being the most important part of speech in every language, I first call attention to the polymorphic and intricate nature of its *inflection* as it appears in the texts. It certainly shows analytic features by not incorporating the subject-pronoun, for this may be placed before or after the finite verb, its place being determined by the run of the sentence. Where this pronoun is found combined with the verb, phonetic attraction alone seems to have produced this effect.

The synthetic character of the Timucua verb exceeds largely its analytic features or anything that could be construed into such. It shows itself in the formation of the modes, participles and verbals, of the numbers, of the voices and tenses, of negative and interrogative verbs. To express grammatic relation and derivation, prefixation is much less resorted to than suffixation.

A large number of American languages do not distinguish more than two tenses, though others show a variety of them. Timucua is poor in tenses ; the tense of the incompleted action, which mostly coincides with our *future*, is expressed by suffixing manda, manta to the stem, a derivative of the verb mani *to desire*. The fact that manda sometimes appears before its verb, and sometimes is used as a verb for itself (*to be willing, to want, to require*), proves that its real function is that of an auxiliary verb. As such it is placed after all the suffixes that may be added to the stem :

viroma niponosiheromanda bohobi cho? did you believe that the husband *would* possibly return (to you)?

honosoma cayamaquene ubahauetilamanda bohobi cho? did you believe that the deer and the partridge *would* not (no longer) be caught?

nocomilemanda it will become true.

The action completed or just being completed is expressed as follows :

1. When the action belongs to the *past*, and is expressed by our imperfect, preterit or pluperfect, -bi, -vi is suffixed to the stem or basis of the verb : taca quosobi cho? did you make a fire?

2. When the action is in course of completion, and the tense answers to our *present* tense, then the pure stem of the verb is used, and -la is added, when the action is done in the presence of the speaker : motala I assent, I agree (while I am here) ; habosotala I accept.

-la, -le being the particle of the *affirmative* mode, expressing certainty, positive statement, actuality, can be added to any tense or mode, but is most frequently used to express the present, especially when the first persons are used.

nocomi ninihabe*la*manda bohobi cho? did you believe that he would certainly expire?

balu nanemima ohohaue*la* it gives everlasting life.

hanibiti*la* evidently he has not neglected.

In chuqualehaue chuquosa cho? how often did you do this? the preterit tense is not marked by any suffix or other syllable.

The *plural* of the verb is often indicated by the suffix -ma, in participles by the suffix -qe, both of which are used for many other purposes also. In the queries (Proc. 1878, p. 498) mante he desires, has pl. mantema they desire or want; lapustela it requests, pl. lapustamala they request.

No instance of a *dual* form has occurred to me in the verb or substantive. From yucha *two* is formed yuchaqua *both*.

Whether the verb is making a distinction concerning *male* and *female gender* is a matter of doubt, and I can adduce only one passage (ibid., p. 498), which seems to indicate some distinction of this kind:

viro uquata puenonicala I bring a male infant.
nia uquata puentanicala I bring a female infant.
viro niaquene puenonicala I bring male and female infants.

Of *the modes* of the finite verb one is marked by the suffix -hero, -ero, -ro, which expresses possibility and probability, corresponding somewhat to our auxiliary verb *may, might, could*. This form, which could be called either a conditional or a facultative mode, may be illustrated by the following syntactic instances:

anoco nihihero manibi cho? did you desire that anybody may die?
balu pontahero he may give life.
niponosihero-manda bohobi cho? did you believe that he would possibly return?

To show the forms of the *imperative* and *exhortative* mode with some degree of certainty we have not enough instances on hand.

Participles are formed by means of the suffixes -mate, -no and -ta, -te.

-mate corresponds to our participle in *-ing*, and to the Latin gerunds, but is appended to nouns also, especially when they become connected with verbal forms in -mate.

paha pononomate samota quosobi cho? after returning home, did you rub yourself with herb juice?

cuyumate honoso honomate feeding on fish and deer meat.

henomate ibinemate for eating and drinking.

etabualunimate after having given birth to.

-no, -nu is found in participles of the medial and the passive form:

eca*no* made, worked, worked over.

itori*no*lehaue equelacoma on days where (people) have to fast.

honoma, calama itulu*nu*leqe fruits prayed over.

na care he*no*mano caqua all these things, when eaten.

-ta and -te occurs in participles of passive, and also of intransitive verbs; to distinguish it from the negative and the interrogative -ti, -te is not always an easy matter. -ta mostly occurs as the ending of a substantive.

ubuata caught, from ubua to catch, capture.

hibate missa the missa having been said, or having said the missa.

atofa hororoquene hebataqe when the owl and the red owl were screeching.

nimota being hunted.

ibirita (a woman) who is menstruating.

eta baluta (a woman) confined.

inosobote one compelled to work.

ituhute over which a prayer was said; prayed over.

There are two *negative* particles in the language, aya (ya) and -ti, -te. The former either stands for itself, or is prefixed to the verb; when prefixed it becomes only agglutinated to, not incorporated into the verb. Aya is a particle of an objective nature, while -ti, -te is used in a subjective, putative sense, the negation of a fact or thought existing rather in the speaker's mind, than objectively. Therefore it serves also as an interrogative particle, and then is mostly joined to in- as inti, though frequently found incorporated into the verb, and placed after particles of derivation. It then corresponds to Latin -ne in dicisne? and to *μῶν* (*μὴ οὖν*) or to our *not* in "don't you say?" which means the same as "do you say?" though with a slight shade of difference.

aya honoma ituhunu fruits not prayed over.

hanibitila he did not neglect.

manino-ticote without feeling hunger.

Diosi hubuasotanatila? have you not loved God?

isayente (for isaye nate)? is she thy mother?

isayeste? does thy mother say so?

The formation of reflective, reciprocal, medial and causative verbs is effected by derivational affixes, and some of them are mentioned among the "Prefixes and Suffixes of Derivation." How frequentative and usitative, durative and attributive verbs are formed cannot be determined yet on account of the infrequency of syntactic examples. Instances how derivatives are formed, will be seen under mo- and orobo- in the "Words and Sentences."

The Noun.

The Timucua *noun* presents many difficult problems. To designate the objective case of the direct object we find in the *substantive* four suffixes: -co, -nu -ma, and the plural suffix -qe, or we find no suffix at all. While -ma is locative, plural and verbal suffix at the same time, -nu seems connected with certain classes of nouns only, of the animate as well as of the inanimate order. None of them is a sign of a distinct *case*.

chofama pilenoma ibine-ichicosa to throw liver and lungs into cold water.

ponachica viroma? niama? do you bring a male, female (infant)?

balunu nanemima ohohauela it gives eternal life.

The adjective, when used attributively, does but in a very few examples agree in its suffix with the substantive it qualifies, and generally has no suffix at all, but stands *after* the substantive.

-mate is a postposition joined to nouns, in honosomate cayamatequene, from the deer and from the partridge, Confess. p. 129.

The possessive pronouns can become suffixed to conjunctions and adverbs just as if they were substantives or participles. Thus the suffix of the second person of the singular, -aya, -aye is met with in examples like the following, which prove that these particles were originally participles or other nominal forms:

naquostanaye? in which manner you?

chucaya haheno? how often did you eat?

equelaya haheno chuqua? how many times a day did you eat?

The third person of the singular:

Diosi hebuano nemoquamima emoqua against God's law; lit. "God's law against his against."

In participles this is observed as follows:

orobotanaye one cured by you.

ara uque naponaye you anointed with bear's grease.

caqi nia hutanaye that woman with whom you slept.

ilifotanaye for your killing (deer).

A syntactic curiosity are the suffixed particles -leqe, -lehe, -ma, -mano, -qe, which are sometimes placed after each word of a series of consecutive terms. They serve, no doubt, to establish a connection or reference, or to show mutual coördination of these terms. cf. tacachuleheco, &c., Confess. p. 132 v.; cuyuleqe, ibid.

The suffix -qe often serves to connect a principal clause with the principal clause just preceding.

We also find repetitions of verbs and nouns, which seem quite unnecessary to us, and embarrassing the sense:

honoso henomate inti uquabi cho? deer-meat eating did you eat?

hehanimanda hanibi cho? did you quit to cease eating?

nia iquimi iquiti mosobi cho? did you insult any women? lit. "to women with insults did you insult-cause?"

Incorporation.

There are also a few instances where the nominal object, direct and indirect, seems to be incorporated into the verb, as it is the rule in the Aztec language. Traces of this have been discovered in many other American languages. Some of the examples below are simply compound words, which differ in nothing from the Greek *οἰκοδομέω* and the Latin *animadverto.*

utihanta one banished from home, exulant; lit. one yearning (hani) after (his) country (uti).

sobae to eat meat; lit. to meat-eat (soba-he).

ibine-ichicosa to put or throw into cold water; lit. to cold-water (something). It is not probable that cosa forms here a word for itself, but ibine ichi, a noun with its attribute, becomes verbified by the suffixation of -cosa. cf. afatacosi to gather chestnuts. If the relation existing between the suffixes -co and -ma was clearly established, we could decide whether -co is here the sign of the objective case or perhaps the radix of the verb coso *to make, produce.*

cuyuhanta one who eats no fish, lit. missing, deprived of fish.

atimoqua lord, master; lit. servants attend (on him).

As well as the direct and indirect object of the verb, other portions of the sentence can become incorporated into one single term in this idiom. If the constituent parts of the sentence, the subject, object, predicate, attribute, etc., were *morphologically* as well defined here as they are in the Indoeuropean and Semitic languages, this would be an impossibility. The grammatic affixes of Timucua do not bear the imprint of sharp logical distinction and segregation, but embody too many relations at once, material and purely relational ones, as we clearly perceive in the example of -ma and -mate.

Diosi hebuano nemoquamima emoqua, lit. God-law-against-his-against (did you proffer curses?). In this sentence -mima, which is the possessive pronoun *his*, could stand just as well after the possessor (Diosimima hebuano), but the simple fact that it can stand elsewhere also, shows us the true character of the language.

Soba sobaebi (for: soba-hebi) cho? did you eat meat? lit. "meat did you meat-eat?" Here the first soba is the object of the verb sobaebi cho, the second soba is the incorporated object of hebi cho only. This sentence seems *to us* to contain an unnecessary repetition, but the Timucua certainly did not consider it in this light.

Chuqualehaue chuquosa cho? how often did you do this? chuqua, how often, is here verbified in both instances, chuquosa standing for chuquacosa. This seems to be more than a mere ellipse of a syllable.

Cuyuma ubuata qibenco melasonolehabetele mosobi cho? did you order that the first fish (pl.) caught be not thrown into hot water? In the direct object, cuyuma ubuata qibenco, the last term only contains the sign of the objective case, *-co*, hence the two terms standing before qibenco must, in the mind of the Timucua, have formed one word only with qibenco through incorporation.

Ano pequataye inosobotequa: your subordinates who are put to work. Here the sign of the plural number, -qua, is appended to the last term only, though plurality extends to pequataye as well as to ano.

Paha pononomate, lit. "after-home-returning." After paha a postposition of a locative character is expected; its lack seems to prove that the Timucua regarded both terms as one compound word formed by incorporation of the indirect object into the verbal form.

Prefixes of Derivation.

Prefixes subservient to the formation of derivatives are not numerous and cannot be easily confounded with syllables entering into the composition of compound words. The demonstrative pronoun na, which we can often render by our definite article *the*, coalesces in some instances with the word following it after losing its accent, and the same is true of the pronoun chi *thou;* but these are not prefixes.

i-, verbal prefix: iquaso, iquase to screech, scream; iparu to swallow (?) iquileno in iquilnona married to the sister of my wife; iquiti to insult, abuse; ko, coso and ike to make, do, to cause to.

i-, nominal prefix: ichini and chini nose, nostrils; iti father; isa mother; isale sister of mother. itori subsequent to: iquini breast, udder, milk; ibine water, lake.

yu-, yo-, a prefix equivalent to our *through, across* or *by, near, past;* yubueha, yubehe to transfix, pierce; yuquiso to deposit on the side of; yoqua past, bygone.

ni-, verbal prefix: mero hot, nimaru to preserve one's heat; naquila to perfume, ninaquilasi to perfume; pona to come, niponosi to return to; nacu to drink, ninacu to ask for a drink.

si-, verbal prefix of a medial signification, which frequently adds to the verbal base the idea of "for oneself" and is sometimes reflective. Siqi or siqisa in siqisama my father, lit. "the one who procreated me," cf. siqita pahana all people belonging to my house, family; uque oil, grease, suquoni to rub something on oneself (for si uquoni).

Suffixes of Derivation.

A short examination of the specimens of Timucua given by me in the "Proceedings" will prove to readers that this language is in a high degree polysynthetic, not only in its signs or syllables of relation (inflectional forms), but also in derivational forms. Often one and the same syllable serves as an inflectional and as a derivational form, and it is a peculiarity of this language that these forms can occur in the form of whole syllables only, either single or double.

Suffixes are more numerous than prefixes. They are either inflectional or derivational. The latter alone will be considered in this chapter, and although the number of them as given here is rather small, Timucua forms a much larger number of them by combination. To define accurately the functions and origin ot them all, is what a full grammar of this Floridian language will perhaps one day be able to give.

-ba, nominal suffix: hiyaraba lion; nariba and naribua old (of persons; from na ariba); hibe louse; soba meat, deer-meat.

-bale, identical with -male, Proc. 1878, p. 497.

-bo, verbal suffix forming transitive verbs: tinibo to pierce, perforate; iniso and inisobo to make somebody work; aboto and abotobo to beat with a stick; orobo and oroboni to cure, heal, to treat for sickness.

-cha, -chi suffixed to nouns is not a real suffix; it is the relative particle cha, hacha, "the one who, those who, that which;" chulufi-chi those of the jay-clan or totem; caru yachimale she that was born with a brother, the female of twins, ya being the pronoun *she;* po-cha, and hachi-pa-cha somebody, anybody, lit. "the one who is born;" ela-pa-cha the members of of one family. lit. "those born young together."

-co in isitoco to cause to bleed; -co is a verbal suffix, but mostly occurs in combination with other suffixes and has a factitive or causative function: ichi cold: ibine-ichicosa to throw into cold water; afata chestnut: afatacosi to gather chestnuts; isi blood: isitoco to cause to bleed. -co also occurs in paracusi head-chief. This suffix seems to be merely the sign of the objective case, here incorporated into the verb.

-fa, nominal suffix: chofa liver, chorofa jay, atofa owl; ituhu to charm, bewitch: itufa conjurer. This suffix probably alternates with -ba, -fi, and also with -hi.

-hani expresses the idea of cessation, discontinuance, and is in fact a verb; when connected with other verbs it serves as a sort of auxiliary verb. (ni) he-hani-manda I shall cease to eat, I will not eat.

-la, -le, nominal suffix: itele uncle, so called by nephews: uncle on fathers' side; cumele heart; iqila sick, diseased; apahola buzzard, crow; eqe, equela day; tola laurel; anoquela lineage, kinship, pedigree.

-lesi, -lesiro, verbal suffix expressing the idea of *to become, to begin to be:* -si being causative, -ro pointing to probability and future time; -le seems to have the power of verbifying, like -si. Christianolesiro to become a Christian. holatalesiro to become chief. muenolesiro to receive a name; lit. "to begin to be called." abotosiro to receive blows, to get beaten.

-mi, verbal suffix: ene to see, enemi to discover, find out.

-mi, nominal suffix: nanemi perpetual; adv. always; nocomi true; hasomi those belonging to one lineage, clan-people.

-ni, nominal suffix: ichini nose, nostrils; ibi, ibine, ibino water, lake; he to eat, hini tobacco; the word for tobacco is in many Indian languages a derivate of *to eat,* because the smoke is often swallowed by the natives. meleni petticoat.

-ni, verbal suffix: hani to cease, stop: hanini to neglect. orobini to go to confession; orobo and oroboni to cure, treat in sickness; suquoni to rub oneself with. icasini to altercate, quarrel; pona to come: puenoni to bring.

-no, -nu nominal suffix, also found in participles of the passive: ituhu to pray, ituhunu prayer; hebua to speak, hebuano word, saying, discourse; pacano subsequent to; pileno lungs; ahono young; banino rainbow.

-no, verbal suffix: pona to come: ponono to return to; bohono to believe.

-ra, -ro, nominal suffix: aba maize, abara maize-field; itori late. posterior; hororo red owl; jufere fish-catcher's wicker basket.

-si, verbal suffix: afatacosi to gather chestnuts; elosi to whistle (or is it elofi?); icasini to altercate, quarrel; niponosi to return to somebody; ibinese to bathe; nulasi to tickle.

-so, verbal causative suffix: uqe rain: uquiso to produce rain; inoso and inosobo to cause to work, to work somebody ; ituhu to pray : ituhusu to cause to pray, to let pray ; uquaso to give to eat ; coso to make, produce ; moso to make, cause ; iquaso, iquase to scream, cry ; inibiso to drink to excess. he to eat, heso to make eat.

-so, nominal suffix : he, heno to eat : honoso deer, antelope.

-ta nominal suffix, forming (1) nomina acti, and other terms : hibuata sayings, words, ceremonial terms ; uquata body, flesh ; afata chestnut ; aquita maid ; ibine water : hibita river ; pequata bondsman ; hulubota maize-ear. (2) occurring in participles : eta baluta a woman after confinement ; ibirita a female during her period ;, nimota for na emota being hunted ; ene to see : na eneta a seer, one who sees ; heta nacuta adv. immoderately.

-ta, -to forms transitive verbs : abo stick, aboto to beat with a stick ; isi blood, isito to cause to bleed ; samota to tinge, rub oneself with ; huta to cohabit with.

Conclusion.

A retrospective view upon all that could be gathered to this day concerning the structure of the Timucua or Atimoke idiom shows it to be remarkably simple as far as its *phonet'c* structure is concerned, but intricate in its morphology. Its syllables consist either of one (long or short) vowel, or of one consonant followed by one vowel. When exceptionally two consonants are joined, some vowel must have been eliminated. The r seems to be a real trilling sound, and not a graphic substitute for some other sound, for it alternates with no other sound but with l

This elementary syllabism impresses its character on all the *morphologic* features of the idiom ; roots, prefixes, suffixes are monosyllabic, or if polysyllabic, the suffixes at least can be proved to be compounds. A vocalic character is imparted to the language by this elementary syllabism, but whether the idiom was *sonorous* is still an open question, the solution of which depends on the fact, whether the vowels were pronounced clear or dumb. No doubt the Timucua dialects showed some differences in this particular among themselves.

The language is thoroughly synthetic in forming the voices of the verb, possesses an affirmative form in -la and a negative form in -ti, and verbals as well as participles are formed by suffixation. Its synthetic structure is also shown by its numerous array of derivational prefixes and suffixes (in this respect Timucua is polysynthetic, not synthetic only). and by a set of postpositions and case-postpositions affixed to the noun. A possessive case does not exist ; possession is indicated by a possessive pronoun added to the sign or term of the proprietor, or by placing the latter before the thing possessed. The other nominal cases are not made clearly distinct from each other by their postpositions. The synthetic character of the idiom is shown also by various suffixes, which serve to form a plural in the noun and in the verb, and by others which impart to the verb a modal or a temporal character.

Timucua is analytic in not incorporating the subject pronouns into the verb; they are placed either before or after the verb. Concerning the object pronouns the evidence on hand is too scanty. The nominal object can become incorporated into the verb, but this is not done regularly.

The language has two relative or demonstrative-relative pronouns, hacha (cha) and acu, which help in a great measure to disengage the intricacy of construction and prevent the language from becoming too "participial." The number of conjunctions seems to be rather small, and in this respect the language is far from being analytic.

The most important question of morphology to be decided by every linguist who gives a grammatic sketch of an idiom to the world, is whether the idiom possesses a *real* verb or not, the verb being typical of the language itself. For the Timucua the answer is, that the verb is neither a real verb, nor a pure noun, but a noun-verb. It is true that the plural is formed in the same manner and by the same suffixes in the noun and in the verb, as we find it done also in the Maya family; it is true that no real subject-case exists, and therefore no real case for the direct object either, all the nominal postpositions being originally of a *locative* character, as it seems; it is true also that several relational suffixes of nouns repeat themselves in the verb. But the subject-pronouns are by no means identical with the possessive pronouns of the nouns and participles, some of which are always suffixed, not prefixed to them, and though the verb does not inflect for person, it inflects for tense and mode. The verbal forms which correspond to our finite verb are *nomina agentis*.

The result is that the verb of this peninsular idiom is a mixed production between a real verb and a noun used as verb; it is a *noun-verb*, holding a middle position between the finite Indoeuropean verb, and the finite Algonkin and Creek verb, both of which are *nomina actionis*.

The nature of the texts makes it difficult to find out whether there is a substantive verb *to be* or not, and therefore we are still in the dark concerning the attributive verbs. However, the existence of a verb *to be* is very improbable; it is often circumscribed by the article *na*. Adjectives used attributively are sometimes inflected with the same postpositions as the noun which they qualify; sometimes with other postpositions, while at other times they show no inflectional endings at all, which proves that they were then considered as forming *one* term with the noun, which they qualify. They always *follow* the noun, unless used predicatively.

The incorporative tendency of the language has been spoken of above. It is not very prominently nor frequently put to use, and most sentences do not show any trace of it; but it *exists*, and this fact is enough for us to direct our judgment concerning the nature of this southern idiom. Subject pronouns and some of the adverbs are not, but most other parts of speech can become united with the verb, or among themselves, into "collective terms," which are so instructive for the study of agglutinative languages.

SELECTED TEXTS.

Questions Addressed to the Chiefs.

Holatama bueta yechinoma cantela.

(Pareja's Confessionario, leaf 183 v.—184 v.)

Did you exact more tribute or other articles from your subjects than you were formerly in the habit of doing?	Andaque cumeleta hachibueno hachi ichusubinaco christianolenaye ofuenona yameta hachima osoarosota nichusimaca mobi cho?
Did you exact the labor or day's work from those who work for you?	Ano pequataye inosobotequa hacheleheco yerebana nayolehecoquene hochi uquabi cho?
Did you employ your subjects at some work, so that they missed the holy mass?	Ano pequataye inosobo chique Missaleno hani mobi?
Did you order [them] to work on feast days without the priests' permit?	Itimilenoye inosohale masetiqua fetecatiqua fiesta equelama inosobi cho?
Did you order, that no one open the corn-crib or approach it, unless the conjurer has previously said his prayers over it?	Ano misoma itubutetima avohopahama iqinoleheleqete mobi cho?
Did you forbid to eat of the new maize or other new fruit, before the conjurer has tasted it?	Tapolabacaqe aya hono tocaco tocoqe uquaca ano misoma hetetileta heqeqere henolehabela motabi cho?
Did you design that weddings should take place to the benefit of the Indians without giving a share to the priest?	Anopira comeleta niamate nata hibuasi mota viroma nacunata hibuasomata mosobi cho?
Did you consent to [your] slaves' sleeping together?	Ateco anoco fastaqe nate manibi cho?
Do you keep any negro slave as a mistress?	Atemimaqua inihimi chu mosobi cho?
Did you consent that some people of your village recite incantations over some herbs?	Hicaye ano niye uquata ituhuteco hibuataqe nate naquenta hanimate manibi cho?
Did you cause any conjurer to search by diabolic arts for something stolen or lost?	Nuquenoco hachibueno teraco chebeque yalacosobi cho?
After eating bears' meat did you ask for drinking from another shell, lest you would fall sick?	Ara-hete toomama nacunuma ninacusi chi caqe honi-hete ninacuqe niqilabosohabele nacunu eyo nacunulehaue mosobi cho?

To preclude young women from dancing did you have some of them insulted, or inflicted punishment on them?

Ela nia muquino iquimi iquiti mosobota hachibueno nabalusobota mosobi cho?

Early in the sowing season did you cause six old men to eat [a pot of fritters]?

Echerosota ano miso marecama hesobi cho?

Just before becoming chief did you order a new fire to be made for six days in the cottage, and to have it closed up by laurels or other things?

Holata ichi qihabeleta taca chaleca alata itorita ela mareca hutanolehaue, acu tolalehecote hachibuenolehecote viro pahama naquiluta mosonolehaue mobi cho?

Did you desire the chief's death to succeed him?

Nihitaruqe honihe holatalesiro manibi cho?

Having fallen sick, did you construct a new house, declaring "Here I shall live and die?"

Chiquilabotanimano paha chaleca neunuleqe fata orobinihale caqua fanomano ninihihauele mobi cho?

Did you order laborers to be punished so as to have their arms broken, not for the sake of work, but for being angry?

Anoco inonino namoquatima maha ine eyo nayuricomita chacali carema tuchemaca mo chi abotomoque yabi vichubi?

For what other reason, but for being angry, did you have anybody punished?

Anoco ineca luba ticote hochie yuricono yebueta iqimileqe ineco nahiqe abotosiro-manda quosta nasisobi cho?

Indian Prognostications and Pagan Ceremonies Still in Practice.

Anopira hachirare isinomet hitinacumelenomatequene cantela.

(Confessionario, leaf 123 r. and v., 124 r. and v.)

When somebody was crazed, did you believe [his] words would become true?

Isucu echa, hebuatema nocomilemanda bohobi cho?

Did you believe that it was a sign of somebody's arrival, or that something new would happen, when a jay was chattering to another bird, and when my body was trembling?

Hachipileco cacaleheco chulufi eyolehecote nahebuasota, caquenihaue qestela, mota unayaruru catemate, caquenihaueqe intela manta bohobi cho?

Did you believe, that by making a new fire in a separate spot, the sick would recover?

Ano iqilabamabuetaleqe taca chaleca arecotana baluhauele-manta bohobi cho?

When you were sick, did you have a fire (candela) made separately so that they may cook victuals to be your food, for otherwise you would die; did you believe in this?

Chiqilabotaqe, taca chaleca nalasinolehaue hono intico tacama echeqe ninihihauela-manda mosobi cho? yanacu ano eyocobueta motaqe bohobi cho?

When a woman was in travail, did you think it sinful to approach the fire (lumbre) just burning?

Vilu tacaco inti uquata ibiretacoco inti uquata quosobi cho?

Did you consent that a herb-doctor should cure you by reciting over you demoniac words?

Isucuma chorobonima hiti hebuata ituhuta choroboqe nate manibi cho?

Did you offer to this purpose at the door of the house the maize to the Devil, as you were in the habit of doing before?

Tapolama ucuchua casota hitima tacatosibinaqechu naquosobi cho?

The ceremony of the laurel, performed to [serve] the Demon, did you perform it?

Tola ucuchua nacaquibinaqechu naquosobi cho?

[When collecting] acorns or other fruits, did you not eat the first [gathered]?

Ahano calama qibemate, hachibueno eyo calama qibemate inti uquabicho?

When lightnings struck into the clearing (roça) or maize-field, did you not eat of it? and did you advise anybody not to eat of it?

Pilema numa hebuama nabotoqe, tapolamano inti uquabicho? yanacu ano eyo, inti uquasota, mosobi cho?

Did you advise not to eat the first maize of the newly-cleared field?

Auara ele tapolama ecano qibemano inti uquata mosobi cho?

When the water is flooding the new fish-pond and the first fish is caught, did you order not to throw it into hot water, lest no others would be caught?

Ichali ele iribosobinaco, cuyuma ubuata qibenco melasonolehabetile cuyuma naqua ubuahauetile naquosatiqua nimaca mobi cho?

Did you place the first fish close to it (the new fishpond), to make come a large quantity by the next tide?

Cuyu ubuata qibenco yuquisotaniqua, cuyu arota ubuahauele-manta quosobi cho?

When flooding a new fish-pond, did you desire that the conjurers pray over it, believing that many more fish will enter it?

Ichali ele iribosota, hiti hebuanomani ituhusinoleqe ubahauele manibi cho? yanacu ituhubi cho?

(Same sentence, the inland term *puye* "weir" being substituted for ichali, used on the coast.)

Puyeca quibinaco hiti-hebuanomani ituhusinoleqe hubuahauele manibi cho? yanacu hoqua itúhubi cho?

(Confessionario, leaf 127 v.)

All these things, all these abuses, the tremblings of the body, the omens from the birds, from the beasts, nothing of them must be believed in.

Una caremaqua hachibueno, care nayalacota, caque nihaue yatala muenomate isticoqe namota bohonole bitima chisisotamano bohatiquani hach(c?).

To Married People.

(Confessionario, leaf 208 r.)

Did you suspect your consort of some wicked action?

Inihimima inibati cumelesta inta ninco nabe v- nale manibi cho?

Did you outrage your consort by affronting terms, by insults, by scoffing, or by laying hands on?

Inihimima hebuanoleheco ininoleheco mosima na-isticosota iquitimosota hebuabi cho?

Have you gratified too much the desires of your sons, allowing them their own will without punishment and correction, and leaving them their liberty?

Siquisonaye maha ere timoqiti mine cumelebi nincoqua na-intanasiqi puenta honochiqe heta nacuta orobistileno chiqena inta alihotahabe nate manibi cho?

Did you consent that your son or others of your house act in a turbulent or knavish manner?

Siquisonayeleheco anoyaleheco orobistitima anoletaqe nate manibi cho?

Did you give no longer to eat to your husband, and did you not act upon his command?

Inifaye cobuosatileta hono. nacume ecatileta tera hebuatanima hanisobi cho?

(Here follows: Have you not murdered......Proc. 1878, pg. 499.)

Misdeeds to be confessed to the Priest only.

(Catechism, leaf 83 verso to 84 verso. In the original, this article is *not* divided into paragraphs or sections as here.)

Hono-melomano pilanileqe nabe chaleqe quenema hayarota ebetoqe ibama nahabosoqe mosotequarebama nahitanima; naquentequa elasosiqe nimarubi michuqui mosilenomano anoco, neneha manibi michuqui mosimano hecate.

The shell of the ocean opens every night and every morning to receive the dew from the sky, wherewith the pearl congeals in it; the pearl locks itself in, when the sun has risen and the day has advanced, and preserves its natural heat (y viene escalentando), and so that it may be seen afterwards by all, it locks itself in.

Naqni monihauemano iniheti ininomile atichicolo orobotemaqua orobinta naahosta mosonihauele eaqi ano orobotemano Iesu Christoma, na ichiqitechule.

We likewise must manifest our shortcomings only to the confessing priest, as to a vicarious person for Jesus Christ, and to none else.

Naque nihaue quentelaha yabamosimano isticoma inta nabo nabomota, naquosonole hetimane na anolatema.

Many are doing just the opposite of this; those who glory themselves when acting mischievously and praise themselves on account of their sins.

Nahitela naquenema Esaias: Istanimano namotemano mine istico inino mimaqua na-iribota hebuata nelacare chienta, Sodoma hicayayima, anoma isomoni michuqui mosotema nahitela.

Of these people says the prophet Esaia: "Peccatum suum sicut Sodoma praedicaverunt." They have praised and publicly exhibited their sins, like those of Sodom.

Naquenema hanta eyobeta taanolenomano unabine yuchinoma elacare chieta, halifonoma nantela.

That the sinner should reveal his sins, unless while confessing, seems to be against nature.

Gatomano piaha-manda ayahibuanoma; piteta nuqua ecate hachipile inemimano, yuchi nihe mosima, apiminaqua nacuquete una oqùo yuchi namotemabeta, na-iqilabono nahitemano isucumaqua nahiabosota eyomano.

Cats will hide their excrements and cover them well [so that they do not stink nor smell bad to others], and all animals cover themselves by their tail; and people who have any ugly infirmities conceal and hide them from others' sight, except from the physicians who are to heal them.

Chiqesta mosote quentemano iniheti ininomileno eyomano; chiqesta atichicolo isucumaqua sacerdote intema toloba ajosta na-orobininolehauela.

All this teaches us, that sins must be covered and concealed from all, save from the spiritual doctors, to whom they must be confessed openly.

Naquenemano ano yaha mosimano iniheti ininomima yucheti elacare ahota.

Sinners must not be like monkeys, who show themselves nude to all, without shame or bashfulness.

Acu caquenta nabalu hache itimilonoma mota nimate canimasela mota nabeta nabonta na-anoletema na hitela quosonolebitila Sacramento na-orobininoma nabena sabata isonola naquenema intila.

There are people, also, who divulge not only the sins which they have confessed, but even the penances, which they have endured for them, and in this manner almost expose to mockery the Sacrament of the confession.

Miscellaneous Queries.

(Confessionario, leaf 210.)

Pahamico anomileheco ano eyolehecote quenema inibati intaqe nate manibi cho?

Did you permit any married or other person to have sexual intercourse in your house or elsewhere?

Inihiminco ano eyo napatabohero maninoma nate quentahaue manibi cho?

Did you consent that any one have connection with your consort?

Niaco obachamisibi cho?

Did you kiss a woman?

Chuqua?

How often?

Niareqe chuquareqe?

How often each woman?

Caqi nia hutanaye inemimano anomicote hu'abi cho?

Are there any mothers among all those with whom you had intercourse?

(Catechism, leaf 50.)

Santa María aquitasiqema hebuasta istala. — I speak with the Virgin Mary.

Caqi aquitasiqe Marianeono chicaconte? — Who is the Virgin Mary?

Mine (h)achibueno tera inemi naya iynomate, graciamate nacumotaqe iyenotima; nocomi Dios-isomima nantela. — Some great queen, rich in all virtues and graces; the true mother of God she is called.

Caqi minequa iyenotincono chanco hibuante? — Where dwells this grand queen?

Hachaqueniqe Diosima muenolete? — Why is he called God?

Nanacu hachibueno carema naeneta naqebanta, numamate utimate quenequa mine ecoyaleta hachibuena carema caquenta hauemantema nantiqe ona Diosila. — Because he sees all things, and ministers to them, he being the powerful ruler of all things in heaven and on earth.

Dios itimi, Dios qiemima Jesu Christo nante, Espiritu Santomate. — God father, God's son Jesus Christ, and the Holy Spirit.

Ano qiemamate Diosi? — Is the Father God?

O, Diosila. — Yea, he is God.

Quiemilenomate Diosi? — Is the son God?

(Catechism, page 27v.)

Mime una oquomimano hachaquenta tuqualamanafaye? — In which state did his body remain when in the tomb?

Nanacu una oquomano utinaleno divinidad muenomacasinta yahota fayela. — His body was united with the Godhead itself.

Nihinima hachaquentaquere tabuale? — In which manner did he rise from the dead?

Acuyano, hachequeniqe Christianolehala mote cho? — Furthermore, why do you declare that you want to become a Christian?

Mine Diosi maqua, inostaniqua numa abo orabonoma nimihero nimandaqe, Christianolesiro ni manela. — That I may serve Almighty God, go to Heaven, and that there the glory may be conferred upon me; therefore I want to be a Christian.

Address of Thanks,

Sent to the King of Spain by his Loyal Subjects, the Chiefs of the Timucua People; dated the 28th of January, 1688.

Shortly after the revolt of the Indians of the northern part of the Floridian peninsula against their Spanish governor, who attempted to send some of their number to the mines in the West Indies, and after the inroad of the Yamassi Indians into their pueblos (1687), the loyal Apalache chiefs sent a letter of explanation to the Spanish monarch, dated Apalache, Febr. 15, 1688, and endorsed by the Governor Diego de Quiroga y Lossada, "Capitan-general," on April 1, 1688; the Timucua chiefs sent to him a loyalty address bearing date of Jan. 28, 1688. The vidimus of this letter states, that it was "escrita de todos los CaCiques de la timucua," and translated by Fray Francisco de Rojas, a Franciscan of Santa Elena Province, interpreter of Timuquano in the city of St. Augustine and "ministro de los naturales, etc." This remark of the translator is dated February 17; the vidimus of the magistrate, "Alonsso Solana," is dated February 21, 1688.

The Apalache and the Timucua letter were published in fac similes of the original documents, with printed Spanish translations and vidimus, by Mr. Buckingham Smith, in an undated (1859) folio edition of nine leaves, and printed in fifty copies only.

A copy having no printed title is in the Library of Congress, and from this I have reproduced the text below. Leclerc mentions the publication of Mr. Smith in his "Bibliotheca Americana," Paris, Maisonneuve & Co., 1878. 8°.

In my English rendering of the address I have followed as closely as possible the corrected Timucua text. The vertical bar | shows the end of each line in the text of the original.

Readers will remember that only the "*Text of the Original*" and the "*Spanish Translation of* 1688," are reproductions of what is left to us. The original is worded in a dialect differing in some respects from that found in Pareja's books, and was written some eighty years later. Where we find, *e. g.*, lahacu, bota in the address, Pareja would use leheco, mota. The queer orthography of the original prompted me *to attempt* a more correct reading of it, and this I have sought to reproduce in my English translation.

At the head of the letter stands the sign of the holy cross, and in the original it is repeated where the C stands before reiheca. Every C of the text is written as a capital letter. The i's have all long oblique dashes over them (í). In the term namonimanibotela the *nam* is erased in the original with ink. Numerous difficulties still encumber the full understanding of this interesting missive.

Spanish Translation of 1688.

†

Al Rey nro Señor

Siempre emos sido vasallos de V. M. pero agora con mejor raçon y de ttodo coraçon lo somos y asi queremos hablar. = V. M. a ynviado muchos governadores pero como Don Diego no emos vistto ninguno; otros que an sidos governadores estan aqui pero como este no emos vistto ninguno, y por estta causa damos a V. M las gracias; nos a socorrido a los casiques y pobres vassallos de V. M. con ropa por cuia causa estamos muy agradecidos, Dios se lo pague a V. M.; y si los señores governadores que han benido fueran como el que oy esta fueramos mejores xptianos y hubiera muchos mas xptianos. Su me^{d} a trauajado mucho en ntro vien con tan malos tiempos y por si mesmo a uisitado ttodos los lugares de xptianos y de ynfieles como fue Basisa y nos a dado mucho consuelo y con todos estos trauajos nunca a dejado de oy^r misa y asi deçimos q^{e} es un hombre santto. A nos encargado mucho que honrremos que rreberenciemos a los saçerdotes que nos asisten, como su m^{d} lo açia delante de nosotros, suplicamos a V. M. se sirua de continuarnos muchos a^{os} al S^{r} Governador que es porque procura n^{ro} vien aconsejandonos como buen xptiano que oygamos misa y atendamos mucho a lo que los rreligiosos nos enseñan; boluemos a suplicar a V. M. nos continue el S^{r} Don Diego nuestro Gobernador para nro consuelo: nro Señor de en ttodo a V. M. ttodo goço y salud como estos pobres vasallos le desean: escrita en S^{n} Matheo en el mes de henero veintte y ocho de mill ss^{os} y ochentta y ocho años. Escripta y firmada de los casiques que nos hallamos presentes.= Don Fran^{co} casique de San Matheo. = Don Pedro casique de San Pedro.=Don Bentura casique de Asile.=Don Diego Casique de Machaua.=Gregorio casique de San Juan de Guacara. = Fran^{co} Martinez Residente en San Matheo.

Text of the Original.

†

C reiheca AnoConiCa

nanemí Anequelamítonoma ní eíabobíla hacacheqeno | CumenatimoCoCo Anoquelamítonoma ní eíabotela | queníqe Anohebasísíronimanibotaqe— — — | Anonaío holata puquahímesoboníbílahaCu | dontieCunaquimosí nínenebobítíla Ano naío holata | yoqua Caremate eíatamalahacu naquímosí ni | enebobitila naquenema betaleq diosíquimí leqeysa- | co niquosoboríhabenamotaniCa ieholataynemímote | Anoquelacunemate Amunapuquanínabarasobo | ta níquo soboníqueysacomanta < intanicala Acu Ano | naioholata ponobí íequcaremaCa. Co niso bonemaqu | mo sínisobomobilenínconо Cristiano nípuquaCoColebo | hela Cristianoleno lenolehabema tacubaníheba | síbonela mínete pataquílononebeleca ynta Crístí. | Anoutíma níparífosibonelahacu pataquilonoma | quayquímíleqemisamano haninibiti la santole | nelenela *namo*nimanibotela ytecarena boso | noletahabe caremate nihebasibotamosoniqeysa | Comanta eíatanicaRemisa oCotono letahabeCa | remate níhebaneCa sibotahomotaminiqe ysaco | manta eíataniCare naquenemabetaleqe Caqi | Anonaíoholatahibantema diosiquimileqe | AnilapusimitaniCale diosibalunu ohontahaue | tomanCo Caquanihi basibontaheronímaní | botaqe Anihebasímitanibale San Mateo | enero elaotuma yuihoqe piqinahíi eromano 88 | don fransisco naystale Acu franciscamartine | Don P San P^{o} holata Dudie go MachaUa holata | Venturo Asile holata Gregorio S Ju^{an} ho | lata — —

Text as corrected by myself:

†

Reyheca anoconica :

Nanemí anoquelamitonoma ni eya bobilahaca cheqeno cumena atimococo anoquelamitonoma ni eya botela queníqe ano hebasi siro nimani botaqe.

Ano nayo holata puquahi míso bonibilahacu Don Diecu naqui mosi ni-enebobitila; ano nayo holata yoqua caremate eyatamalahacu naqui mosi ni-enebobitila. Naquenema betaleqe Diosi iquimileqe ; isaco niquoso ponihauena mota nica naye holata inemi mote anoquelacunemate amuna puquanina barasobota niquoso boniqe isaco manta intanicala. Acu ano nayo holata ponobi yoque caremacaco nisobonemaque mosi nisobo mobilenincono Cristiano nipuqua cocolebobela Cristianoleno lenolehauema. Tacubani hebasi ponela mínete pataquilono nebeleca inta Cristi (-anole?) ano utima niparifosi ponelahacu pataquilonomaque iquimileqe misamano haninibitila santole nelenela nimani botela ; itecare nabosonoletahaue caremate nihebasibota mosoniqe isaco manta eyatanicare misa ocotono-letahaue caremate nihebanica sibota homotaminiqe isaco manta eya tanicare. Naquenema betaleqe caqi ano nayo holata hibantema Diosi iquimileqe, ani lapusi mitanicále Diosi balunu ohontahaue tomanco caqua nihibasi pontahero nimani botaqe. Ani hebasi mitanimale San Mateo, enero erao tuma yuchaqe piqinahu eromano 88. Don Francisco na-istale, acu Francisco Martinez. Don Pedro, San Pedro holata. Du(n) diego Machaua holata. Ventura Asile holata. Gregorio San Juan holata.

English Translation:

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To our King our Lord :

Always we have been your subjects, but now with more reason and with whole heart are we your subjects, and intend to speak in this way.

Some white governors you have sent us, but like Don Diego we have seen none ; former white governors stay here, but like him we have not seen any. Therefore we invoke (upon you) the grace of God ; he has succored us, the chiefs and the poor subjects (of you) with clothing, and for this cause we show our gratitude. Those white governors who came (here), had they all been like the present one, we would be better Christians, and there would be many more Christians in existence. For our benefit he has worked a great deal, and in person has visited all settlements of Christians and unbelievers, has helped us with advice, and having during all his trouble never neglected to attend holy mass, we hence call him a saint; all the priests who assist us, he told us to honor and reverence, as he has done himself before our eyes. We therefore pray you to let the governor stay many years with us, for he works for our weal, advising us to hear mass, and listen to the teachings of the priests. Therefore we supplicate, that God bestow His graces upon this white Governor, our adviser ; we all pray God he may give life (to him), and thus we constantly pray and wish.

We all present have thus spoken at San Mateo, the twentieth and eighth day of the year (16) 88. Don Francisco was speaker, and he Francisco Martinez. Don Pedro, chief of San Pedro. Don Diego, chief of Machaua. Ventura, chief of Asile. Gregorio, chief of San Juan.

WORDS AND SENTENCES.

acuyano besides, further, furthermore; in addition to.

afuenoma, see ofuenoma.

Alimacani a Floridian chief, also called Halmacanir, Allimicani paracussi; contains the word maca, moca *sea, ocean*. The map in De Bry, Brevis narratio, locates his settlement on the coast, just North of the mouth of St. John's River.

anoleta knavishness, sin, misdeed.

antipola bonassu. These words were uttered by the Indians on the St. John's River, when they saw De Laudonnière revisiting them on his second expedition. They seem to represent the Timucua words: "anta, balu pona cho?" brother, have you come (returned) alive? This author interprets them by "brother" or "friend," and A. Gallatin (Archæol. Amer. II, page 106) attempted to explain the first word by a Chá'hta, the second by a Creek term.

ati, ate subordinate person; slave, subject, servant. Atemima chu somebody's negro slave. Atemalema master and slave, or: female slave and owner.

atichicolo spiritual.

atichicoloye atimoqua your spiritual lord; your Christian God.

atimoqua, atimoqe master, ruler, lord; from ati and maqua, moqua.

Atore, Athore, nom. pr. of the eldest son of the paracusi Saturiwa (De Laud.). Contains the word itori following, subsequent to.

ayahibuano excrements; lit. "what cannot be spoken of."

benasaba, balusobo to dance.

betale to supplicate.

Bimini, nom. pr. of the mythic "Fountain of Life" imparting eternal youth to those who drank from it and restoring health to the diseased. Ancient traditions and maps place it on an island north of the Bahama Islands. Contracted from ibine mine, "superior water." The authors of the sixteenth century mention the Antillian bi *life* and mini *source*, but I have looked in vain for analogies to these terms in the other Galibi dialects.

cani 1) palmetto leaf 2) hat made of palmetto leaves.

care, pl. carema "together;" expresses the idea of temporal and sometimes local simultaneity. Viro niaquene care uquata: male and female infants at the same time. Caru amitimale: male twin, lit.: brother born at a time with a sister. Hica no*coro*male: fellow-citizens.

Chilili, nom. pr. of an inland Indian town, on an affluent of St. John's River, and of its chief.

Chiquola, nom. pr. of a "great lord of the country," dwelling north of St. John's River. His stature exceeded that of his subjects by more than one foot (De Laud.).

chulufi, chorofa jay; chulufi-chi those of the jay-clan (chi, apher. of hachi).

cote, ticote, ticotacu, cotacu (suffixed to verbs): unless, lest, if not; although, though not.
 manino ticote without feeling hunger.
cote, cota tongue; language; portion of discourse, paragraph.
 mine cotemano the first part (of book, sermon, etc.).
 anacoti councillor, adviser.
Cuaresma the fasting period of Lent, lat. quadragesima.
 Cuaresma pira: Red Lent, viz: Lent marked red in the calendar.
cumele heart.
 cumelenima bohote cho? do you believe with (or *in*) the heart?
 cumeleno natimo heartily, with full heart (de todo coraçon).
 cumelesota document; c. hebuanoma d. of all what was said.
ecaleta to perform, to obey, act upon something.
ecano made, prepared; part. of ica to make.
 auara ele ecano field recently cleared or prepared for maize-culture.
ecoyaleta ruler, manager.
elo, elosi, or elofi to whistle, hiss at; aqetu elosibi cho? did you hiss at the tempest?
Emoloa, Emola, Molua, nom. pr. of a Timucua settlement and of its cacique or chief, who is reported to have been subordinate to the Holata Utina. De Bry's map has a locality Homoloua on the St. John's River, near Fort St. Charles.
equelete to-day.
hachipacha some person, somebody; lit. "who is born."
hani to cease, stop, quit. itorinoma hanibi cho? did you cease fasting?
 Missaleno hani to miss the holy mass. inifaye viroma chi haniqe after your husband had left you.
 hanini to neglect; haninibitila he has not neglected.
 utihanta exulant, deserter.
Helicopile, nom. pr. of a chief (De Laud.).
heso to cause or give to eat; from he to eat.
heta nacuta, heta ucuta to excess, immoderately.
hete what can be eaten: meat, food, edibles; hetetileta untasted yet.
 ara-hete bear's meat; honi-hete edible mussel, nutritious sea-shell.
hiatiqe interpreter.
hibuasi, hibuaso wedding.
hini tobacco; der. of he to eat.
Hiocaia, nom pr. of a chief dwelling twelve leagues north of Fort St. Charles. From hio to imitate, and caya turkey, partridge, the name perhaps referring to a headdress of feathers.
Hirrihiqua, nom. pr. of the Timucua chief, who captured Ortiz, a Spanish soldier. This is in fact a local name; War-land, or war-district (iri, hica).
hitiqiri owl, lit. "demon-screecher."
hochie, hochi, echa, other pronunciations of hacha, pron. relat.
hono 1) shell, fresh-water or sea-mussel; lit. food (he: to eat).

honi-hete edible shell, bivalve; hono-melo shell of the salt (melo) water; oceanic shell, pearl shell. On Floridian fresh-water shells, shell heaps and shell mounds, cf. Fifth Ann. Report of Peabody Museum, Boston, 1872, page 22 sqq.

2) fruit; berry found in the woods.

hororo red owl.

Hostaqua or Hustaca, nom. pr. of an Indian settlement and its chief, on an affluent of St. John's River.

iarua sorcerer, conjurer (De Laud.). This epithet given to the Timucua shamans refers to their prophetic power and the convulsions affected by them to obtain oracles of war; from yuru to tremble, to be shaken or contorted.

ichi cold; ibine-ichicosa to throw into cold water.

ichuqui to throw away, to spill.

inoni to work. Domingo equelemate inonibicho? did you do any work on Sunday?

inoso, inosobo to make work, to cause to work.

iquaso, iquase to cry forth, to utter a cry, to scream; iquaseti not to utter a cry. Cf. qi in hitiqiri.

Iracana, nom. pr. of a river falling into the Atlantic, probably in Georgia (De Laud.); also called Salinacani. The French called it "*la Somme*," or according to the map of De Bry, *l'Aisne* (Axona).

iriboso to flood something.

isi blood.

isito to bleed; ichinima isitoco to cause my nose to bleed.

itori alligator. These reptiles served as food to the Timucua people.

ituhunu prayer.

jufere a wicker basket for catching fish (Span. *nasa*).

yechino query, question.

yoqe, yoqua past, bygone. ano nayo holata yoqua former white governors.

yuquiso to lay, deposit on the side of.

yubucha, yubehe to transfix, pierce, strike. atulu chi yubeheti the arrow may pierce you.

yubuo, yubana sodomite.

Yupaha, nom. pr. of a town seen by Hernando de Soto's army. Contains paha "houses;" perhaps: Yoque paha, "Oldtown."

yuri, yuru to be shaken up, to tremble; to be angry.

iyorona (for yuruna) eel.

Maracu, in the French orthography Marracou, an inland camp of Indians. Seems to contain mero, melo *warm, hot.*

mela, mero hot, heated, boiling.

melasonolehabetile cuyuma: not to throw the fish into hot water.

nimaru to preserve one's heat.

meleni petticoat; probably made of bulrushes of the salt marsh (cf. melo).

meleniqi to put on a petticoat.

melo salt. ibini melo salt water; moca melo salt sea; hono-melo ocean shell. Probably identical with mela, mera hot, warm, the temperature of the sea water forming a contrast with that of fresh-water springs in southern latitudes.

mine winter ; minama in winter-time, during the wintry season ; viz. first (mine) of year.

miso old, aged ; older than. ano miso mareca six old men. ano misoma itubute incantated by a conjurer.

mo to speak, say, tell.

mono, mueno to call by name, to name.

moso to make.

mani to consent, desire ; manino to be hungry or thirsty.

manta, manda 1) to wish, desire ; 2) sign of the future tense.

mota to agree, consent, declare ; 2) a word, saying ; 3) thus, so.

moqua, maqua to serve, attend to wait upon, cf. atimoqua ; mine Diosi maqua to serve the great God.

nabe, every, each ; nabe chaleque every morning ; viz. : every new (day).

naboto to strike (for ni-aboto) ; said f. i. of the thunderbolt (numa-hebua).

nacu to drink ; ninacu to ask for drinking.

nacunu contr. from na acu ano.

nayo (when standing for na eyo) : another, any other.

naquila, ninaquilasi to perfume ; from uque oil, grease.

nate (among other significations) or, or else, or either ; acunate again.

Nia Cubacani, nom. pr. of a woman (De Laud.) ; probably : niaco pacano.

niponosi to return to somebody; from pona to come.

niponosihero-manda bohobi cho? did you believe that he would possibly return (to you)?

ofuenoma, afuenoma, ofonoma, 1) after, behind (temporal and local). ofuenoma Diosima : in preference to God, after God. hibate maytines ofonoma : after having said the morning mass ; halifonoma nantela I call it to be against nature. 2) on the subject of, concerning, about something : caqi mandamiento ofuenoma yechino cantela, *or :* caqi mandamiento ofuenoma na-yechinoma cantecarela : all these are questions (or queries) concerning that commandment.

Olataraca, nom. pr. of the nephew of the chief Saturiwa (De Laud.). The first part of the name is holata, chief.

orobo, oroboni to cure, heal ; to treat for sickness.

ch-orobonate you to be cured.

orobisi to correct, chastise. orobini to go to confession.

orobisiono advice, counsel ; na orobisionoma (good) advice, intelligence ;

orobaso to bewitch. orobota incantation, witchcraft.

orobono glory (of heaven).

Patica, nom. pr. of a coast settlement or locality eight leagues from the French Fort St. Charles, on St. John's River. It lay a short distance south of the outlet of that river ; the name is a compound of paha *houses*, and tico *canoe ;* canoe-houses, cabins near a harbor.

pia, piaha to hide, cover up.

pile field; pilema numa hebuama nabotoqe when lightnings have struck the field.

hachipile animals; lit. "what is on the field."

purucusta to run. If paracusi is a derivative of this, it means "the chief of the war-expeditions."

samota 1) to bathe in; samota niyena to bathe in the juice of an herb; 2) a rubbing with, a bathing in.

Sarrauahi, also written Saranay, Serraney; nom. pr. of a river and of an Indian settlement located on its shores, north of the outlet of St. John's River.

Saturiwa, or, in French orthography, Satourioua, nom. pr. of a paracusi on St. John's River, mentioned by De Laudonnière. Lived on sea-coast, a short distance south of the outlet of St. John's River.

Seloy, nom. pr. of a river in the Timucua territory, interpreted by De Laudonnière par "la rivière des dauphins," Porpoise River.

sieroa pira red metal, *gold* (De Laud.).

suquoni to rub on, to rub oneself with; niye suquoni to rub oneself with the juice of herbs.

Tacatacuru, nom. pr. of a river falling into the Atlantic Ocean north of the St. John; contains taca *fire*, probably in a redoubled form. The French under De Laudonnière called this river *La Seine*.

tapaga tapola "little baskets of mill" (Hakluyt); a compound term; the latter word is holaba, tapolaba Indian corn and contains abo stalk, maize-plant.

toca "new fruit," tococo to eat that "new fruit."

toya name of a feast of the Timucua people (De Laud.).

tola laurel; Tolemaro a town near the outlet of the St. Mary's River, on Northern boundary of Florida; once inhabited by Timucua Indians. The name contains tola laurel.

ubua, uba 1) to enter, go into, as into the net. cuyuma ubuata qibe the first fish (plur.) caught; 2) to catch, get hold of.

uqua to eat, said of certain edibles only. tapolamano inti uquabi cho? did you eat the maize (-ears)? uquaso to eat, and to give to eat.

uque oil, grease; ara uque bear's grease.

uqui, huqe, rain; uquihe, uquisa, uquiso to produce rain.

A Mirror for Illuminating Opaque Objects for the Projecting Microscope. *By Persifor Frazer, Jr.*

(*Read before the American Philosophical Society, Feb.* 20, 1880.)

The subject of the present note is an arrangement for representing opaque objects through the gas microscope, especially adapted to Zentmayer's $1\frac{1}{2}$ inch objective. It is only claimed to be better than the parabolic reflector of Smith & Beck, J. Lawrence Smith, Sorby and others, where the working distance of the microscope is comparatively large (*i. e.*, the distance from the objective to the object on the stage is $\frac{1}{2}$ inch or more) and for the purposes mentioned. Where the distance is as great as that just mentioned the dispersion of rays from the reflexion at one point, of rays from very different parts of the mirror, is so great that only a few rays from the upper part of the mirror reach the lens at all. It would be different with a lens having a very small working distance, and in this case a parabolic reflector would be preferable.

The apparatus consists of a brass tube made to slide over the lens, on the lower end of which is fixed a glass plate about 1 mm. in thickness so attached as to be capable of a sliding motion towards or away from the hinged mirror which is attached to the edge of the metal flange in which the glass plate slides. This simple contrivance permits the glass plate to be brought into close contact with the reflecting mirror no matter at what angle the latter may be placed.

The mirror is made of nickel-plated German silver neatly mounted on a small hinge.

The light is admitted from below through a diaphragm after the rays have been rendered parallel by the condenser of the lantern, the aperture of the diaphragm being adapted to the maximum thickness of beam which can be effective for illumination, and which (calling a the aperture of the lens and i the angle of incidence of the beam) $= a \cos i$: or for an aperture of $\frac{7}{8}''$ ($= 0.875''$) and an incident angle of 62°, 0.411″ or roughly 0.4″.

The less the incident angle of course the larger the beam of light will be, and the greater diameter of the diaphragm. The refractive index of the glass employed to make the plate being 1.5, in order that the critical angle 41° 48′ may not be exceeded in the refracted ray, this angle of incidence or i must not be less than 61° 51′ or roughly 62°.

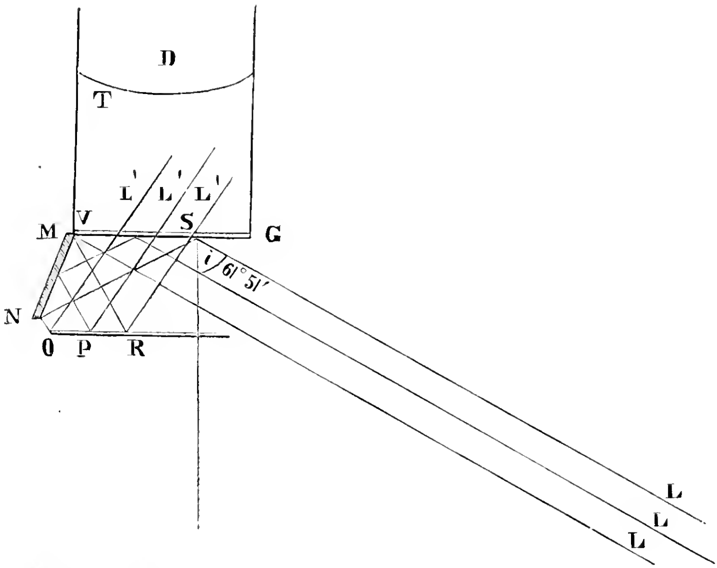
This minimum value of i determines the area of surface which can be illuminated on the microscope stage, but by altering the angle of the mirror very slightly all parts of the object may be successively projected on the screen. This minimum value is easily obtained from the critical angle of the glass employed, which is 41° 48′. The complement of this, or 48° 12′, is equal to the angle of refraction (or r) when the minimum value of i is attained.

$$\frac{\sin\ i}{\sin\ r} = 1.5$$

$$\sin\ i = 1.5\ (\sin\ 48° \ 12')$$

$$i = 61° \ 51'.$$

In other words, the angle between the luminous ray and the glass plate can never exceed 28° 09′, or in round numbers 28°.



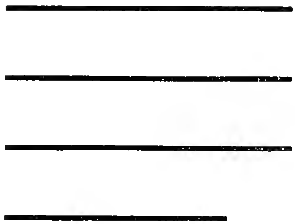
GM. Cover glass.
MN. Reflecting mirror.
OPR. Reflexion on object.
L′L′. Rays which pass through the objective.
D. Lens.
T. Sliding tube carrying reflecting mirror.
Angle of incidence 62°.

Three Methods and Forty-Eight Solutions of the Fifteen Problem. By *Persifor Frazer, Jr.*

(*Read before the American Philosophical Society, March* 5, 1880.)

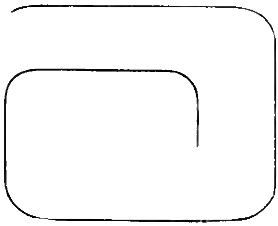
First Method.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	



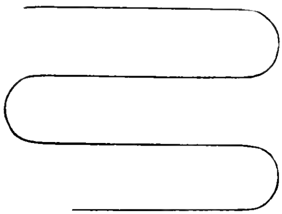
Second Method.

1	2	3	4
12	13	14	5
11		15	6
10	9	8	7



Third Method.

1	2	3	4
8	7	6	5
9	10	11	12
	15	14	13



The requirements of the popular Fifteen Puzzle are to "move the blocks until in regular order." This regular order may be of three kinds, when the numbers are in consecutive series and the blank space is left either at the beginning or the end :

1. That usually understood where the numbers follow each other in broken lines like reading matter in type, or in the opposite direction.

2. Where the numbers follow a single coil from some point on the edge of the box to the centre, or *vice versa*.

3. Where the numbers follow a zigzag course across the box, reading from left to right on the first and third lines, and from right to left on the second and fourth, or *vice versa*.

It can be shown that the three conditions which render possible one or the other of these solutions are : 1st, the number which heads the outside column, whether 1 or 15 ; 2d, the direction in which the numbers increase along the outside, whether with or against the motion of the hands of a watch ; 3d, the order in which the four middle numbers occur.

NOTE. The direction of the motion of the column itself must always be such that the head does not move to a square just vacated by one of the series of which it is the first or last member.

There are sixteen possible solutions under each of the three methods, eight of them applicable to cases where 1 is at the head, and eight to cases where 15 is at the head.

Of these eight solutions four only are possible in any given position of the middle blocks in the box, the other four becoming possible when the positions of any two of the middle blocks are exchanged.

Of each group of four possible solutions in any given position of the middle blocks, two are possible when the outside column of numbers increase in magnitude with the motion of the hands of a watch, and two when the increase is the reverse of this.

Finally of the two possible solutions where the outside numbers are in arithmetical series and the position of the middle blocks is given, one brings the head of the outside column to a given corner, and the other to the diametrically opposite corner.

The middle numbers must always be the lowest four or the highest four.

The following four tables comprise all possible groupings of these two sets of four numbers. The dots in the small squares indicate by their number the method by which the solution can be obtained without disturbing the middle blocks, provided the outside numbers have been put in the proper order :

TABLE I.

	1.	2.	3.
a	12 15 14 13	12 14 13 15	12 13 15 14
b	13 14 15 12	13 12 14 15	13 15 12 14
c	14 15 13 12	14 13 12 15	14 12 15 13
d	15 14 12 13	15 13 14 12	15 12 13 14

TABLE II.

	1.	2.	3.
a	12 15 13 14	12 13 14 15	12 14 15 13
b	13 12 15 14	13 15 14 12	13 14 12 15
c	14 12 13 15	14 13 15 12	14 15 12 13
d	15 12 14 13	15 14 13 12	15 13 12 14

TABLE III.

	1.	2.	3.
a	1 4 3 2	1 3 2 4	1 2 4 3
b	2 4 1 3	2 1 3 4	2 3 4 1
c	3 2 1 4	3 1 4 2	3 4 2 1
d	4 3 1 2	4 1 2 3	4 2 3 1

TABLE IV.

	1.	2.	3.
a	1 2 3 4	1 3 4 2	1 4 2 3
b	2 4 3 1	2 3 1 4	2 1 4 3
c	3 2 4 1	3 4 1 2	3 1 2 4
d	4 2 1 3	4 1 3 2	4 3 2 1

No combination in any one of these pairs of Tables can be shifted to any combination in the other of the same pair (while the outside numbers remain in proper order) without lifting out of the box and transposing two of the numbers; but any combination can be shifted into any other in the same table by temporarily placing one number in the outer row and shifting the positions of the other three once, or twice.

Tables I and II are for all cases where 1 heads the column, Table III and IV are for cases when 15 heads the column.

In the first and third methods the box is turned till the first four numbers fall on the top line, or the last four on the lower line.

First Method.

Arrangement of numbers in consecutive lines reaching from left to right or from right to left.

Number one heads the column of outside numbers.

Solutions only possible when 12 and 13 are *diagonally* adjacent. The motion of the head of the column must be past 15–12 in the order named, the 1 stopping on the square diagonally adjacent to that occupied by 12. Only those combinations permit solution when the 12 and 13 are *diagonally* adjacent. After the first row is complete, the 5 with its following series pass on the next line pushing the 15–12 before them, and the 9 and following three numbers pass on the third line pushing the 13–14 before them. When this third row is complete the numbers are in order. If after the outside series is complete the middle numbers occur as in any of the combinations of Table I (which are resolvable into each other by moving one of the blocks temporarily to the vacant space on the outside, rotating the others and then replacing it and if necessary repeating the operation by thus temporarily moving one of the blocks which is in its right place and rotating again till the desired combination is effected) the following solutions are possible:

I. *The middle numbers occur as in some combination of Table I.*

1. The increase of outside numbers is with the motion of the hands of a watch; a 1, and b 1 (turn box half round).
2. The increase of outsiders is opposite to the above; c 2, and d 3.

II. *The middle numbers occur in some combination of Table II.*

1. Increase of outside numbers with motion of watch hands c 1, and d 3.
2. Increase of outside numbers opposite to motion of watch hands a 3 and b 2.

Number fifteen heads the column of outside numbers.

Solutions are only possible when the 4 and 3 are *diagonally* adjacent. The 15 passes the 1 and 4 in this order and stops at the square diagonally adjacent to the 4. The 11 passes to the next line pushing the 1–4 before it; the 7 to the third line pushing the 3–2, and when this line is filled the numbers are arranged.

III. *The middle numbers are one of the combinations of Table III.*

1. The decrease of outside numbers with motion of watch hands, c 1 and d 2.
2. The decrease of outside numbers against motion of watch hands, b 3 and a 1.

IV. *The middle numbers are some combination of Table IV.*

1. Decrease of outsiders with motion of watch hands, a 2 and b 1.
2. Decrease of outsiders against motion of watch hands, c 3 and d 1.

SECOND METHOD.

Number one heads the outside column.

Solutions only possible when 12 and 14 of the middle numbers are *diagonally* adjacent. Bring the 11 alongside of the 12.

I. *The middle numbers occur as some combination of Table I.*

1. The increase of outside numbers with motion of watch hands ; a 3, and c 1.
2. Increase of outside numbers against motion of watch hands ; d 1, and b 2.

II. *The middle numbers some combination of Table II.*

1. Increase of outside numbers with motion of watch hands ; b 3, and d 1.
2. Increase of outside numbers against motion of watch hands ; c 2, and a 1.

Number fifteen leads. Solutions only possible when 1 and 3 are *diagonally* adjacent.

Bring the 5 alongside the 4.

III. *The middle numbers occur as some combination of Table III.*

1. Decrease of outside numbers with motion of watch hands ; b 2, and d 1.
2. Decrease of outside numbers against motion of watch hands ; a 3. and c 3.

IV. *Middle numbers occur as some combination of Table IV.*

1. Decrease of outside numbers with motion of watch hands ; a 3. and c 1.
2. Decrease of outside numbers against motion of watch hands ; b 2, and d 2.

THIRD METHOD.

The numbers read from left to right on the first and third lines and from right to left on the second and fourth, or *vice versa,* thus :

1	2	3	4
8	7	6	5
9	10	11	12
	15	14	13

The order of outside numbers is 1, 2, 3, 4, 8, 7, 6, 5, 9, 10, 11.

Solutions are only possible when 12 and 15 or 1 and 4 are diagonally adjacent. The first four numbers pass 13–12 in I and II, and 3–4 in III and IV, in the order named, the head of the column coming to rest at the square diagonally adjacent to the 12 or the 4 respectively.

Number one heads the column. The upper line is full.

I. *The middle numbers a combination of Table II.*

1. First four numbers increase with motion of watch hands ; a 2, and d 2.
2. First four numbers increase against motion of watch hands ; b 1, and c 3.

II. *Middle numbers a combination of Table I.*

1. First four numbers increase with motion of watch hands ; b 3, and c 3.

2. First four numbers increase against motion of watch hands ; a 2, and d 2.

Number fifteen heads the column. Order of outsiders, 15, 14, 13, 12, 8, 9, 10, 11, 7, 6, 5.

III. *Middle numbers a combination of Table IV.*

1. Last four numbers decrease with motion of watch hands ; a 1, and d 3.

2. Last four numbers decrease against motion of watch hands ; b 3, and c 2.

IV. *Middle numbers a combination of Table III.*

1. Last four numbers decrease with motion of watch hands ; b 1, and c 2.

2. Last four numbers decrease against motion of watch hands ; d 3, and a 2.

It is thus seen that there are four tables, each containing twelve combinations of the middle numbers or 48 combinations in all. Each of the three methods of solution takes four combinations from each table or one from every horizontal line, and no combination will permit of but one solution. Since these are all the possible combinations and a solution is given for every one it follows that no other solutions are possible than those above given.

It is but just to say that the first demonstration of the possible solutions of the first method was printed by me in the *Bulletin* of Feb. 26 ; showing that in the 13, 15, 14 difficulty position, two solutions were possible, but that the box must be turned if the 1 was to occupy the left hand upper square. Afterwards a paraphrase of this was printed in the New York *Herald* of Feb. 28, without credit.

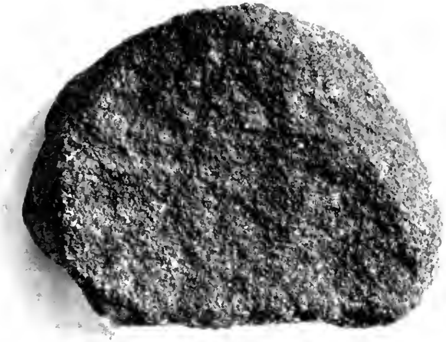
Erratum on page 258, 3d line from bottom. For 1000 meters read 1000 feet.

R. RATHBUN.

TO ILLUSTRATE A PAPER
ON THE
CONSTITUTION OF THE BRADFORD OIL SAND,
BY
CHAS. A. ASHBURNER, M. S.

Fig. 1.

Fig. 2.



NATURAL SIZE.

THIRD OIL SAND,
OIL CREEK, VENANGO COUNTY;

BRADFORD OIL SAND,
KENDALL CREEK, McKEAN COUNTY;

PENNSYLVANIA.

Phototype. F. Gutekunst. Philadelphia.

CELEBRATION

OF THE

HUNDREDTH ANNIVERSARY

OF THE

INCORPORATION.

AMERICAN PHILOSOPHICAL SOCIETY.

VOL. XVIII. MARCH 15, 1880. No. 106.

Special Meeting at the St. George Hotel.

Present, 71 members.

President, FREDERICK FRALEY, in the Chair.

Vice-Presidents, Mr. Eli K. Price, Prof. E. O. Kendall, Dr. John L. LeConte.

Secretaries, Prof. P. E. Chase, Dr. Daniel G. Brinton and Prof. J. P. Lesley.

Curator, Mr. Henry Phillips, Jr.

Treasurer, Mr. J. Sergeant Price.

Councillors, Mr. Henry Winsor, Mr. William A. Ingham, Mr. Benjamin V. Marsh, Dr. George H. Horn, Prof. Robert E. Rogers, Mr. Richard Wood.

Members :

Hon. Joseph Allison,
Dr. Robert H. Alison,
Prest. William H. Allen,
Dr. Harrison Allen,
Mr. James C. Booth,
Dr. T. Hewson Bache,
Mr. William Blasius,
Mr. J. Blodget Britton,
Prest. Thomas Chase,
Mr. E. B. Coxe,
Mr. B. B. Comegys,
Prest. Wm. C. Cattell,
Prof. E. D. Cope,
Mr. William M. Canby,
Prof. G. H. Cook,
Prof. T. M. Drown,
Prest. D. C. Gilman,
Prof. Wm. Henry Green,
Dr. Wm. H. Greene,
Dr. Traill Green,
Prof. S. D. Gross,
Mr. Frederick Graff,
Prof. Arnold Guyot,
Dr. Henry Hartshorne,
Prof. John S. Haines,
Dr. F. V. Hayden,
Prof. S. S. Haldeman,
Dr. Wm. A. Hammond,
Prof. George A. König,
Mr. Strickland Kneass,
Mr. Philip H. Law,
Dr. R. J. Levis,
Mr. Henry C. Lea,
Mr. J. B. Lippincott,
Mr. Wm. V. McKean,
Mr. A. S. McCreath,
Mr. M. H. Messchert,
Dr. S. Weir Mitchell,
Mr. S. H. Nichols,
Mr. Henry M. Phillips,
Mr. Titian R. Peale,
Prof. T. C. Porter,
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Mr. P. F. Rothermel,
Mr. William Sellers,
Dr. Albert H. Smith,
Prof. Charles W. Shields,
Mr. A. Loudon Snowden,
Mr. Henry Seybert,
Mr. Frank Thomson,
Mr. Jos. B. Townsend,
Prof. Theo. G. Wormley,
Mr. John P. Wetherill,
Mr. William S. Vaux,
Hon. John Welsh,
Mr. Joseph M. Wilson.

1. *Address by the President,*

FREDERICK FRALEY, LL.D.

"It is not facts which perplex us, but the opinions about those facts."—*Epictetus.*

In May, 1843, our Society celebrated the One Hundredth Anniversary of its foundation. The century that had thus encircled it was one of the most remarkable the world had witnessed.

Whether looked at from political or scientific points of view it was marked by most important changes, the fruits of which as now enjoyed have added greatly to the civilization, wealth and happiness of mankind.

The historian of the Society, in his address in 1843, gave a most eloquent and faithful account of the history of our institution, but he found his limits too narrow to portray all that he desired, and it was left to others in sessions that continued for several days to tell of the wonders of scientific discovery.

When my esteemed friend Dr. Robert M. Patterson closed his address he made a pointed reference to the incorporation of the Society, in March, 1780, and expressed the hope that when another celebration should be held, the Society could be found as honorable and as honored in the years to come as it has been in those which he commemorated. Little did I think then that I should stand in his place to-day and try to trace with no hand or voice like his the record that he left unfinished and the story of the years that have followed. I can scarcely realize that I am the only surviving member of the Committee of Arrangement for the Centennial of 1843, and that my venerable friend, Dr. Isaac Lea, is the only survivor of the Board of Officers and Council of that day.

The then roll of members is greatly diminished, but our ranks have been filled up with the names of men whose worth and whose works keep up our well-earned history.

It has been my good fortune to have had personal knowledge of all the Presidents of the Society, except the first three, and to have been knit in bonds of active friendship and almost constant intercourse while they lived, with Chapman, Patterson, Franklin Bache, Dallas Bache, Kane and Wood. Dr. Patterson spoke of Franklin, Rittenhouse, Jefferson, Wistar and Tilghman; and what histories were theirs.

Franklin, the philosopher, economist and statesman, the diplomatist, the noble and true courtier, the man of America, the useful citizen of Philadelphia, to whom we owe so much for the establishment of our institutions of learning and charity. We may thank Boston for having given him to us, but God planted him in his true field and he did great honor to the planting.

Rittenhouse, the astronomer and mechanician, self-cultured, like Franklin, mild, modest, benevolent, just the man to be loved for his virtues and to be honored for his great and perfect knowledge.

Jefferson, the statesman and philosopher, whose pen could write the strong words that came from heart and head to rouse a young people to the assertion of their rights, and afterwards to command and guide them in the path of wisdom for their preservation.

Wistar, the beloved physician, the gifted Anatomist and Surgeon, one of the worthiest of the worthies, who raised the Medical Department of the University of Pennsylvania to its great reputation, and withal, the kindest and gentlest of men, opening weekly his hospitable house as a centre for the assembling of men of learning: whether in science, law or politics, philanthropy or general affairs. He died comparatively young and one of his successors made his fitting eulogium.

Robert Patterson, the fifth President and the father of Robert M. Patterson, was born in Ireland, in 1743, of humble but respectable parents. After a varied and somewhat trying youth, he emigrated to this country and attempted business as trader. This was not congenial or successful. The bent of his mind was for Mathematics and Natural Philosophy and he speedily turned his attention to teaching. He applied for and was elected to the office of Principal of an Academy at Wilmington, Delaware. It is recorded of him that his duties required the giving of instruction in the Latin language, of which he knew nothing, but he manfully went to work to study it and to keep ahead of his pupils, thereby managing to give satisfaction to his patrons. He was engaged in this work when the war for Independence broke out, and before and after school hours drilled several companies of his townsmen in military movements. The knowledge for this he had acquired as an enlisted soldier in Ireland, having been enticed into that sort of life by a promise on the part of the sergeant that he would have the chance of studying mathematics while in service.

He entered the army of the Revolution first as an assistant surgeon, for which he had qualified himself by a short study of medicine, and was afterwards appointed Brigade Major. On leaving the army he commenced farming, and being disheartened by the loss of some sheep that had strayed away, while absent in search of them his wife accidentally found by an advertisement in a newspaper of Philadelphia, that a Professor of Mathematics was wanted in the College of that city. He proceeded with her advice to apply for the place, and after a courteous reception from Provost Ewing, he was appointed and continued in office for many years, holding in addition to his Professorship the office of Vice-Provost. He was one of the best mathematicians of his day, and his general knowledge of scientific and general subjects was large and usefully employed.

His residence in Philadelphia brought him immediately and closely in contact with the leading men of the day, and he soon became a member of our Society, contributing to its Transactions and filling the offices of Secretary and Vice-President. In 1805 he was appointed Director of the Mint of the United States, which office he held until within a few weeks of his death in 1824. He took a deep interest too in the progress of mechanical science, and became one of the original members of the Franklin Institute, and, I think, was Chairman of its Board of Managers when he died. His career was one of great honor and usefulness, and his obituary notice by Chief Justice Tilghman is full of interest. Tilghman, the great jurist to whom the law owes many of its noblest expositions, whose tender and affectionate spirit was like that of a woman, but whose love of justice was as inflexible and exact as if in him were enshrined the purest conceptions of the truly god-like duties he was called on officially to discharge.

These six were the heroes of our earlier history, and we come now to the men of whom we can remember the goings out and comings in.

Duponceau, who presided at the Centennial of 1843, had come from France to be the private Secretary of Baron Steuben during the war of Independence, and afterwards was admitted to the bar. He was a scholar of considerable acquirements, of a philosophic mind, very patriotic in his impulses, and served the Society faithfully and acceptably for many years as President. He made a number of valuable contributions to the Transactions of the Society and was highly respected and justly esteemed by its members. With his death in 1844 the more modern history of the Society begins. Two gentlemen equally distinguished in their professions were voted for and the choice fell on Dr. Robert M. Patterson, but with that chivalrous feeling that distinguished him and in accordance with the preference he had expressed for his competitor, he declined to accept the office, and the presidency remained vacant for a year, both Chapman and Patterson serving as Vice-Presidents.

In 1846 there was no contest and Dr. Chapman was elected President. He was a doctor of medicine, skilled in the highest degree in his profession, a Professor in the Medical School of the University, with a large practice. He was one of the most brilliant men of his day, and his sententious lectures told for the advancement of the knowledge of his students, as the vast resources of his wit and humor, gave brilliancy and pleasure to his social life. For many years he filled a large space in society in Philadelphia, and was one of the most popular men of his time.

Dr. Robert M. Patterson, was our next President, one of the most accomplished men I ever knew. In early life becoming Professor of Natural Philosophy and Chemistry in the University of Pennsylvania, in the Department of Arts he soon achieved a wide reputation for his learning, and for his skill as a teacher. He was a most eloquent man, of captivating manners, and so genial and attractive that the old as well as the young sought his society. He was for a time a Professor in the University of Virginia, and for many years was the Director of the Mint of the United States. He was one of the original members of the Franklin Institute, and its first Professor of Mechanics and Natural Philosophy. To me he was one of the first links in a chain of friends, which being welded in 1825, held together for nearly twenty years unbroken, and then in death, link by link, it gradually fell asunder. With him began the list of Presidents that formed the body of my own personal and very dear friends, and the years that I spent with them are filled with the choicest of my recollections.

For a while the Society had a rule that the Presidential term should be for two years, and hence it was that dating from the time of Dr. Chapman to that of Dr. Wood, we had five Presidents.

Franklin Bache was the next President. He was a great-grandson of Dr. Benjamin Franklin, and in many traits of character resembled him. He had a bland serenity of manner, a great deal of quiet humor, a very sagacious mind, and habits of careful and persevering industry. He was for a long time one of the Secretaries of the Society, and the neatness and completeness of his records, and their handwriting greatly identify him with his ancestor.

He was a doctor of medicine with considerable practice, but soon became a Professor in his favorite Department of Chemistry. He succeeded Dr. Wood as Professor of that subject in the College of Pharmacy, and held the same Chair in the Franklin Institute. He was subsequently chosen Professor of Chemistry in the Jefferson Medical College, and held that office until the day of his death. He was one of the authors of the Dispensatory of the United States, and wrote and published a good deal on the subjects to which he devoted his attention. He was a liberal donor to the Society, and for many years one of its most useful and influential members. He was a man of very noble personal presence, and courteous and kind to his young associates.

Next in the order of succession comes Alexander Dallas Bache, another great-grandson of our illustrious Founder. As Franklin Bache resembled Franklin in many traits of character, Dallas Bache was regarded by those who knew him intimately as being almost the "tout ensemble" of the venerated sage and philosopher. Like Franklin, he was not college bred, but after an early training in our best private schools, he was appointed a cadet, and finished his preparatory education at the West Point Military Academy. I say *preparatory*, for he never ceased to be a student or to learn. He graduated from that institution with great honor, and was in course appointed a Lieutenant of the United States Artillery, and placed in charge of the construction of fortifications at Newport, Rhode Island. But he was an innate scientist, and was soon called to act in that sphere, being chosen Professor of Chemistry and Natural Philosophy in the University of Pennsylvania. Here he expanded into his true proportions, and took his rank in the highest social and professional circles. He became an active member of the Franklin Institute, and with the coterie of devoted men that then influenced its counsels and organized its labors, not only laid the foundations of its great usefulness, but raised it to that pre-eminence as a widely useful institution, which it has so long enjoyed, and which it so successfully maintains.

When the munificent bequest of Stephen Girard was given to the City of Philadelphia, for the establishment of the Girard College, and the plans for organizing that institution were to be prepared, the Directors elected Professor Bache, President of the College. He resigned his chair in the University and accepted the appointment. He immediately proceeded to Europe to visit and study the educational institutions of all kinds then in operation there, and his Report on Education in Europe, made to the Directors on his return, contains a complete account of such institutions, and was the most full exhibition of the subjects of which it treated that had up to that time been published. When he returned the College buildings had not been finished, and while awaiting their completion he prepared the plans for and organized the Philadelphia High School, serving some time as its Principal, and bringing to his aid the very men who could enter fully into his plans and aid him in an enterprise which had so much promise of usefulness. He was an admirable organizer and the great success which has attended the school is due in large measure to the perfection with which he started it. Delays having attended the completion of the Girard College buildings and being unwilling to hold nominal offices, he again accepted his old chair in the University which had become vacant by the resignation of Professor Roswell Park. He was heartily welcomed back by Professors and students, for there was no man who possessed a greater faculty of reading human character and striking the chords that could bind every one to him and, as it were, making them a part of his own being. He was not allowed to remain long in his old and much loved seat. By the death of Mr. Hassler, the office of Chief of the Coast Survey of the United States became vacant and the unanimous voice of the scientific men of the day designated him for the place. The Government wisely yielded to this call, and the wisdom of the appointment was demonstrated by the complete success which attended all the subsequent prosecution of the work.

He put new life into all its departments, he organized anew the details of the field and office work, he caused more accurate and delicate instruments tc be made and the measurements and observations to be recorded, verified and tabulated in the most complete forms. Here, as in every thing else, confided to him, he always found the right man for the right place, and for years the work went on, full of honor for him and for his associates, and alike honorable and useful to his country. It still bears the impress of his genius and skill, and is justly regarded as one of the great marks of scientific progress of the century.

His services were called for in many other matters of public concern, and were always faithfully and efficiently rendered. He was one of the founders of the National Academy of Science, and by his will gave it a bequest of a considerable sum for its endowment. I have dwelt on his noble character and great merits with peculiar pleasure, for he was my schoolmate in youth and one of my dearest friends for half a century.

Our next President was John K. Kane, born and bred in Philadelphia, and admitted to practice in its courts at an early age. He was a fine scholar and an active citizen, participating in many ways in measures of public interest. He took an active part in the proceedings of the Society and was highly esteemed in its councils.

After practicing his profession for many years, he was appointed Judge of the District Court of the United States, for the Eastern District of Pennsylvania, and died in office as Judge and President.

All the Presidents from Duponceau, to and including Judge Kane, had held office as Secretaries and Vice-Presidents, and were thereby characterized by full knowledge of the working of the Society.

Dr. George B. Wood was elected President in January, 1859, and by re-elections held office until his death in 1879. He was born in New Jersey, and received both his literary and professional education in the University of Pennsylvania. He was by profession a doctor of medicine, and was as a general practitioner one of the most skillful and successful of his day. He soon became distinguished too as a teacher, and was successively elected Professor of Chemistry in the College of Pharmacy, Professor of Materia Medica in the University of Pennsylvania, and finally Professor of the Theory and Practice of Medicine in that institution. He was a man of peculiarly grave and imposing presence, and yet had so much of kindly human sympathy that he could readily be kindled into great geniality, and give out very bright flashes of hearty humor.

He was quite a voluminous writer, and one of the great standard works of his labors is the United States Dispensatory, which he prepared in conjunction with Dr. Franklin Bache as before stated. His special Text Books are held in high esteem by the profession. He was quite an eloquent man, and participated in public affairs to a considerable extent. He was a liberal giver in all philanthropic movements, and took a deep interest in the prosperity of the Society, and besides special donations gave it by his will a legacy of $20,000 for aiding in the erection of a fireproof building for the preservation of its valuable library and other property.

I have thus briefly sketched the personal history of our Presidents to the date of our present Centennial Celebration.

Would that I had time and space to make a like record for our members. But as that is impossible, I can only invite your attention to the names which our roll of past and present associates will give you of those who have been deemed worthy of our fellowship. Both at home and abroad men have been selected for this honor who had either already won or were winning the highest distinctions in Politics, Science, Literature, and in the liberal and useful Arts, and also men of influence in the general walks of life and in what are called "affairs."

It has thus come to pass that the Society may be considered as presenting the most perfect type of a body devoted to the "promotion of useful knowledge."

It has not forgotten either to recognize that women as well as men are in the circle of those to whom the world is indebted for its progress, and that same roll contains the names of women of eminent and varied knowledge deemed worthy of such honorable recognition.

Let me repeat here the counsel given in 1843, by the Committee of Arrangements and specially enforced by a resolution then offered by our late associate, Joseph Henry, that it should be a matter of special concern that the officers and members should keep constantly in mind that it is an imperative duty to call every one to membership who by worth, virtue and special fitness is calculated to benefit the world by what he can give to it out of the gifts bestowed on him.

But I come now to a field on which I really fear to tread. My predecessor in Centennial duty shrank from it on account of its vast extent; and the years that have elapsed since he spoke have added immensely to any adequate conception of what has been wrought in the civilized world from 1743 to 1880. I shall, therefore, as he did, leave to others, to make special references to the various subjects into which the history divides itself and present only a summary of what has marked our human progress.

As on good government all the true advancement of society mainly rests, we may mark what has been accomplished for the settlement and amendment of political institutions. The principles introduced into the government of Great Britain in 1688, had to be cultivated and sustained by many grave struggles and partial civil wars, before the complete settlement of the institutions of that country, in nearly their present form was finally accomplished, by the full acknowledgment of the House of Hanover as the source of sovereignty. That government is the only one in Europe that has not been changed by violent revolution, and its permanence under wise provisions for general amendment, seems now to be perfectly secured. Our own Country in 1776, then thirteen Colonies, literally struggling under many political burthens and disadvantages, boldly struck for its independence and freedom, and after a seven years' struggle, conquered the full acknowledgment of them, from the British King. They soon found that the bands of a Confederacy were too weak and loose for a Nation, and in a peaceful examination of respective rights, powers and duties, the sovereign States yielded enough of sovereignty to the people to establish a glorious and permanent Union, to be a model for the world, of the advantages of self-government, and of adaptation to meet the wants of a constantly growing Empire. The thirteen feeble Colonies of 1776, have grown to be thirty-eight powerful States. The three millions of people that won independence, are now swelled to more than forty millions, and our Country, in Arts, Science, Manufactures, Literature and Arms, is acknowledged as a great power in moving and molding the world.

France copying from the United States has within the century tried four times to remodel her government in the interest of true liberty, and has three times relapsed into the bonds of despotism, but we may hope that the fourth effort will be attended with happier results.

The struggles for freedom have indeed pervaded the whole continent of Europe with more or less effect in securing popular rights and modifying ancient institutions.

War has had a great hand in accomplishing all this, and the needs of war have stimulated human industry and ingenuity.

Nearly the whole of the continent of South America has been freed from monarchical rule, and the whole of the two Americas now seem destined to be republics on our model.

The art of war has been wonderfully improved, and as its instruments have become more powerful and complete its carnage and misery have been increased. But even in it we find compensations by a better recognition of the political rights of States, and also by a better regard for the laws of humanity and private rights.

If the political interests of mankind have been improved by these great changes, how infinite have been the advantages derived from the mechanical inventions of the last hundred years.

The steam engine, the great motor for nearly all of these as they now exist, has emerged, as it were, from an embryo, to almost a living being, weaving the gossamer threads of animal and vegetable life, with the same ease that it moves the mighty masses of ocean steamers, or wheels the countless trains of cars over the iron pathways of every continent.

Machinery for almost every mechanical art has become nearly automatic, and whether it moves the minutest drill, the loom, the printing press or the wonderful ponderous or delicate hammer, it is everywhere in our most active life, the willing and obedient servant of men.

Railways were in their infancy, when the celebration of 1843 took place, now they count by hundreds of thousands of miles, they are even threading the routes of ancient commerce. As they increase and multiply, so the world is knit more closely and happily together, and human brotherhood becomes more intimate and perfect. Has science stood still during all these years?

The answer comes back to us through the telegraph, the telephone and the myriads of inventions that depend on Magnetism and Electricity. It speaks also in the wonders of Geology, Biology, Chemistry, Astronomy, Physics, Metaphysics, Historical research, and in Medicine and Surgery.

But would these results be ours if we had not had the use of types and printing? What revolutions they have wrought in our speech and thoughts. If the world's knowledge had depended on slow copyists, multitudes would never have had one bright intellectual ray.

Our founder, Franklin, was a printer, and perhaps the most intelligent and skillful of his day. Look at his old press as it stands now in one of our museums, and compare it with one of those that to-day strike off many thousands of copies in an hour, and you can form some conception of what types and printing are doing for the promotion of science and useful knowledge. When the world was brought to this city in 1876, to interchange the exhibition of its natural and artificial productions, we had an instructive picture of what the present civilized world is. History enables us to penetrate in some degree the obscurity and imperfection of ancient times, but we could have no other feeling than that of real exultation in beholding spread before us in our Great Centennial Exhibition our present world in all its strength and grand proportions and its ability to realize for mankind what the ancient poet wished for his people:

"O fortunatos nimium sua si bona norint."

I must forbear from the further attempt to give the marvels of what 1743 to 1880 reveal. Many of them take date within my own memory, and I am truly grateful that I have witnessed the revelation of such gifts to men.

We may be proud to feel that our Society has had a full share in all this wonderful work.

Among our members have been found the Statesmen, Philosophers, Mechanicians, Manufacturers, Doctors, Lawyers, Judges and Merchants who both here and elsewhere have been the workers in the fields. We have in our Transactions and Proceedings essayed to give the world the benefit of their discoveries and investigations, and in return they have reflected honor on us.

I must now leave to my associates to tell us of the march of modern science in all its forms, and to perfect the imperfect sketch of it which I have given.

The Society published the first volume of its Transactions in 1773, and they now number twenty-one volumes, with an additional one, ready for publication. These volumes contain the more elaborate and important subjects that have been communicated and are to a considerable extent the important records of scientific progress.

The publication of the Proceedings was begun in 1838, and they have now reached 104 parts.

Practically they for many things supersede the Transactions, being less formal in their character, and issued in rapid succession, give the current contributions of our members for the advancement of science and the progress of original research.

Our commemoration would not be complete without some reference to the Society as a corporate body. It was incorporated by the General Assembly of Pennsylvania, March 15, 1780. The preamble of the act declares the objects for which it is created with considerable detail and then come the enacting clauses which gave its name and powers.

It is remarkable how fully and clearly the powers are expressed, and the only amendments or additions that have been made to them since are those which enable us to sell and rent our real estate. It contains one remarkable clause which shows the clear and catholic views that our founders held as to the neutrality of science, for it provides that all correspondence or communications to or from the Society shall have free transmissions, notwithstanding the prevalence of war.

In 1785, the State granted a lot of ground to the Society, as a site for the erection of a hall. This lot forms a portion of Independence Square, and its dimensions are 70 by 50 feet. The building was begun in 1785, and it was occupied but not completely finished in 1789. The old minutes to which I refer any curious inquirer,* contain many amusing as well

* The plan for incorporating the Society was ordered at a meeting held (as usual then) in the University, Dec. 17, 1779. Dr. Smith, Dr. Duffield and Mr. Biddle being constituted a committee.

Feb. 17, 1780, inquiry began to be made for some lot of ground on which the Society might erect a building for itself.

April, 11, donations were ordered to be solicited.

as instructive memoranda of the difficulties of getting through with such an important work. Such difficulties are not unknown even to the present generation. But at last they were happily surmounted, and with but a slight change in the basement story, the building stands to-day in the same shape as originally constructed. By several additional enactments the legislature authorized the Society to rent such parts of the Hall as were not needed for its own purposes, and under these we have always had a considerable income from rents. The city of Philadelphia is now the owner of the whole of Independence Square, except the lot on which stands our Hall. They purchased the Square from the State in 1814, and out of the sale, our lot was reserved, and a prohibition made of the erection of any other buildings on the Square, than those which were then on it. Although this restriction was subsequently repealed, the historical associations of the Square are still so strong, that the power to build has been only once exercised by placing a Court House on the Sixth Street

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Proposals were made to the Library Company to unite in the purchase of Carpenter's Hall.

Resolved, that for the present, the Society's meetings should be held in Carpenter's Hall, to which the Society's effects were soon transferred.

Then follow many minutes of transactions respecting a Silk Society and Factory, an Act of Legislature vesting the Silk Society stock and machinery in the Philosophical Society, and much trouble with the trustees or directors of the Silk Society.

March 6, 1783, Rittenhouse moved the transfer of the Library and Cabinet to some member's house, which in time resulted in his being virtual librarian and curator, and finally president of the Society.

April 10, 1783, enquiries were made of the University at what rent the Philosophical Society might use its house in Fifth Street.

The Society owned some "house in the State House yard," and a committee was empowered to sell it.

In July an effort was made to purchase a 40′ by 48′ lot in Fifth Street.

In September Mr. Willing's lot in Third Street was looked at.

In November a lot belonging to Mr. Powell was examined.

front. As early as 1835, the city desired to purchase the Hall, and a few years afterwards conditional arrangements were made for such a purpose but they were verbal and informal, although intended on both sides to be carried out in good faith.

There was at that time a large building known as the Chinese Museum, situated on Ninth Street, South of Chestnut, which contained the large and valuable collections of the Philadelphia Museum, originally founded by C. Wilson Peale.

An arrangement was made, by which the Society should purchase this building, and lease part of it to the Museum Company, and use the remainder for its own purposes and benefit. It was supposed that what the City would pay for the old Hall, would enable the Society to buy and substantially pay for the Museum property. The Society made the purchase, and used all its funds in making the required payments.

These funds it was expected would be replaced by the money to be paid by the city for the old hall. The price of the hall was to be fixed by referees, of

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Later in that month the committee reported that they could get Mr. Jno. Dunlap's lot in Fifth Street for $1000.

In December Mr. Hopkinson offered his S. E. cor. Seventh and Arch Street lot, "near" the Observatory, 40′ by 100′, for $1000. In fact this (?) lot "next" the Observatory, enlarged to 40′ by 306′, was, in the next February, purchased of Mr. Hopkinson for £600, half down, half on mortgage.

January 16, 1784, Mr. Hopkinson inaugurated a building excitement in the Society, and, February 6th, the Society resolved that measures be immediately taken for erecting a suitable building. Subscriptions were ordered; an application to the Legislature for aid; and, as soon as £1000 should be subscribed, a committee to plan and superintend the edifice.

The Legislature responded to the call, and, March 5th, the Treasurer of the Society was ordered to draw on the Treasurer of the State.

Sam. Vaughan, Mr. Rittenhouse and Mr. Hopkinson became a committee.

At the next meeting the committee reported a petition of the Philosophical Society and Library Company conjointly to the Legislature, for two lots of ground, one on each side of the State House yard.

which each party was to choose two, and in case they could not agree a fifth referee was to be chosen by the four referees and his concurrence in an award by any two and himself made the award binding and conclusive on both parties. It so happened that when the four referees met three would not concur in any award. The fifth man was chosen and he would not agree with any two of the other referees and so the project of a sale fell through.

While these negotiations were in progress the memorable financial troubles of 1837–1842, were in full operation, the city declined to carry out the conditional bargain that had been made and the Society was plunged into the depths of financial trouble, which for a long season threatened bankruptcy and even ruin. The sequel of this melancholy story was that the Museum building was sold under a paramount mortgage of comparatively small amount against which it was supposed the Society was protected by a valuable lot on Chestnut street, adjoining the Museum prop-

In June a botanical garden was started on the Arch Street lot, which was subsequently rented to Mr. Rittenhouse, and finally, after some years, sold.

In December Mr. Vaughan reported that the Library Company were dissatisfied, and that he had presented to the Legislature merely the petition of the Philosophical Society.

The petition was granted, and the lot on Fifth Street obtained; for, in

April, 1785, it was again resolved to open subscriptions for erecting a building on the newly acquired ground; and in

June, Mr. Vaughan presented the plan of a house, substantially such as was built; except that the north half was to be divided into two rooms, instead of the south; and that vaults beneath the cellars were discarded as too costly.

November came, and Mr. Vaughan asked authority to "shoar" the cellar walls against the frost, at a cost of £3 16s. 6d.

1786. The following November, Mr. Vaughan's committee had expended £305 10s. 4d., in building, and asked authority to protect it against the winter, and to put an "area" around it, at a cost of £2 5s.

1787. In May a subscription of £300 for carrying on the building was erty, which had to be sold first, and also by collateral security in other forms. But all these protections failed us in the day of fiery trial, and even our library and collections were at one time levied on by the Sheriff. It is to this peculiar crisis in our history that Dr. Patterson, so feelingly refers in his address of 1843, with hope but yet with fear. But the good old ship was still manned by a gallant crew, although somewhat cast down they were not dismayed.

They went to work manfully, gathered their resources together, paid their debts, and, as it were, took a new and more vigorous start in corporate life, and to-day the Society has a fund of nearly $60,000, the income from which in addition to its rents enabling it to defray all proper expenses and make liberal appropriations for its publications.

It is a source of unalloyed pleasure to me to have participated in this successful restoration of our affairs, and that I am able to answer to 1843: We have overcome and prosper.

Before I close I must refer to a subject in which my

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opened by the Society. But it was hard work, getting money. Finally, in November, Franklin (who was president of the Society until his death, in April, 1790) came to its relief and lent it £500, to finish the building. The Street Commissioners objected to the height of the front steps, and they were afterwards transferred indoors. Plans for letting rooms to the University, to the College of Surgeons, to the Freemasons, and to Mr. John Vaughan were formed, and in some cases subsequently carried out; the Society retaining for its own use only the south-west room, and the College of Surgeons taking the south-east. But it was not until the following summer—

Aug. 21, 1789, that a resolution appears on the minutes that, when Franklin's health would permit of his leaving his house, the Society should meet, not there, but in their own "Philosophical Hall."

No trace of a corner-stone laying ceremony can be discovered in the minutes. The accommodations must have been poor, for two years afterwards—

March 4, 1791, it was resolved, that the south-west room should be *finished in a neat manner, as soon as contributions could be raised by the building committee.*

lamented predecessor, Dr. Wood, took a very deep interest. It is well known that our Hall is not fire-proof, and our valuable library and other property is constantly exposed to great peril. At his request in 1866, a Building Fund was started, to which he liberally contributed, and the increase of which he watched with great care. It did not reach during his life to a sufficient sum to procure a fire-proof edifice. By his will he gave a legacy of $20,000 to aid the fund.

The object that he had at heart is not yet accomplished. Let us follow his good example, and make a new Hall, such as he desired, the enduring Monument of this celebration.

What has been the influence of our example in the United States? We are the oldest scientific Society of the New World, but our correspondence with kindred institutions in our own country shows to what an extent science is now cultivated among us. Some of them are beginning to hold their centennial celebrations, and others their semi-centennials. Our sister of Boston, the American Academy of Arts and Sciences, invites us to its Centennial in May next by a delegation. This invitation we have cordially accepted, and the reunion of Philadelphia and Boston will kindle glorious recollections of our Revolutionary history.

We may truly rejoice over the triumphs of the century that closes with this day.

The civilized world is blessed with universal Peace, Science and the Arts are moving irresistibly onward, Commerce spreads her sails in every sea and her cars on every land, the art of Government is undergoing manifold changes full of importance to the future of the human race, and that Charity which is the greatest of all graces is doing its perfect work. May the next Centennial celebration of the Society have as much to glory in as we are enabled to record of the one just terminated, and may 1943 and 1980 find our successors still in the field labouring for the Promotion of Useful Knowledge.

2. *The Early Botanists of the Society*,

Prof. Asa Gray, Cambridge, Mass.

" E'en when the hoary head is hid in snow,
The life is in the leaf."—*Dryden.*

Prof. Gray being unable to attend the dinner and respond to the above toast, sent the following letter to the Committee which was read by Mr. Price:

Cambridge, Mass., March 10th, 1880.

To the Committee of Arrangements of the American Philosophical Society:

Dear Sirs:—I am gratified and tempted by your kind invitation to the dinner of the American Philosophical Society, in commemoration of the one hundredth anniversary of its corporate existence. I knew that your Society was still more venerable, but I did not know that so much of its vigorous youth was anterior to the charter of incorporation.

It is interesting to me that your anniversary celebration occurs at this time, for it happens that the eldest sister of your Society, the American Academy of Arts and Sciences, is preparing to celebrate the one hundredth anniversary of its foundation a few weeks later, and on the very day of your foundation, viz. May 25th. As one of the elder of the living Fellows and a past President of this Academy, I should have been glad to appear before you as a representative of the sister institution, to bring you its felicitations and at the same time to solicit your interest in our approaching commemoration. I know that it is intended to invite the American Philosophical Society to send us a delegation. But I find myself unable to leave home at present, and so shall have to forego this pleasure.

If I could have been present it would have been fitting and pleasing to me to address a few words to the Philosophical Society in commemoration of the distinguished Botanists it has nurtured or fostered. A list which begins with the name of John Bartram, the earliest indigenous botanist of our country, and includes the names of Barton, Mühlenburg, Collins, Schweinitz and Nuttall, ought to suggest and inspire some remarks which would not be inappropriate or uninteresting upon the occasion: although no doubt others will better fill the place and grace the occasion in which I shall not be able to bear a part.

With many thanks for your kind invitation and with my best wishes for the perpetual prosperity of the American Philosophical Society, I remain, yours very truly,

ASA GRAY.

3. *The alliance of Universities and the learned Societies,*

Prest. D. C. Gilman, Johns Hopkins University, Baltimore, Md.

"Die Weltgeschichte sucht aus sproedem Stoffen.
Ein reines Bild der Menschheit zu gestalten."—*Hebbel.*

In response, President Gilman said:

Mr. President and Gentlemen of the Society:

As a representative of the youngest of American universities, I am happy to greet the oldest of American academies, and to congratulate the members of this association upon the success which has followed its operations from the colonial days until now. I congratulate you on beginning right and on keeping right through a century of incorporated life, and on the prospect of a good continuance through years to come. As the eldest in a family is looked up to as a leader, so the eldest in the academic sisterhood is watched and followed by a long line of younger kin. Your methods of work, your modes of selecting associates, your philosophical discussions, and above all your publications of important contributions to human knowledge, are scrutinized throughout the land. Your progress has been the progress of science; in your success the country shares; in your centennial the academies and universities of the nation rejoice, and to your future they look forward with bright anticipations.

The sentiment to which you have asked a response suggests the reflection that in this wonderful epoch of intellectual activity, when light beams from such unexpected sources, on so many crypts, dispelling the shadows and ghosts with which they had been occupied, Universities and Academies stand like priests at the altar of truth, keeping bright the coals from which the torches of research are lighted. Their objects are the same; perhaps indeed there is a correlation of forces, and university heat becomes academic work. This at least is certain, that they are the most potent agencies which our civilization possesses for the discovery of truth. While it is important that they should be co-operative, it is also important that their methods should be individual, not identical, or in other words that their distinctive functions should not be confounded. I take it that the prime purpose of the university is education, its secondary object is research; while the converse is true of the academy, which should always make its major task investigation, and its minor instruction. The best university will include among its professors those who can advance the sciences to which they are devoted, and among the associates of an academy there will always be those who are capable and ready to diffuse among men the knowledge discovered. The university will develop the talents of youth, the academy will task the powers of full grown men. Universities plant seed; academies reap fruit.

I do not indulge in these antitheses for the sake of rhetorical amplitude; but because, in response to the sentiment which has been proposed, it seemed to me well to emphasize at once the unity of purpose and the diversity of method which are characteristic of these complex institutions, and the need there is of giving both full scope.

There are always strong men in a community to whom universities do not offer a career. Leibnitz, at the beginning of the Royal Academy of Berlin, and Humboldt in its later days, are examples of scholars who found in learned societies and not in universities, the spheres of their activity. Newton on the other hand was efficient both in the University of Cambridge and in the Royal Society of London; and in our own day Sylvester has been equally active as a university professor and as a contributor to academic deliberations and memoirs. Two of our countrymen, as the biographer of one has shown us,* both named Benjamin, both born in Massachusetts, both devoted to experimental physics, both resident in foreign lands,—Benjamin Franklin, one of the founders of this Society, and Benjamin Thompson, Count Rumford,

* Rev. G. E. Ellis, D.D., in his Life of Rumford.

founder of the Royal Institution in London,—were deprived in youth of the advantages of university and collegiate training; but both of them enjoyed within the fellowship of learned societies intellectual excitement and instruction, and both have helped to perpetuate to our day the good influences in which they participated.

The mention of Rumford's name is suggestive of an important investigation recently completed, which beautifully illustrates the joint operations of an academy and a university. Your younger sister, the American Academy in Boston, holds a fund which was given by Rumford for the encouragement of researches in respect to light and heat. It has given the Rumford medal, first to Dr. Robert Hare, a distinguished member of this Society, and then to Ericsson, Treadwell, Clark, Corliss and Draper. Of late years it has bought instruments for the promotion of physical investigations.

Three or four years ago a new university originated in Baltimore, and one of the first men of science called into its service was a young physicist of Troy, whose studies in electricity, hardly noticed in this country, had attracted the commendation of Clerk Maxwell, in the University of Cambridge. This Hopkins professor suggested to one of the Rumford trustees a method which might be employed for the more accurate determination of the mechanical equivalent of heat. The Academy listened to the proposal and agreed to furnish from the Rumford fund a part of the cost of the necessary apparatus; the University encouraged its professor to undertake and prosecute the inquiry and bore a part of the cost of the instruments. The investigation has been concluded, and its results have been published in a memoir of nearly two hundred pages by the Academy in Boston. Its conclusions are of fundamental importance;

but this is not the place to rehearse them, were I qualified to do so. I simply call attention to them as a good example of scientific co-operation, and especially as an illustration of the mode by which an academy endowed by the courtier Rumford, more than eighty years ago, and a university, recently founded by Hopkins, of the Society of Friends, are able to unite in the discovery and publication of scientific truth.

Before I close, Mr. President, may I be allowed to add one more remark? There are three neighboring cities which it seems to me have not yet done what they might for the intellectual advancement of this country. I refer to Baltimore, New York, and, you will pardon me for adding, Philadelphia. They have good institutions, they have learned men, they have great wealth; but they need stronger and closer combinations than now exist,—better organization for the advancement of learning. We may hope that with recurring prosperity, increasing vigor will be shown in their academies and universities.

In such activities there may be emulation, but there should be no rivalry; for, as the forts which guard the Chesapeake, the Delaware, and the Bay of New York support one another, so these three great cities may strengthen and encourage each other by the firm establishment of institutions for the protection and defense of society against ignorance, bigotry and pretense. Sure that the central city of the trio, the intellectual and financial center of the Keystone State, will do its part,—I beg leave, in conclusion, to offer this sentiment:

The American Philosophical Society and the University of Pennsylvania: may they shine as a *stella duplex* through centuries to come.

4. *Our friends who have passed away,*

Dr. W. A. Hammond, New York City.

"Plena fuit vobis omni concordia vita;
Et stetit ad finem longa tenaxque fides."

In reply, Surgeon-General Hammond said:

Before coming on here I was selected by the members of a Scotch society to attend a dinner which was to be given upon the anniversary of the birth or death of Robert Burns, and I was requested to post myself thoroughly upon Scotch medical men; that I would be required to respond to the toast, "The Medical Men of Scotland." I did so. To my great disgust I found I had made a mistake in the dinner; that instead of coming off on Tuesday, it came off on Wednesday; so that I come here rather filled with ideas concerning Scotch doctors. Mr. Price said that I would not be expected to make a mournful speech; that I could respond in the best vein possible. I think we will all agree that we have much more regard for the man who makes us laugh than the man who makes us cry, and crying would be greatly out of place this evening.

For the history of the dead of the American Philosophical Society, you have only to think for one moment of those remarkable men who have passed away, who have given their lives to science, and were at the same time members of this Society. Of them I have nothing to say, because they are familiar to you. But there are three or four men with whom I was well acquainted, and first in regard to my old friend, Charles B. Trego. I knew him thirty or forty years ago. My very first idea of any scientific impetus was received from that man. I saw him frequently, and he treated me as a father would treat a son, and the amount of knowledge which I acquired from him at that time was far more than I have got from any other one person. Strange as it may seem in these days, Mr. Trego was elected to the Legislature. They do not send such men to the Legislature now; and if they did, they would probably be entirely out of place. Mr. Trego and I were very frequently together, and I will go on loving him as I love my own father. He was not what could be called a jovial man. I recollect that I went to the Capitol at Harrisburg one day to hear the debates, and some western member was speaking without much reference to the matter before the House. Mr. Trego saw him and came over to me and said, "Do you know what that man is talking about?" I said, "I have not the slightest idea." "Well," he said, "neither have I; he is letting the dark out on it."

Then about Samuel Jackson and Joe Carson. What a remarkable man Jackson was. Paralyzed in both of his legs, yet I never saw anything but a smile upon his face. Carson was more grave, more dryly humorous. He once gave me a conundrum which was unlike anything I had ever heard before. I was then an assistant surgeon of the army, and rather more puffed up than I am now. Carson said to me, "I have often noticed that assistant surgeons of the army are the knowingest military men in it; I have been thinking about a conundrum. As a military man, can you tell me the difference between a piece of roast beef and a fortification?" On my replying in the negative, "Well," said he, "I will tell you. A fortification is a work placed usually for purposes of defence at the entrance of a harbor, armed with heavy guns, sometimes built of stone, and sometimes built of earth; usually garrisoned by troops, and these troops have various munitions of war, which are furnished them for the use of the ordnance. Now, on the contrary, a piece of roast beef is the cooked flesh of the ox, endowed with highly nutritious qualities, usually served upon the table and people eat it, and hereafter when any person asks you the difference between a piece of roast beef and a fortification, you will probably be able to tell it."

There is my old friend, Dr. Wood. Although dignified to an extreme degree, he was the personation of kindness. As a scholar and man of letters, I suppose we shall scarcely look upon his like again. There is one point in regard to him which is worth mentioning here and with which some who hear me are doubtless acquainted. He made a tour through Europe, and after completing it, he sold his carriage and horses and invested the proceeds in fine Burgundy, Chambertin I think, and I have had intense satisfaction in drinking a good deal of that Burgundy. I think the most pleasant recollections I have of the doctor are connected with that Burgundy.

It would be very easy to say more or less about the worthy dead, and although what I have said to you has been rather in a jovial strain, yet there is enough for serious thought. The history of science in this country could be told in the biographies of these men. I now propose, "The memory of those who have gone from among us."

5. *The study of Languages,*

Prest. Wm. C. Cattell, Lafayette College, Easton, Pa.

"Quæ philosophia fuit, facta philologia est."—*Seneca, Ep.* 108.

President Cattell, in reply, said:

Mr. President and Gentlemen:—It is well known that the Founder and first President of the American Philosophical Society was in his way somewhat of a Philologist, though it may be taken for granted that he never abandoned the pursuits of Philosophy for those of Philology, as Seneca in the quotation upon the programme seems to assert was done by the wise men of his day. But philology in this age means something very different from what it meant when Seneca wrote these words, or when Franklin presided over the deliberations of this Society, whose Centennial we celebrate to-night. Dr. Murray, the President of the Philological Society of England, says, in a late number of the *Independent*, that as recently as twenty-five years ago, "English Philology was in its pre-scientific babyhood;" so that Franklin, though he was no mean Latin scholar and knew several modern languages, could not have played what would now be regarded a leading rôle as a Philologist. Yet the illustrious sage brought his philosophy to bear upon the English language at a point where many of the great Philologists are now concentrating their strength, namely, the reform in spelling. Not only did this practical, honest, economical printer revolt at the unnecessary expenditure of time and labor in setting up the silent letters and of paper and ink in printing them, but his philosophic soul was vexed at the wild and reckless spelling that obeyed no law and could be reduced to no order. He published a dissertation upon the subject, based upon these three eminently philosophical principles, (1) that there should be no letter that is not sounded, (2) that every letter should be confined to one sound, and, (3) that there should be no distinct sounds in the language without letters to express them. To carry out his reform he invented a new alphabet, contemptuously dismissing six of the present letters as useless and introducing six new characters to express the sounds not already provided for. In his letter to Miss Stevenson, 1768, written in the reformed spelling and with the new characters, he disposes in his plain common sense way of the objections urged against the new departure, including the very ones most frequently advanced now. But the great man, who handled the lightning with such success, failed hopelessly in his encounter with the English spelling; and in his letter to Mrs. Mecum, 1786, he sorrowfully admits that "what is still called the *bad* spelling in English is really the *best*, as generally conforming to the sound of the letters and of the words;" he also quotes, with undisguised admiration, the conundrum of Mrs. Brown's housemaid, "if *yf* don't spell *wife*, what does it spell?" and then abandoning all further efforts "to propagate useful knowledge" in this direction, he suddenly disappears as a spelling reformer.

The great astronomer, David Rittenhouse, Franklin's successor as President of this Society, was too much occupied with the heavenly bodies to care much about what was going on upon the earth, but his successor, Thomas Jefferson, had a personal and practical interest in this matter. He had to write many messages to Congress. This led him to a more thorough study of the language through which these important communications were made to his fellow-citizens. I am not sure that Jefferson was, technically speaking, a spelling reformer. Having undertaken to reform the old Federal party, he probably found his hands full, and declined any more contracts in that line; but a sentence near the close of his celebrated essay upon the Anglo-Saxon language, written in 1798, is pleasant reading for the spelling Reformers now; says he, "to express the sounds of a language perfectly, every letter of its alphabet should have but a single power, and those letters only should be used whose powers, successively pronounced, would produce the sounds required," and then he declares with an emphasis that would have rejoiced the honest heart of Franklin, that the English spelling is farther removed from this state than that of any other language with which he was acquainted. He also asks in the same connection and with a cheerful confidence in the answer that must be given by all sensible persons, "if the English word *cough* were spelt *cof*, would that change the word?" Permit me to add, that although our third President did not do much to advance the reform so dear to the heart of our first, he did a great service to the English language by introducing Anglo-Saxon studies into the curriculum of our Colleges and Universities. He made the mistake, pardonable in those days, of regarding the Anglo-Saxon as "merely an antiquated form of our present language," asserting that, if we "would remove the obstacles of uncouth spelling and unfamiliar characters, there would be little more difficulty in understanding an Anglo-Saxon writer than Burns' poems;" but he was eminently sagacious in insisting upon "the necessity of making the Anglo-Saxon a regular branch of Academic education," and was far in advance of his time in giving to this study such prominence in the great university he founded.

But, with your permission, Mr. President, I will add that there are other members of the American Philosophical Society who have become eminent as Philologists, though they have not been called upon by the Society to occupy the high official position once adorned by Franklin and Jefferson, and now by yourself. We need only look around these tables to see them. The learned Professor of Hebrew in Princeton

Theological Seminary, Dr. Green, who sits at my right, has no superior as an Oriental scholar in this or any other country; and near him I see my old College friend, Mr. Ingham, whose graduation speech was delivered in Latin—the honor then awarded by the Faculty to the first scholar of the class—and although he would not, I am sure, allow me to name him among the specialists in the study of languages, I know that by his philological studies at home and abroad during the intervals of a business life, he has proved himself worthy of the spurs he earned at Princeton College thirty years ago. I see also President Chase, whose scholarly editions of the Latin and Greek classics are in the hands of all our College Professors; and Mr. Phillips, the cultured scholar, whose good work, both as a Philologist and Antiquarian, is recognized abroad as well as in America; and Dr. Brinton, eminent as an authority in the aboriginal languages of our country, and whose learned contributions to our knowledge of the Indians have really done much to redeem the American people from the dishonor of having broken all the treaties we have ever made with them; and I see at the farther end of the room, the genial and still youthful face of that veteran Philologist, Dr. Haldeman, the mention of whose honored name brings me back to the spelling reform, for it was this eminent scholar who carried off, over a host of learned and distinguished competitors, the prize offered by Sir William Trevelyan in 1857, "for the best essay upon a reform in the spelling of English." As often as I turn to the pages of this Thesaurus of philological learning and remember that it was written in Dr. Haldeman's "pre-scientific babyhood," *quoad philologiam* I am reminded of Hercules, who while yet in his cradle displayed such marvelous strength in freeing himself from the monster which held him in its huge coils. But that was probably a lying fable. What Dr. Haldeman did is a fixed fact; and this learned pioneer in the spelling reform claims, and with justice, to be the first English scholar who can honestly use the exultant line of Bryant, "I broke the *spell* that bound me." Certainly, he and his learned coadjutors—for I do not know of an eminent philologist who is not enlisted to some extent in this spelling reform—have brought the brightest hopes of Franklin and Jefferson to the point of realization. This I concede heartily—but also sorrowfully, for at my time of life it is horrible to think of learning to spell over again. There was a time, I confess, when my zeal to undergo this personal tribulation for the benefit of posterity which (it has been forcibly said) has never conferred any benefits upon us, was not strong enough to keep me from devoutly wishing that a kind Providence would confound the counsels of these conspirators against the established disorder, at least until I was out of the reach of their new spelling books. Even now, I cannot help expressing the benevolent wish—benevolent to myself and my contemporaries—that this every-way desirable and even necessary reform had come earlier. I wish that Franklin had finished up the matter, and that our patriotic forefathers under his wise and practical leadership had succeeded in driving the bad spelling out of the country with the discomfited British. It really seems as if those long years that tried men's souls, would have been just the very best opportunity to dispose of this vexed question. There was so much turmoil and confusion during the war, such pecuniary distress, such afflictive social and political antagonisms that the misery, inevitable to the generation that reforms the English spelling, would hardly have been noticed; and the people of the Colonies would have emerged from this double and synchronous revolution a really free and independent nation upon a sound political and orthographical basis!

But I must not lose sight of the text you have given me, which in connection with the quotation from Seneca suggests more than the spelling reform. Those who are familiar with this epistle of Seneca to his friend Lucilius, cannot have failed to notice the reluctance with which he admits that the Philosophers have become Philologists. With him philology meant the love and pursuit of science and literature. A noble aim. But the aim of philosophy was higher; it was the love and pursuit of wisdom, sapientiæ amor et adfectatio, as he defines it in another epistle to the same friend, or as Cicero in his *De Officiis* had already defined it, sapentiæ studium. This wisdom—the sapientia of the Latins, and the σοφία of the Greeks—was to all these thoughtful men, what it was to the inspired writer, "the principal thing;" the mater omnium rerum bonarum, says Cicero; the ars vitæ, adds Seneca. To turn away from this high subject in any direction was a descent, and Seneca could not without sorrow record the fact that what was formerly philosophy had now become philology. But may not the modern Philologists claim to have reascended these heights, where the Philosophers are gathered to discuss their great questions? Philology has long ceased to be regarded, even in the popular mind, as merely a curious study of words by antiquarians who delight in archaic or obsolete forms, the "Diversions of Purley," in the search for impossible derivations, or a learned and laborious discussion of the changes of vowels and consonants in which, according to the gibe of Voltaire, the vowels count for nothing, and the consonants next to nothing. Philology, from the modern point of view, is a thorough and comprehensive study not only of all languages and their literature, but of the science of language. This is to study man, for as a distinguished authority says; "there is no nook of man's mind or heart or will, no part of his nature or history, into which the student of language may not be called to look." The Philologist therefore equally with the Philosopher, may use the oft-quoted line of Terence, humani nihil a me alienum puto. We continue, indeed, to send our boys to the schoolmaster that he may teach them Latin and Greek, for the scoffing of this practical age has not made us undervalue this thoroughly tested and approved means of cultivating the youthful faculties, nor the opulent results, in maturer years, of a familiar acquaintance with the languages in which is contained the literature that has quickened the intellectual life of all cultured nations. But the study of languages in this age has more in view than mental discipline or the ability to translate easily and correctly the classic authors. Its aim is not merely to know the thoughts of men which have come to us in many languages—a great heritage—but to know also the laws of mind in which all language is grounded. Words are things. The Philologist studies his word as the Botanist his plant. He inquires not only to what uses it may be applied, but *by what laws it grows.* Words not only contain thought but they are—merely as words—the product of the laws of thought. To study these laws is to study mind; and does not philosophy reappear in philology, which thus comes to study with it those great questions which lie nearest to the lives of men? It would, perhaps, better suit another time and place to show how what I have said as to the study of those words which have grown up between man and man, is also true in a most significant and solemn sense of the great WORD, which was in the beginning with God, and which conveyed to man the thoughts of God. For He was not merely a teacher. He was himself a revelation. We must not only know what He taught;—it is life eternal to "KNOW HIM."

In the retrospect, which our celebration to-night suggests to us all, we must as American citizens rejoice in the progress which the study of language, in whatever light we view it, has made in our own country during the past century. I venture to say that never in any other age or country has the great and noble end of this study been more intelligently apprehended or have its methods and appliances been more complete. To enumerate the really valuable text books and publications upon this subject that have appeared in America, even within the last quarter of the century, would be to recite a list as long as the catalogue of ships in the Iliad. The work done by the American Philological Association is in the advanced line of comparative philology. Our colleges vie with each other in the intelligent application of the latest results of philological investigation. The London *Athenæum*, an authority in such matters, says that the studies of a philological character carried on in one of our Pennsylvania colleges, "are not surpassed in thoroughness by those which we are accustomed to associate with German universities." And then the great scholars who have arisen among us to give lustre to the age! In this presence I need not name them; but I beg to give one illustration of the progress made in American scholarship. Mr. Jefferson, in the essay from which I have already quoted, alludes to the few printed works in the Anglo-Saxon then published, and confesses with patriotic grief, that the scholars of America could do nothing to enlarge the supply. He then says, "the publication of the inedited manuscripts which exist in the libraries of Great Britain only, must depend on the learned of that nation." But let me say that it is an American scholar who, during the past year, has been requested by the Early English Text Society of London to edit, as one of the series of its publications, the famous Anglo-Saxon manuscript—Alfred's translation of Orosius—now in the library of Lord Tollemache! I need scarcely say that the name of this great American scholar is Francis A. March, whose Comparative Grammar of the Anglo-Saxon language is a text book in the universities of England and of the continent. The mention of his name leads me also to refer to the recent enlargement of the curriculum of languages in all our colleges by the introduction of the philological study of the English, not as belonging to the department of Rhetoric or of English Literature or of Belles Lettres, but to the department of Language equally with the Greek and Latin, for in this Dr. March has been a pioneer, and the chair which he occupies, uniting in one professorship the study of the English language and Comparative Philology, was the first of the kind established in this or in any other country.

Let me say further—for the presence of Dr. Gilman, the learned and accomplished President of the Johns Hopkins University, reminds us of the fact—our college graduates are no longer dependent upon the universities of Europe for advanced instruction in the study of languages. Of course, foreign travel and even residence abroad for a limited time are still valuable for the young graduate, and there are great scholars and teachers and magnificent libraries in Europe; but he is no longer actually compelled to go abroad for post-graduate instruction. All the great colleges and universities of our country now offer courses of special and advanced studies, in most respects equal and in some superior to those found in the oldest and the best universities of Europe; and it is not invidious to say that the post-graduate courses of study offered by our youngest sister of Baltimore lead all the rest.

But, Mr. President, I must not trespass further upon the time allotted to these speeches. Already I fear that some of the gentlemen at these tables have called to mind, and with grave forebodings, that the original meaning of Philology, was "love of talking;" and it is, perhaps, something more than a coincidence that Seneca in the sentence immediately following the quotation given upon the programme to-night, quotes the well known phrase of Virgil, *fugit irreparabile tempus*. These ominous words contain a hint of special significance to after-dinner speakers; and so I bring these remarks at once to a close.

6. *The Society's name,*

Dr. DANIEL G. BRINTON, Philadelphia.

"A thing which Adam had been posed to name."—*Pope.*

Dr. Brinton, in response, said:

MR. PRESIDENT AND GENTLEMEN:

In rising to respond to the toast which has been proposed, I feel I need not insist before such an assemblage as this on the paramount importance of *names*. Whatever philosophy people many theoretically advocate, they are essentially *nominalists* in daily life. They attach more value to the name than the thing. The writer of fiction thinks his work half done when he has discovered a taking title, a catchy *name* for the infant of his fancy. A bad name has hanged many a good dog, and a good name has saved many a man who would have been the better for the hanging.

Such opinions are not irrational. The name alone has perennial life, it perpetuates existence when all else is gone, on it alone hangs the fame of heroes and the glory of the great. The name is the subject of thought and speech. With it begins the first glimmer of knowledge, as we are reminded by the sentiment attached to this toast. In the first essay of his new-made mind Adam named the beasts of the field, both small and great.

Names applied to institutions have another and peculiar significance. They reflect the purpose and object of such institutions, they hint the hopes that gave them birth, they figure forth the ideal which is to be the goal of effort. I invite you to study the name of our Society in this sense, to seek its original significance, and perchance thus to learn the purpose which our revered founder had in mind in bestowing it upon our association. For it is probably not unknown to any of you that it was Dr. Franklin himself who stood godfather to the infant fraternity, and one hundred and thirty-seven years ago suggested for it the name it still is known by, *The American Philosophical Society*. In his circular of May, 1743, this is the style and title he proposed.

Like all that he did, this name was the result of mature consideration, and the motives of his choice may be divined from his own words and the scheme he proposed.

He named it *American* because he expected its activity to be occupied mainly with the New World, it was organized, as he said, to "promote useful knowledge among the British Plantations of America." His luminous eye foresaw the vast additions to human knowledge which this then unexplored continent would furnish; he knew, what other men only guessed, the capacity for marvelous development that lay in those colonies scattered on the virgin marge of an unknown world; with a sublime faith that partook of prophetic inspiration, he set to work to build for a future which even the sanguine deemed visionary.

In the name he may also have conveyed a limitation as well as an extension; he may have hinted that the subjects of research with which this Society should occupy itself should be those in some way relating to its surroundings; that it were well to leave to others the pursuit of investigations into classical and mediæval matters and into localities of old world note.

This leads me to the character and purpose of the inquiries he designed to foster by this organization. They are signified in the word *Philosophical*.

A century and half ago this term had a wider meaning than is current now. Bacon's definition was still in vogue. That great thinker divided philosophy into three branches, divine philosophy, in which "the contemplations of man penetrate to God;" natural philosophy, which covered the whole field now embraced in natural science; and human philosophy, under which was included what we now know as psychology, social science, political economy and the like.

It seems to me that Franklin must have had this very definition of Bacon's, with its threefold divisions, in his mind when he composed his circular of May, 1743, in which he first projected and named this Society. With wording drawn from the early verses of the book of Genesis, he defines its mission to be "to let light into the nature of things, to increase the power of man over matter, and to multiply the conveniences or pleasures of life." Clearly this is but a free and popular rendering of Bacon's scholastic language; and obviously therefore, Franklin wished this Society to meet, in the fullest sense, the requirements of the title *philosophical.* All that pertains to man and nature are the legitimate subjects of its inquiry, providing they can be applied to some useful end. Moreover, with that practical wisdom for which he was famous, his notion of utility was not limited to dry and hard applications. He recognized the pursuit of the pleasures of life as a becoming and worthy subject for philosophical research. He recommended it specifically to his associates, as a desirable object of learning.

If we pass from the Baconian to the more strictly technical meaning of Philosophical, we shall find other matter for our thought. The philosophical mind is one earnest in the love of knowledge. But that knowledge is of a peculiar kind. It is not the accumulation of detached facts; it is not mere erudition and extensive learning. It is that manner of knowing which Bacon in a famous aphorism calls "true knowing," knowing through principles and laws, knowing through *causes.* *Veré scire est per causas scire.* This it is which gives facts their real value, this it is which transforms the grains of knowledge into the pearls of wisdom. The highest effort of thought is to pass from the special fact to the general law, from the experiment to the principle, from the concrete to the abstract, and this is what is meant by a philosophical knowledge of things.

To achieve such a knowledge, to build it on a firm foundation, can only be done by uniting the results of many observers and comparing them in the light, one of the others. Hence it is essential that a Philosophical Society should embrace a wide variety of scholars, each of ability in his special pursuit. It should be a society free from the control of specialism ; it should cover the whole field of observation and not be dominated by one part of it, by one department of study or thought. Franklin framed the constitution of the association to fulfill this meaning of the word. The members were to be chosen from all the learned pursuits; they were to communicate to each other such results and conclusions as should be of benefit to all, not mere details of their special lines; and the results to be published were to be confined to abstracts and papers "of public advantage."

In pursuance of this plan, Franklin provided that the minimum number of active members should be seven, each of whom was to pursue a different branch of study. One of these was designated as a "General Natural Philosopher," and under this title it appears to me he had clearly in view the formation of a class of thinkers which has been earnestly advocated in this day by Comte and Herbert Spencer; that is, a class who shall unite together the results of the different specialists in science under broad philosophical schemata, and weave them into a system of knowledge co-extensive with observed facts, and subsumed under the widest possible generalizations.

In this way alone do the innumerable details of science become available to the public good, and manageable by the general intellect. At the date of the origin of this Society, the need of such an appointment must have been but slightly apparent; but now that the details of specialties are becoming day by day more technical, more abstruse, and more remote from even general scientific language, the need is urgent. The danger is constantly present that the pursuit of a narrow path of investigation, which, however, demands the most strenuous labor to follow out, will warp the thoughts from the broad views and common motives of human culture.

Finally, Dr. Franklin called the organization a *Society*. Nothing is more impressive in the biography of this great man than the profound appreciation he had of the benefit of uniting men together to accomplish a purpose, of the value of free combination, of voluntary co-operation in social and national life. This idea lies at the basis of all modern, as distinguished from ancient progress. In the classic periods we read of the master and his disciples, of the noble and his retainers, of closely united classes and callings, but of nothing which corresponds to a modern scientific or literary *Society*. Such an institution belongs to a period when the sacredness of the individual is recognized, when an equality of knowledge overweighs the difference of wealth or birth, when all are willing to take off their shoes as they enter the temple of Truth.

One of the earliest public results of Franklin's life was the gathering together of his "ingenious acquaintances" into the well known "Junto." The fundamental principles of the Junto were three:—to be free from prejudice on account of profession or religion; to desire the welfare of mankind in general; and "to love truth for truth's sake." Whether our Society was or was not an outgrowth of this Junto, undoubtedly it was the intention of the philanthropist who created both associations, to inspire both with the same grand and holy principles of toleration, good feeling and sincerity. All that tends to these ends would surely be consonant with the name we assemble under and the projects of our founder; and certainly an occasion like the present, which brings us together to recall the worthy labors of our predecessors, to extend to each other the social courtesies of life, and to express our aspirations for the continued advance of the Society in the grand career which was from its birth marked out for it, does in a significant manner meet the requirements of our name and the objects of our association.

7. *The need of an elevated and permanent civil service,*

A. Loudon Snowden, Esq., Superintendent U. S. Mint.

"Oh, reform it altogether."—*Hamlet.*

In response, Mr. Snowden said:

I am honored, Mr. President, by your call, and doubly so by the cordial manner in which it has been received by the gentlemen of the Society, and heartily wish it were in my power to repay your kind partiality by something worthy of your consideration.

It must be a pleasure to all the members of the Society to be present upon this interesting occasion, not alone to discuss the good things provided by the thoughtfulness of the Committee of Arrangements, but to partake of the intellectual feast which has been so bountifully provided.

You have been pleased sir, in presenting my name, to associate with it, the names of three of my predecessors in the management of the Mint of the United States in this City, who were also presidents of this ancient Society, which has embraced in its membership, and upon its rolls of honor, some of the most illustrious names in letters and science which the last century has produced.

The three distinguished gentlemen to whom you were good enough to refer, David Rittenhouse, Robert Patterson and Robert M. Patterson, were, in their day, citizens and public officers who conferred lasting benefits upon the public service, and who were, in all the relations of life, examples worthy of imitation.

David Rittenhouse, who succeeded Benjamin Franklin, and preceded Thomas Jefferson, as President of this Society, was wisely selected by Washington on the passage of the Act of 1792, authorizing the establishment of the Mint in this City, on account of his eminent scientific knowledge and great mechanical skill. He superintended the erection of the Mint building on Seventh street, saw to its equipment in machinery, to the perfecting of its organization, and, in 1793, issued the first coinage of the Republic. Little did he dream in that day of small things, that in less than fifty years, the one cumbersome screw press then in use, and capable of executing all the coinage required, at the rate of about ten or fifteen pieces a minute, would give place to the steam toggle-joint press with a capacity of from eighty to one hundred pieces to the minute, and that in much less than one hundred years, over thirty of those grand coining presses, with largely increased capacity and power, would be kept thundering night and day to execute the coinage demanded by law and by the wants of the people.

Robert Patterson, the fifth President of this Society, was called to the management of the Mint by President Jefferson in 1805. He had been honorably connected with our Revolutionary struggle, and subsequently was a Professor in the University of Pennsylvania, conspicuous for his learning and thorough administrative ability.

Robert M. Patterson, elected the eighth President of this Society, was a son of Robert Patterson, to whom I have just referred, and succeeded Dr. Samuel Moore in the Mint.

He graduated at the University of Pennsylvania, and subsequently prosecuted his studies in Europe. On his return to Philadelphia, he was elected Professor in our University, was Vice-Provost, and filled, successively, the Chairs of Natural Philosophy, Chemistry and Mathematics. In 1828, he became a Professor in the University of Virginia, from which he was transferred to the Directorship of the Mint in 1835; in which position he remained, rendering most acceptable service, until 1851, when failing health induced him to retire from public life.

It were well, Mr. President, for the honor and profit of our country, if high public station were always as well filled, and sacred public trusts as faithfully administered as in the instances to which, by your courtesy, I have been permitted to refer.

This brief allusion to the services rendered by these distinguished public officers brings me very naturally to the consideration of the theme you have been pleased to assign me this evening, to wit:

THE NEED OF AN ELEVATED AND PERMANENT CIVIL SERVICE.

This is a practical and important question, touching very closely the highest and best interests of our Country, and entitled to the thoughtful attention of every American citizen.

Neither the proprieties of this occasion nor your patience would justify an elaborate or exhaustive discussion at my hands. What I shall, therefore, with your leave, submit, will be but a brief reference to the most obvious points that present themselves in a rapid glance at the subject.

In the minds of all thoughtful and patriotic men, there can be no doubt as to the great advantage resulting from the elevation of our civil service above the control and influence of mere partisan interference. The battle to be fought before the triumph of this important principle is assured, will be sharp and well contested at every point, although no one should despair of the result, in view of the general and increasing intelligence of the people, now being brought to bear upon the question.

Of late years, public attention has been much directed to the subject, but, as was to be expected, it has met the most determined opposition from the representatives of all parties. Every weapon that sarcasm, ridicule, and falsehood could forge in the workshop of selfishness, has been hurled against its advocates. And yet it must be confessed that the greatest injury inflicted, has come from pretended friends, who, under that garb, have attempted to accomplish selfish ends, and thus have brought ridicule upon the cause.

Nevertheless, steady advance has been had within the past few years, and some lodgment made in the minds of the people.

That there is too much foolish, intemperate, and unjust denunciation of our present service there can be no doubt. If we were to believe one-half that is written and spoken on this subject, we must conclude that but few, if any, honest or honorable men are engaged in public affairs.

This tendency to carp and cavil at, and criticise all men engaged in the public service, is said to be a natural outgrowth of our free institutions, which makes every citizen a censor. But whether this be true or not, the fact is nevertheless patent, that from the very organization of our Government, there has been more or less of this sort of thing prevalent. Even Washington, the most illustrious of all our citizens, if not the most illustrious man of all the world, was not exempt; nay, on the contrary, in spite of his invaluable services to the country, his nobility of soul, and his transcendent patriotism, he was subjected to the most violent, bitter, and unreasonable abuse, and under it retired from public life.

It was fashionable then, as it is now, among certain grumblers and inconsiderate persons, to denounce our civil service on all occasions. They do not take the trouble to obtain reliable facts upon which an intelligent judgment may be formed, as touching the general service, but are prone to take isolated instances of wrong-doing, and base their opinion of the whole service thereon.

That this is a most irrational and unjust process from which to arrive at a sound conclusion, there can be no doubt, and yet it is the usual mode.

These grumbling pessimists who find no good in their own country or times, are very often least fitted, either by cultivation of mind or purity of character, to form a sound judgment of their fellow men.

Dismissing this class as worthy of no farther attention, it must be admitted, that although our civil service fairly represents the average moral and intellectual status of our people, it can nevertheless be elevated and rendered more efficient by means which are simple in themselves, and not difficult of application.

When I say the means of accomplishing this desired end are simple and easy of application, I should say, they are so, provided the people have courage and patriotism enough, to demand of their political leaders, that our civil service must be *permanent—promotions coming through efficiency, and the tenure of office dependent upon good behavior.* It will not do to simply incorporate these ideas or principles into the political platforms of the parties, as catch votes, to be forgotten after elections are lost or won ; but let our civil service be organized under the sanction of law, as are the military and naval services, and thus secure a permanent application of this important principle, no matter how often administrations change, or parties succeed to power. That the law should bind all parties in this respect—if the principle is good—must be quite apparent. An attempt on the part of any administration to establish such a wholesome system without the binding force of law to sustain it, can only hope for partial and unsatisfactory results, no matter how earnest and honest may be the effort.

It is doubtful, indeed, if any administration is strong enough to enforce the reform against long established precedent, and the selfishness of partisan managers, unless fortified and strengthened by law.

The reasons are manifold why the policy, as a mere administrative measure, is likely to be a failure; First, if for no other reason, because it would be looked upon as an ephemeral effort or experiment, likely to disappear with the administration, if not break down before it terminated. Second, because as such, it would be constantly assaulted with a view to its abandonment; whereas, if under the sanction of the law, it would be accepted as a fixed fact and remain practically unassailed; and Third, because it would have no binding force upon succeeding Presidents, who could and probably would overthrow in a day the work of years.

President Hayes will ever be remembered for a noble effort in this direction, and although much good has been accomplished, yet, from the causes I have enumerated, and others, results expected and hoped for have not been fully realized.

General Jackson is credited with the declaration that, "to the victors belong the spoils," and whether he or William L. Marcy is responsible for the utterance, there can be no doubt that Jackson was the first President who broke down the old tenure of office, handed down to us from our English ancestors, and recognized by Washington and his compatriots, as of the highest value in the administration of public affairs.

It is well to remember, however, that whilst General Jackson struck a fatal blow at the civil service, and prostituted it to selfish partisan ends, the service itself was largely responsible for the blow that was given.

Although existing by English and American precedents, it was not restrained by law within its legitimate sphere.

The service at that time was largely composed of those who differed politically with Jackson, and as it was a period of bitter partisan strife, they did all in their power to hamper and embarrass his administration. This was neither wise nor prudent, and exhibits to us the fact that, with the exception of the tenure of office, the service was badly organized and conducted. Instead of performing quietly and efficiently its legitimate functions, without regard to the change in the political head of the government, it was violently partisan, and used its entrenched position to defeat the measures advanced by the President.

There was, therefore, some excuse for Jackson's course. He was a positive, brave, although sometimes an indiscreet, man, and accustomed, from his habits of thought and training, to strike an enemy whenever and wherever he could find him. He struck his Whig adversaries, fortified in the civil service, and paralyzed them, as a power against himself. But in doing so he inflicted an evil upon his country which has widened and deepened as the years have followed. Had Gen. Jackson succeeded in applying a remedy for the evil justly complained of, by such legislation as would prevent a civil officer—as the unwritten law prevents officers in the army and navy—from participating in partisan strife, he would have accomplished the immediate purpose in view, and left to the future, this, as the brightest page in his remarkable career.

The primary and paramount object of all service is, to promote that which is best for the people at large, without distinction of party; whereas, under a corrupted system, it is customary to consider all the offices of the country as the common property of the party in power, to be distributed to their partisans as rewards for services rendered, or as implements to be used for future party purposes. No one will deny that this is the fact, and yet it is an utter perversion of the true and legitimate objects for which the offices were created.

The number of officers or places under the government is quite insignificant in comparison with the population of the country, and it is of very little moment to the great bulk of the people whether John Smith, Jones, or Robinson hold office or place; but it is of the highest importance that whosoever does hold the same, be skilled, intelligent, polite and trustworthy.

How are these essential qualities to be obtained? Is it by rotating a man in or out of office for a political purpose, or in having his continuance in place dependent upon his ability to carry a precinct or a ward convention in partisan contests, or, on the contrary, are not the offices more likely to be well and acceptably filled by having those holding them understand that so long as they are honest, attentive and faithful in the discharge of their duties, they will be retained and promoted for meritorious conduct when an opportunity presents? The continuance of a faithful and intelligent officer increases his opportunities for usefulness to the public. One of the evils, and not a small one, attending our present defective system is, that we are, by our short tenure, constantly put to the inconvenience and expense of educating new men.

A change in the national administration of the Government, especially where one political party is succeeded by another, must of necessity be followed by a change in such leading and important public positions as reflect the purposes and policy of the party in power, but in the name of all that is reasonable and proper why should a change in the administration necessitate a perfect upheaval in all our civil service, from the humblest laborer to the most skilled expert, mechanic or accountant? Because a new President is elected, is no reason why a skilled workman in the Mint, an intelligent, well trained letter carrier, or any other faithful employé of the Government should be removed. They have been educated for the service at the public expense, their education and equipment is the common property of the people, and should not be thrown away to gratify partisan selfishness.

What man of business, banker, manufacturer or merchant would think of adopting such a short-sighted or pernicious system in his own business? I know of no such man.

And why should we not apply in public affairs the same common sense principles and rules that govern in the ordinary pursuits of life? It seems to be so reasonable and proper a course that I cannot conceive of a good argument against its adoption. Because the people, as is their right, see fit to change the administration of national affairs on account of important public questions, such as the tariff, finance, state right encroachments, or centralization, or any other issue that may arise, is no reason why all the faithful and skilled employés of the Government, from the lowest up, should be turned out to give place to inexperienced successors, whose education and equipment for the service is attended with discomfort, errors, and loss to the people.

Without going deeper into the subject, in all its bearings, or trespassing farther upon your kind indulgence, I think it must be admitted that a civil service based upon so illogical and uncertain a tenure, is defective in the extreme, and should be replaced by one resting upon common sense, as manifested in the usual business affairs of life. The opposition to a change from the present to a better system, comes principally from those leaders of both parties who claim that patronage is an important partisan weapon. But I am clearly of the opinion that an honest and fair test of the new system would satisfy even these persons, that they had over-estimated patronage as a factor in partisan contests. I think our political leaders would discern, like many an intelligent man of the South has, by the great lesson of the war, that, whereas he formerly leaned upon slave labor—felt he could not exist without it—yet, when schooled in adversity to self-trust and self-support, would not now return to the same order of things, or repossess his slaves if freely proffered him. Patronage is not always a power—and is ofttimes a weakness—and I am convinced with some knowledge and experience, that its influence is much overrated.

Some of the grandest and most memorable contests ever fought upon the political battle-fields of our country have been fought and won without patronage, and indeed against the whole patronage of an administration improperly used.

The proposed change in our civil service would not only elevate and increase its efficiency, but would eliminate much that is venal, selfish and dangerous to the politics of the country. This branch of the subject is too wide and far-reaching in its results for more than a passing allusion to this evening.

Knowing the defects in our present service, and the evils flowing therefrom, what is the remedy, and how shall it be applied? The remedy I would suggest is, *to remove by law the civil service of the country from under the control of partisan interference, and prevent its subordinates from an active participation therein.* By this course you will elevate the service, increase its efficiency, and largely decrease its expense to the people.

Is the remedy an impossible or even a difficult one to apply? To a nation which has laid forests, built splendid cities, peopled a continent, overcome a mighty rebellion, and emancipated four millions of human beings within the stride of a single century—it would seem as if this might be accomplished.

I know full well that it can be done, and that quickly if good men of all parties will only unite and determine that it shall be.

If the pernicious influences exerted by our present defective system are eliminated from our politics, we will have removed one of the greatest hindrances to our advance, and danger to our future peace, tranquility and prosperity as a nation.

8. *The tendencies of scientific culture.*

Dr. John L. LeConte, Philadelphia.

> " Reasoning at every step he takes,
> Man yet mistakes his way;
> While meaner things, whom instinct leads,
> Are rarely known to stray."

Dr. LeConte, in reply, said:

You have already been told that one hundred years ago the Commonwealth granted to a body of well-educated citizens an act of incorporation constituting them "the American Philosophical Society," and to this name was added, "held at Philadelphia, for promoting useful knowledge."

It seems appropriate on this occasion, when we are met to do reverent homage to the memory of those founders of the Society, to enquire what were their objects, and what was then, and is now, considered "useful knowledge."

Before doing this, let us review, briefly as the time permits, the names and objects of some similar societies in older countries. Two examples will suffice:

In the first years of the seventeenth century there was founded at Rome the "Accademia dei Lincei," or the Academy of the Sharp-seers, for the general promotion of higher intellectual culture; this has since developed into a full Academy, under governmental protection, consisting of coordinate branches for different departments of learning.

Three score and ten years later was organized in Germany the Leopold-Caroline "Academia Naturæ Curiosorum;" persons curious about Nature. Its objects related chiefly to medical art, and are declared to be the study of Anatomy, Botany, Pathology, Surgery, Therapeutics and Chemistry. The transactions were published as "Miscellanea curiosa."

These names are now far from expressing the aims of scientific thought; yet in them may be discerned the lineaments of the embryo of modern science, whose sudden appearance and influence parallel the ancient myth of the birth of Minerva. These names accentuate the difference, not between the old and the new philosophy, but between mediæval scholasticism and modern observation. The former, constructed from the depths of its own consciousness, gave answers to all physical and spiritual enigmas, based upon human motives and passions and sensations; the latter endeavors to ascertain the government of the Universe, and the means of conforming most perfectly to its laws, by close scrutiny of what is within our scope of comprehension. In other words, the latter replaces by observation and classification the *a priori* guesses of the former.

As the domain of knowledge became extended, a division of branches of science took place, each of which has contributed, though in unequal degree, at different times, to the rapid advance of modern civilization; and thus all are entitled to be comprised in the limits of useful knowledge. Though I am free to say that some which have yielded and will in future yield the most valuable results, are still regarded by the mass of the community, if not with ridicule, at least with a charitable contempt for the men who waste their lives in such trifling pursuits. Even as late as 1786, when the Magellanic Fund of this Society was established, there existed a prejudice against "mere Natural History," which led to its express exclusion by the donor from the benefits of his gift.

All this is now changed. The truth of the ancient text, showing the shortsightedness of the ordinary man, has again been vindicated: "The stone which the builders refused is become the headstone of the corner." The much despised Natural History of the past generations has become the Biology of the present, and rightfully reigns, by more than human authority, seated in the long usurped throne of the "Queen of the sciences."

Let us now examine the various ways in which the sciences have manifested their usefulness.

You will all agree with me that first in importance must be placed the higher personal education, which characterizes the best modern instruction; the substitution of common sense and individual judgment upon matters of fact, for unintelligible jargon or incomprehensible dogma. For, as is well observed by Prof. Huxley, "science is common sense at its best, that is: rigidly accurate in observation and merciless to fallacy in logic."

To this end, that is, to the perfection of observation, the highest inventive power has co-operated with the most acutely directed reason, in devising instruments of precision by which magnitudes and movements, inappreciable by the unaided senses, are accurately observed, and even demonstrated to large bodies of spectators.

Ingenuity of a higher kind than that employed in commercial workshops, and labor more severe than any known to the artisan or mechanic, have been given to the construction of philosophical apparatus, and to the collection of materials for investigation. The community has often profited by the economic advantages indirectly derived from such untiring exertions, which were inspired by higher objects. The reward striven for has been, indeed, rather spiritual and moral than physical and sensuous. The love of knowledge and truth for their own sake is the stimulus; and, as is natural in communities growing in intelligence, greater influence in the realm of thought is the result. For be it observed, that the largest contributors to the thought of the present day are biologists and physicists; and their opponents are chiefly among those wedded to prejudice of ancient usage, or addicted to pursuit of their own temporal advantage.

These classes, we have reason to believe, are gradually diminishing in number, and will more rapidly lessen, as the genial influence of the still youthful science of observation infuses itself into our daily life and conduct.

It may be observed, in this connection, that while mathematics, physics and chemistry have contributed, both by their apparatus and processes, to this result, Biology, aided by these appliances, has given the finest and highest developments of modern thought. From the formerly despised collectors of curiosities, weeds and bugs and bones, have been evolved the classifiers and morphologists, who are displaying to your view the magnificent procession of animated beings through measureless periods of time, and demonstrating to you the much misunderstood correlation of the different organs of the body. In their hands are truly the keys of prolonged human life, increased power and enlarged usefulness.

During the new reconstruction of thought, based upon observation, many *antiquated* notions, by a perversion of language called *venerable*, have been rudely assailed. Metaphysical terms eluding definition or relating to subjects not capable of thought, have been replaced by words of clear meaning. The mists of superstition are being dispersed. The necromancer (*vulgo* spiritualist) instead of being turned over to legal or ecclesiastical tribunals for torture, is viewed either as a juggler practicing his trade for fraudulent purposes, or as a fatuous hysterical individual sadly needing the care of his family physician. Persecution is obsolete; with liberty of thought has begun a tolerance of opinion and a charity towards action, unknown in previous ages, from which may be expected the happiest results in the future.

While such has been the influence of science upon religious teaching and moral instruction, there is one matter which it is my duty to mention with regret, though this is not the place nor the time to exploit it fully. It is the status of scientific men in courts of justice. As students above all others single-minded in the pursuit of truth, as trained observers, as careful and conscientious instructors, they are entitled to be invited into court as the advisers and enlighteners of the judge in regard to facts which he has neither the time nor the opportunity to ascertain for himself, and not to be summoned as the witnesses of the advocate. I say it with sorrow, but I think I can say it with truth, that upon no class of minds has the progress of contemporaneous science had so little influence as upon the legal; and no kind of business has been so slightly modified by its influence as legal procedures.

The other influences of science upon society are perhaps more generally appreciated, though hardly with strict adherence to the great law of sequence, or cause and effect, which dominates everything within human cognizance. A mere mention of them must suffice, lest I trespass unduly on the courtesy to which I owe the present opportunity of addressing you.

Next in order to the spiritual advancement which I have mentioned, are the habits of discipline and self-control which are essential to any serious study of science. As an educator, scientific training must be rated as coördinate with mechanical skill. For, whereas, a person trained as an artisan has always the power of earning a living, one versed in accurate observation and reflection has greater power of resisting the disturbing influences of evil than he would otherwise possess.

Thirdly, and lastly, by the labors of the investigator, the inventor is enabled to devise and perfect his application of science to the ordinary wants of the community: a thing which the man of science has rarely any opportunity of doing. For, it is quite evident, that the rivalry for priority, the embarrassments of legal proceedings, and the expenditure of time, and the distraction of thought necessary to make any invention, however meritorious, a commercial success, are absolutely fatal to the accuracy and serenity which are essential to investigation. But the suggestions by the student of future applications of scientific principles, are not seldom the gems of thought, in which are latent the immense fortunes and interests created by the inventor.

It may be truly said of the philosopher, that as soon as the pecuniary or personal value of his science becomes prominent in his mind, his spiritual force is weakened. He is properly a coadjutor, and not a rival, to all who are engaged in the good work. It is his duty to assist, not to supplant. To strive for the best that is attainable, with gratitude but without desire for approbation, and also without fear of censure, must be the life-law of the man of science, as it must also be for the artist and for the religious teacher.

If time permitted, I would be glad to mention to you what I conceive to be the proper functions of scientific Societies, and the claims they have upon popular sympathy and assistance. They are in a strict sense neither oral teachers nor custodians; but to use the phraseology of Smithson, so happily interpreted and applied by our venerable (in its true sense) associate, Prof. Henry, "institutions for the increase and diffusion of knowledge among men."

I could show, by many examples, how, by departing from this simple path of duty, the resources of Societies have been crippled, and their usefulness paralyzed by indulging in the fascinating luxuries of large museums, and ornate architecture. The former should be under the protection of Governmental assistance, or in the care of largely endowed institutions of learning. Voluntary contributions and unpaid labor can never support a museum which is rapidly growing; nor do such collections fulfill their functions except as appendages of Universities. They soon degenerate into imperfectly classified storehouses of curiosities, occasionally visited by students desiring to verify types which have been imperfectly described. Though an investigator can be assisted, I have rarely known one made by the influence of a large museum. The material is too vast for the use of a beginner.

The true life of scientific Societies resides in the zeal of the members, the completeness of the library, and the facilities afforded for publication. The objects for study lie everywhere around us and in us; and, as Prof. Agassiz told me, many years ago, the most familiar objects, and those most frequently scrutinized, will give the most important results.

If I have correctly exposed to you some of the influences which science can exert upon daily life, it is just to infer that upon the results of the labors of investigators (the accurate observers, and the correct interpreters of the phenomena of the Kosmos), future generations will rely for:

1st. The emancipation of religious teaching from the shackles of traditional superstition; the promulgation of reasonable dogma, and firmer adherence to correctly defined morals.

2d. The reform of the practice of the law in stricter accordance with the principles of substantial justice.

3d. The rational directions of primary education, so as to cultivate the observation and the judgment of the pupils.

4th. The increase of comfort, the suppression of disease, and the prolongation of life, by the natural outflow of commercial applications of scientific truths now, or in future, within the reach of man.

5th. The reformation of many departments of general and local governments, by the appointment to offices, requiring scientific knowledge, of men qualified to perform the duties; and in truth, by a cheerful recognition of the fact, that men of science are not inferior to ordinary men, either in capacity or integrity in the transaction of business. It has become too much the habit of unthinking persons to confuse the earnest student of progressive science, the man of practical thought, who often makes a life-long sacrifice of "such things as men possess,"* with the inventor; who with eye to prospective profit is sometimes led into visionary schemes, based upon imperfect information, or into attempts to prematurely introduce contrivances, well devised perhaps in principle, but not needed for the present desires of the community.

And it is my firm conviction, under the Providence, which presides over, and directs the system of Evolution, that none of these reliances of humanity will be vain.

9. *Daily and Periodical Literature,*

Mr. W. V. McKean, Philadelphia.

"To aim at learning without books, is with Danáides to draw water in a sieve."
—*R. Williams* (1639).

Mr. McKean, after a few playful observations expressing his astonishment at finding himself set down for a speech in the pretty little book containing the menu and the programme, when he had decidedly asked to be excused from speaking upon the valid ground that he, being among the youngest of the American Philosophers present, preferred to

* Müller, Sacred Books of the East, I, 78.

listen to the Sages of the Society, and, after referring to the subject assigned him as being far too large for the ten-minute rule sagaciously adopted by the Committee, continued as follows:

Mr. President and Gentlemen:—With your permission, I will change the subject. When I found that I was actually booked to speak, I gave very close attention to what was being said, in the expectation that some one of the speakers, by a chance word, would furnish me with a theme. President Gilman supplied the topic in his mention of the name of Benjamin Thompson, more widely known as Count Rumford, the American founder of the Royal Institution of England. A great deal has come to the world from that institution, though Count Rumford had not much money of his own to conduct it with, and did not succeed in obtaining much from others, but it is worth while to consider what the world has gained by the simple endowment of a chair for original research in that institution as compared with the outcome from institutions with princely endowments in this and other countries, where the money has been largely expended in stately architectural structures.

Let me illustrate. It happened once to me to make a visit to a neighboring city (I won't say what city) with a very dear friend of mine, who had endowed a university. Not far from our hotel on that occasion, was an institution that had also been endowed very largely by an eminent American. If I mistake not the amount of money that was put into the building and its equipment was about half a million of dollars. I went into it with the son of the gentleman whom I speak of, and found there a library, rather choice. but not very large. But in looking around its shelves I saw but few books that were not upon the shelves of other libraries in the same city. There were five persons in the library at the time looking at the books. We passed out of that and went into the basement, and there we found an orchestra playing some very fine scientific music, and in front was an audience hardly more numerous than the orchestra itself. There were perhaps forty persons there, mainly ladies, and from their appearance belonging to wealthy families living in the neighborhood of that building, every one of whom could have paid for that sort of luxury. There was the result of an endowment of half a million of dollars! A stately and expensive building—a library that was not better than other libraries in that town, and an orchestra playing scientific music to people every one of whom could pay for it themselves and for their families! Certainly that was a very meagre result for that much money.

Well, gentlemen, similar results may be seen in other parts of this country. There are a great many magnificent structures put up from these grand endowments. The first thing the trustees appear to have in their minds is to employ an architect to put up a monumental structure which drains the fund nearly to the bottom, and after that comes what? Poverty. Poverty in the administration, *nil* as to the results in the way of promoting and diffusing useful knowledge among men. I won't go over them, you know where these buildings are and what the results are.

Let me now return to President Gilman's mention of Benjamin Thompson (Count Rumford), a Massachusetts man, who left this country about the beginning of the Revolution because his neighbors disputed his loyalty. He was a man of the Franklin type—an inquiring man, an investigating man. Nothing passed before him that he did not want to know something more about it. Even a wheelbarrow was not beneath his notice. He would investigate a lamp, or a stove, or a kitchen, or a smoky chimney, or the phenomena of heat, or light, just as Franklin did. Through his efforts, with some of his money and what he could induce a few others to contribute, the Royal Institution of London was founded, and he left at his death some money for medals as prizes for original research. I hardly agree with President Gilman that the best result of Benjamin Thompson's gifts and legacies came out of the Harvard medal and other prizes. In my judgment the best results that came out of Rumford's work was the Royal Institution. It was not provided with a grand architectural home at the expense of the foundation fund. I do not know what kind of housing it has now, but for a long period of its career it had a very plain habitation, and yet from that small amount of money given, or procured to be given, by Count Rumford to that institution, we have Sir William Young, Sir Humphrey Davy, Michael Faraday and John Tyndall, and all the progress in useful knowledge they have given to the world. No money was wasted there upon a structure. He simply, with the aid that came to him and to his idea, provided and endowed a chair in which a man of philosophic mind, a man with a turn for scientific investigation could give his whole time to original research, the sort of investigation that has moved the world along. It was not required that the man who occupied that chair should be occupied all night long as a teacher, in getting up his lectures for his class; it was not required that the occupant of that chair should be subjected to the drudgery of life—to earn money by which his family was to be supported. But there was an endowment, a small endowment, which gave to its occupant a sufficient sum of money to carry him along, and he was not required to do a thing except to carry on investigations in the line of original research; and the outcome to the world are the four magnificent characters named a little while ago, with their grand results in chemistry, electricity, physics, and natural sciences generally.

That is an example for us in these days in this country. There has been in this room to-night a man who ought to have been the Pasteur of the United States if he had been provided for, as those men were in the Royal Institution, and it would have taken but little money to do it. There has been a man here to-night if he had been taken care of in the same way, and if he did not have to go through the daily drudgery to earn money to take care of his household, would have been, and has the ability to be the Faraday of the United States. We do not provide as many of that kind of men for the world as we ought to do in this country. I am not unmindful that we have students in this country who are very distinguished; I am not unmindful of the Le Contes, Leidys, Copes, Marshes, Newcombs, Drapers, Mitchells, Rutherfords, and others, but we do not give to the world as many as we ought, and we do not do justice to the men whose names ought to stand in emulation with those of men in other countries like Huxley, Pasteur, Helmholtz and Tyndall in this day in England and on the continent of Europe. It would not take much money to do all this, very little money indeed. The example set by Benjamin Count Rumford is an example to be commended and remembered, that ought to be made known far and wide as far as the influence of the members of the American Philosophical Society can reach. Endowed chairs for original research in which to place our able men, are the equipment for our day—chairs so endowed that the occupants shall be relieved from the drudgery of teaching and the necessity for this day's work to pay for the next day's living. We have able men who need no more than this to place them as peers in the promotion of useful knowledge with the best in the world. This plan, gentlemen, is, in my estimation, worth more to the country and the world than all the monumental buildings for university and college purposes in all our land, and it costs but a tithe of the money. President Gilman can get as good and beneficial work out of the old warehouses—the old buildings and back kitchens—in which the Johns Hopkins University is now housed, as he could if it were housed in the Capitol at Washington. The one building and equipment to which I have already referred cost as much as it would to endow ten chairs, and its outcome is not, or not long ago was not, equal to a tenth part of what came from the chair Michael Faraday occupied.

I thank you, gentlemen, for your attention.

10. *The Spirit of a Philosophical Society*,

Prof. J. P. Lesley, Philadelphia.

"Science moves, but slowly slowly, creeping on."—*Tennyson.*

Professor Lesley, in response, said:

The serious and the gay things of our existence are so blended in our experience as individuals, that a very slight apology will be demanded of me, if, on this joyous occasion, I venture to suggest a few grave topics of reflection.

We meet as members of a Society which boasts of venerable antiquity—after an American fashion—or rather on an American scale; a boast which would certainly be ridiculous were it made in the city of the Pharaohs, or the city of the Cæsars, or at Aix la Chapelle, or almost anywhere except in the city of William Penn.

Let us suppose, however, that we were (as a Society, I mean) one thousand years old instead of one hundred. What real difference would it make? We should be invested perhaps with more vanity, but with not a whit more faculty: nor be a whit less responsible to our own exertions for practically translating pride into power.

I take it that perhaps the crowning beauty of human history lies in the essential identity of mankind of all ages. So far as thought is concerned there is nothing *new* and nothing *old*. The ancients proposed the same problems to themselves that we do; wondered at Nature as heartily and helplessly as we do; questioned the gods in precisely the same spirit (though by means of different apparatus) in which we question the forces; found the same excitement in the struggle for existence, and the same repose in old age. Temperance, justice and family love were then as now the acknowledged palladia of society; while the older sages stood upon the same platform of philosophical indifference to circumstances, and confidence in the resources of a free will for all purposes of offence and defence against evil, from which the philosophical minds of our nineteenth century now preach tolerance for opposition and trust in the order of events.

Neither is the difference greater between climes and races than it is between generations and ages. There have been Turanian as well as Aryan philosophers; and their scriptures are so like in spirit that they might have been written in the same alphabet.

On the other hand: while God has made thus of one blood all the dwellers upon earth, the diversities of individual character baffle our comprehension. In one and the same family the physiologist and psychologist may find—not merely representatives—but exaggerations of the different human races: in feature, tendency of affections, modes of thought, and lines of practical pursuit.

A philosophical society like ours, dating far back—representing in fact the traditions of the middle ages, and the ages beyond them—composed at first of emigrants or the sons of emigrants from every nation in Christendom beyond the seas—established on no narrow or special basis, but consecrated to the diffusion of useful knowledge as a whole and in all its forms—absorbing into itself all coming tendencies, informations, systematic developments of the ideal and of the practical, like a fertile farm sown every new year with fresh seed and every year yielding a new, fresh harvest—surely such a Society is one of those fair phenomena of Nature over which the poet may sing his most exalted strain, while the philosopher invents for it his freest and finest hopes.

We celebrate, then, the birthday of a living being, to which a hundred years is but as one year, and which in one year may live an hundred.

We celebrate the creation of one of those immortal things of this world which have beginning, but which need not have an end. Political dynasties, like families, expire; but scientific societies should be ignorant of the possibility of death. Like ecclesiastical organizations, they recruit their wasting tissues by a perpetual renovitiation; but, unlike ecclesiastical organizations, they run no risk of becoming fixed and hard; their tenets can never become effete, for the basis of their life is the old ever being made over new—truth out of truth, a thousand times reverified, improved, self-illustrated and self-luminous. Growing with the growth of the world, and of man, and of knowledge, the freshest blood of each successive generation courses through their veins. For them the past is rectified in the alembic of the present. Like the mountains they grow gray without growing old. Like the immortal gods, they are not subject to the decay of memory; nor can their wealth become the prey of robbers.

We celebrate to-night the proofs of the immortal youth of our Society.

Nevertheless, the despotic law to which all living beings are subjected is the same for them all: they must eat; and their food must be wholesome.

This is the topic of reflection which I wish most to intrude into the menu of this festival.

Who is to feed our Society? or, rather, with what food is it bound, by the laws of life, to feed itself? For, all nature shows us that only invalids are fed by other hands than their own. Let us feed ourselves. I appeal to every member of the Society to judge between him and it, whether he has felt this necessity. I ask you to consider—to frame in a picture—what our stated meetings would be like were we to come to them as people come to a picnic party, each one with a hamper of savoury viands to swell the common feast. I see around this table lawyers, doctors, clergymen, naturalists, mathematicians, poets, artists, merchants, mechanicians, politicians and philanthropists (which are, of course, one and the same)—every one of whom has been taught fine things of (and by) his self-elected art or profession. One hundred and fifty such members reside within walking or riding distance of the Hall. Only thirty meetings are held in the year. If, then, each member of the Society would—only once in five years—skim the thickest of the cream from his milk pans, and make a bold (or a shy) present of it to the Society, it is quite evident that every year of its existence would be a twelve months' festival.

Gentlemen, the Hall of the Philosophical Society is no club-house. It is a rendezvous for thinkers. Its Society is a republic of men who have inherited knowledge—who have themselves manufactured and sold knowledge—who are more or less disciplined to tell what they know—whose function it is to diffuse true information—whose very nature it is to be hungry for truth, jealous for the truth, thankful for the truth, proud of the truth, believing and trusting in truth as the alpha and omega of the principles of things animate and inanimate, and apt in the use of all the truth they can get for the conduct of life.

Let me say a word of the spirit which should characterize a Philosophical Society like ours.

When I began to attend its meetings many years ago—I was an ardent young man then—the first thing that struck me was the coldness of the room. I do not mean to conceal the fact that there was a bright anthracite fire in the grate on winter nights. But when anything too earnest or a little enthusiastic was said, there was not only no applause, but commonly no response. Chilling silence like a fog fell upon orator and audience. Among the elders I could notice a great regard for forms and precedents. Certainly a younger man was always respectfully listened to, but somehow or other he seemed to have no heart to speak again.

The meetings, too, were often as short as they were formal, an adjournment was moved as soon as might be after the minutes, obituary notices and nominations had been attended to. Then a few old cronies would gather around the fireplace, and the real meeting would apparently begin. There was little or nothing strictly *philosophical* to stay for; but racy anecdotes and sometimes very clever jokes would go round the semi-circle; and a good many of them made my young unhardened cheeks burn.

Is it possible, thought I, that men the report of whose wisdom and learning is in every mouth—for whom all the seed of past ages has been sown—to whose eyes the mysteries of the universe have been in part unveiled—for whom the awful future waits—can turn so noble an institution as this into a jest? Can these portraits on the wall fail to restrain levity and arouse enthusiasm? Is such air as this to be spoiled with the odor of earthiness? I understood it better after hearing the sad story of the Chinese Museum speculation, which had swept off like a flood all the savings of the Society and left its Library and Cabinet in the sheriff's hands. I cannot help wishing the whole of this story were written and published for the warning of the members in future years, a perpetual protest against all attempts or suggestions to alter the thrifty policy of the Society, and a cogent argument against the founding of a museum or the erection of a pretentious edifice.

But my allotted time is out. I have missed the track of my remarks. All that has passed away. Our meetings now are as full of life as they seem to have been in the days of Franklin, Rittenhouse, Hopkinson, Hutchinson, Samuel Vaughn, Ewing, Rush, and Timothy Matlack, a hundred years ago. And the life of our meetings is genial as well as dignified. Every wholesome and thoughtful utterance is openly welcomed. Perfect equality, cordial friendship and honest science seem to make our evenings what they should be. Yet I sometimes wonder whether the traditions of five and twenty years ago do not yet linger about us and prevent our fellow-members from waking up to the knowledge and appreciation of the case as it now stands. Surely more of them would then attend the meetings, bringing their best thinkings with them. Is it an idle fancy that every one of our meetings *might* be made a good deal like this one?

The spirit of a Philosophical Society should, as it seems to me, have two elements of character. It should be generously catholic; and it should be both critical and exclusive in regard to both persons and papers.

These are, in fact, the two poles of human excellence, both in thought and feeling. The first bestows liberty; the second guarantees honor and security.

I cannot end without noticing a strange prohibition in the usage, if not in the laws, of our Society, which forbids the discussion of questions of religion and questions of politics. In past times this may have been an excellent safeguard against dissension and perhaps dissolution. But it seems an odd attitude for a Philosophical Society to maintain now-a-days.

Can there be a philosophy which does not concern itself with religion and politics? Yes: a philosophy resolute in shutting its eyes to all of the universe which does not consist of brute matter. Good then! let us resolve our Society into an association of physicists and naturalists.

For my part, as I believe in God as much as I believe in man, and in a commonwealth as much as in a geological formation, my idea of a Philosophical Society is, that its members should busy their brains about *all* truth, temporal and eternal, material and spiritual, formal and essential: interrogating the past, the present and the future: in a spirit neither weakly catholic and generous, nor harshly critical and exclusive.

I beg leave therefore to offer this toast: May the spirit of the American Philosophical Society ever be reverent toward God, generous for opinions, critical of facts, and benevolent towards mankind.

At the conclusion of Prof. Lesley's address, Mr. Fraley arose and said:

The hour of adjournment has now arrived. I congratulate you upon the success of this celebration, and I hope that when those who are to come after us celebrate 1943 and 1980, they will have as good a dinner as we have had, and, excepting what I have said myself, as good speeches as those to which we have listened.

Adjourned.

INDEX TO VOLUME XVIII.

Stated Meetings Held.

New Members Elected.

* Members who have accepted by letter. † Members who have taken their seats.

Members Deceased.

Obituary Notices Read of

Photographs of Members Received from

Diplomas Received and Acknowledged by

Pending Nominations Read.

*[1] Obituary notice to be prepared by Dr. Hayes Agnew.
*[2] " " " " " Mr. Peter McCall.
*[3] " " " " " Prof. R. E. Thompson.
*[4] " " " " " Mr. Moncure Robinson.
*[5] " " " " " Mr. Frederick Fraley.
*[6] " " " " " Hon. M. Russell Thayer.
*[7] " " " " " Dr. Henry Hartshorne.

Regular Business.

Occasional Business.

Special Donations.

Correspondence.

ERRATA.

Page 327, line 15 from bottom, for *meaning* read *meanings*.

Page 451, line 17 from top, for *currents* read *current*.

Date Due