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TRANSACTIONS

OF THE

New York Academy of Sciences.

October 1, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-four persons present.

The resignation of Prof. T. EGLESTON as member of the Council was received, and Prof. H. L. FAIRCHILD was elected in his place.

Dr. NEWBERRY spoke on the subject of his travels and observations in the West during the past summer.

Prof. D. S. MARTIN referred to a visit recently made to Trenton, to examine the stone implements found by Dr. CHARLES C. ABBOTT in the Glacial gravels in the vicinity of that city. On his motion, Dr. CHARLES C. ABBOTT was then elected a Corresponding Member of the Academy.

Prof. MARTIN then read, by title and abstract, a paper, by Prof. THOS. EGLESTON, on

THE PATIO AND CAZO PROCESSES FOR THE AMALGAMATION OF SILVER ORES, USED IN MEXICO AND CHILI.

(Printed in the Annals, Nos. 1 and 2, Vol. III.)

Dr. B. N. MARTIN exhibited a specimen of crystallized chloride of silver from Canada.

Dr. N. L. BRITTON exhibited specimens of zeolites, associated with native copper, and of sulphide of copper from the Isle Royale Mine near Houghton, Mich., and a large and regular pseudomorph in chlorite after dodecahedral garnet.

The PRESIDENT remarked that the Isle Royale Mine was the second locality in the Lake Superior region at which the copper sulphide has yet been found. The carbonate and silicate of copper occurred there only in crusts, while the native silver and copper, whose abundance is well known, are precipitates from chemical solution by electrolysis.

Prof. MARTIN mentioned the recent death, at Hamburg, of Dr. THEODORE H. TELLKAMPF, a member of the Academy, and referred to his valuable studies and papers on the ascidians of our coast.

Mr. A. R. CONKLING briefly explained the Patio and Cazo processes for amalgamating silver ores.

The PRESIDENT suggested that the costly mills and stamps, now used for reducing silver ores, must give way largely to simpler and cheaper machinery and methods employed in the leaching process.

October 8, 1883.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-five persons present.

Mr. B. B. CHAMBERLIN exhibited a specimen of graphite from a boulder found on the bluff at Weehawken, the first discovered in the vicinity of this city, and probably derived from the outcrop at Bloomingdale, N. J.,—also specimens of graphite from Hull, Canada; Mr. G. F. KUNZ, a curious specimen of capped or penetrated beryl, in which a pyramidal crystal of that mineral was enclosed within another of the common hexagonal form, from the topaz locality at Stoneham, Me.; and the PRESIDENT, a specimen of native lead from the Wood River region of Idaho, the mineral occurring in the upper portions of the veins, associated with red oxide of lead, and solid unchanged galena, in masses of quite unprecedented size.

The recent death of a Resident Member, Mr. H. G. CHAPMAN, was announced, and also, in last August, of Mr. EDWARD PRIME of Riverdale, one of the early members and a subscriber to the original building fund.

A paper was then presented by Prof. WILLIAM P. TROWBRIDGE, illustrated by diagrams, on

TORNADOES.

DISCUSSION.

Dr. A. A. JULIEN recalled the careful observations and hypotheses of Redfield and Espy, according to which the initiation of a tornado depended upon the ascent of a rarified column of heated air. The subsequent conflict of opposing currents, and the continuance and development of the central area of diminished barometrical pressure, seemed to be, however, but the secondary phases of the phenomenon. In illustration he described a similar class of facts observed in the birthplace of the hurricanes of the tropics—the great marine plain of the Caribbean Sea—during the " hurricane season," from July to September of every year. There, as over the Western plains of our continent, the atmosphere becomes strongly heated by the fervid rays of the sun, quivering with ascending currents over the broad sheets of naked and white coral limestone which forms the plateaus or rims of many islands. Over the sea, heaped up and swelling cloud masses of cumuli mark here and there the ascent of a strong aërial current, and at times numerous waterspouts project toward or down to the sea in all stages of formation. Of these he had observed one or two dozen, visible at the same time, while residing on the Key of Sombrero, and also while voyaging through the Mona Passage. On one occasion a waterspout approached the precipitous eastern cliff of Sombrero, within a distance of five hundred feet, before it suddenly broke and disappeared.

Even on the land the same ascensional tendency is frequently shown by the passage of whirling dust columns, catching up sand and light objects in a funnel-shaped, whirling shell, sometimes fifty to a hundred feet in height. So gentle is the breeze in which these whirling columns are developed that they move quite slowly along the level surface of the ground. A person can manage to walk at an ordinary pace within the centre of the whirling current, and can distinctly exhibit its tangential velocity and the form of the whirling shell by suddenly throwing into it a quantity of fragments of paper or similar light material. All these phenomena are produced in a still atmosphere, or among very gentle breezes from easterly points ; but it is important to note that the rising of the wind, especially from opposite points, occurs rarely at such a season, and seems to indicate the second stage of atmospheric disturbance—the beginning of a hurricane or cyclone.

Mr. H. L. WARNER inquired as to the cause and mode of origin of the extreme ascensional velocity at the centre of the tornado, and of its enormous lifting power and circular motion, since he could not understand how the force at the centre could exceed the pressure of a vacuum.

Prof. W. P. TROWBRIDGE replied that in a cyclone the motion, which in the Northern Hemisphere proceeds from right to left, comes from the motion of the earth. In whatever direction a body may be moving along the surface of the earth, a tendency to deflect it to the right is caused by the earth's motion. Aërial currents flowing toward a central point thus become deflected, and a rotary motion ensues. In a cyclone, therefore, the currents of heated air rushing from opposite directions result in an ascending current, surrounded by a rotating column, both of extreme velocity.

The PRESIDENT remarked that he had been much in the arid regions of the West, as in Arizona and Nevada, where the sun's rays produce intense heat, with violent currents of wind and numerous eddies or "whirlwinds." This action was often observed in running water, as shown by the whirlpools, which possess far higher velocity than that of the main eddy. So in this arid region frequent contrasts of currents of air occurred, generating at the points of junction local whirlpools of great velocity.

He regarded the statistics that had been published, in relation to the occurrence and number of tornadoes, as likely to mislead. The atmospheric conditions were much alike in most of the States of the Mississippi valley, and it is probable that if observations on the occurrence of tornadoes should be carried on for a long time, perhaps for some centuries, closely agreeing results would be obtained.

He described the phenomena of a tornado in Ohio in 1847, by which not only fences and houses were destroyed, but half-buried logs were torn up out of the ground, a plow carried along by the wind left a spiral furrow, and chickens were almost completely stripped of their feathers.

In the forest-covered region east of the Mississippi, winds are more obstructed and less violent, and tornadoes are probably less common than on the prairies, but are not unknown. Many have been recorded since the country was occupied by the whites, and many more are self-registered in the tracks they have left in the forest. These tracks are known as *windfalls*, and every woodsman is familiar with them. They are passes opened by whirlwinds, which, for a longer or shorter distance, and greater or less breadth, have prostrated or twisted off the trees. In Ohio and Michigan hardly a township is without them, some recent and some very old, for such a record would hardly be obliterated in a hundred years. Their number proves the frequency of the occurrence of wind-storms, and that no part of the country was exempt from them. As the number of towns, villages, and farmhouses increases, storms attract more attention, as they cause destruction of property and loss of life ; but we have no reason to suppose they are more frequent now than formerly, and they are liable to occur in all parts of the United States. If the early settlers of the forest-clad region had made notes of the windfalls they had observed, we should have a more interesting meteorological record, and one which would add much to our knowledge of the distribution of these fearful phenomena.

October 15, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-four persons present.

Prof. O. P. HUBBARD stated that he was one of a large party of business men, chemical experts, and the Chinese Legation at Washington—invited on the 10th inst., by the Rio Grande Sugar Company, to visit their plantation and refinery, situated about five miles north of Cape May, N. J.

The region is of a light sandy soil, of which there is an immense area in East New Jersey and the sea coast of Delaware and Maryland. The plantation contains 3,000 acres, and 73 were in crop of the Early Orange and Amber varieties of Sorghum, which, notwithstanding a long drought, seemed well developed and matured. All the processes of the manufacture, with improved machinery, were in active operation—from the entering of the cane to the rollers, defecation of the juice, and boiling the syrup in open and vacuum pans, to the crystallization and separation of the sugar by the centrifugal process into a yellow and a white variety, ready for market. The State of New Jersey wisely aids this important industry by a bounty of $1.00 a ton on Sorghum thus raised, and one cent a pound on all sugar manufactured from it.

Prof. HUBBARD exhibited several heads of the seed of the Early Orange and Amber varieties of Sorghum, and specimens of crystallized white and yellow cane sugar, manufactured from the plants raised by this Company.

Mr. A. H. ELLIOTT referred to the mode of development of the beet sugar industry in Europe. In England, the product of sugar, obtained from the sugar-beet, had been raised to seventeen or eighteen per cent. Half of the sugar of the world is now derived from this source, and the earlier stages of its introduction resembled very much those which now attend the development of the Sorghum industry.

The Vice-President, Dr. B. N. MARTIN, remarked on the introduction of the sugar-beet, many years ago, into Massachusetts, by means of seed imported from France. The plant thrived, and the root was rich in sugar; but the industry met with an insuperable difficulty in the fact that the farmer found the product more valuable for feeding stock.

The PRESIDENT stated that he had seen thousands of acres of Sorghum, in Missouri, Kansas, etc., and that we hardly realized the importance of this industry in many parts of the country west of the Mississippi. The cane was liable there to be overtaken by untimely frost, by which the profits of the crop were often lost. The crop there has been thus injured this year to such an extent, that in many places only syrup can be made from the canes. Sorghum can be successfully cultivated in all the Middle States by a proper mode of planting and choice of varieties. Its product, for a long time, consisted only of a syrup which had a peculiar flavor, earthy, raw, and offensive at first; but this has been since removed by improved processes, though the mode of manufacture is somewhat complicated.

Mrs. E. A. SMITH exhibited a series of interesting specimens of siliceous sinter and of silicified wood from the Yellowstone region. In regard to these, the PRESIDENT explained that similar specimens of silicified wood were abundantly found in the Bad Lands. Their geological position is in the Tertiary and near the top of the Cretaceous formation. They are generally of coniferous wood, and represent trees similar to the gigantic Sequoias of California, which, in the Tertiary and Cretaceous ages, formed forests which contained many splendid forms of arborescent vegetation, now extinct, as well as the finest of our living forest trees, and covered all the continent to the Arctic Sea. Floated down the ancient rivers of the country, and buried in the silt which accumulated in the bottom of great lakes which once existed there, they were subsequently replaced by silica, particle by particle, so that the structure is often perfectly preserved. In Yellowstone Park is a veritable petrified forest of such trees, successive generations of which were buried under volcanic ashes and mud, like that which covers Pompeii, and were in part silicified standing.

The specimens of the deposits of the geysers and hot springs of the Park, exhibited by Mrs. SMITH, are of two kinds; one, silicious (geyserite), from the geysers; the other, calcareous, from the "Mammoth Hot Springs." The first kind was produced by the action of hot water on a silicious volcanic rock (rhyolyte); the second, on limestone, which underlies the northwest corner of the Park. A third kind of deposit is seen in the "paint pots" and "mud geyser" of the Norris basin, a pink or white clay, apparently derived from the feldspathic portion of the decomposed rhyolyte, the quartz having been dissolved out. The clay in the paint pots is sometimes highly colored, forming a pasty or semi-fluid mass in a state of constant ebullition from escaping steam. The deposit of calcareous tufa, from the Mammoth Hot Springs, is quite rapid, coating objects, like the horse shoes and other things shown, with a film an eighth of an inch thick, when they are immersed in the water for two or three days.

The PRESIDENT exhibited specimens of brilliant anthracite, sent by Mr. M. C. READ, Corresponding Member of the Academy, residing at Hudson, Ohio. They are reported to come from Hastings Co., Canada, a region underlain by Laurentian rocks. If this report is correct, they are probably the residue of the spontaneous distillations of petroleum, like the asphaltic anthracite of the Calciferous sandrock of Herkimer, in New York, and of the Utica shale at Canajoharie.

Mrs. JAMES WELD exhibited some peculiar crystals of carbonate of lime from Fort Laramie, Wyoming Ter.; hexagonal prisms, 1 to 2 inches wide, $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, with bevelled edges; the form of aragonite, with minute and partial internal rhombic cleavage of calc-spar—probably aragonite changing to calcite.

Mr. N. H. DARTON read a paper

ON THE STRATA OF INDURATED SHALES BETWEEN BERGEN HILL AND THE PALISADES, N. J.

Prof. DANIEL S. MARTIN then spoke on the subject of

THE TRENTON (N. J.) GRAVELS, AND THEIR CONTAINED IMPLEMENTS, AS BEARING ON THE ANTIQUITY OF MAN.

(*Abstract.*)

After reviewing the general facts regarding prehistoric archæology abroad, as to the differences between palæolithic and neolithic implements, the speaker passed to the study of similar objects in this country, with special reference to the discoveries of Dr. C. C. ABBOTT in the river gravels at Trenton, N. J. During the past summer, the speaker had visited the localities near Trenton, and had conference with Dr. ABBOTT on the whole subject of his studies thereabout. (A black-board map was here employed to show the position and limits of the "river gravel" along that part of the Delaware Valley, in distinction from the earlier "yellow gravel," probably marine Tertiary, which covers much of the region of Southern New Jersey.)

Dr. ABBOTT had long been interested in gathering the Indian relics (neolithic and modern), which are found in great abundance on and near the surface of the country all about Trenton. Some years since, after reading the works of Sir JOHN LUBBOCK, he began to pursue the study more systematically and with growing enthusiasm, having entered into correspondence with Sir JOHN LUBBOCK, and sent him from time to time specimens of the implements, to the number of many hundreds. In this correspondence and study, it soon became apparent to both gentlemen, that a marked difference existed among the specimens. The majority of them were of the ordinary "Indian arrow-head" type, fairly wrought from flint, hornstone, or quartz; but a few were found of much ruder shaping, and made of a dark, compact argillite. Careful search and comparison soon revealed the fact of a corresponding difference in the mode of occurrence of these two forms, the ordinary ones being found on or near the surface, in ploughed fields, etc., while the rough argillite specimens were obtained only at a few points along the immediate river bank, and had, to all appearance, fallen or been washed out of the gravel bluff, which is some 30 to 50 feet high. Upon this, Dr. ABBOTT made his first published announcements of the discovery of remote pre-Indian relics in the river gravels, and connected those beds with the floods derived from the melting ice of the Glacial period.

So important a claim, naturally, was not suffered to pass unchallenged. The objection was raised at once, that proof was lacking of the actual occurrence of these implements in the gravels proper,—that they might have been washed down from the surface. The next stage of the investigation, therefore, was to search for the implements *in situ;* and it was not long ere they were successfully discovered, imbedded in, or projecting from, the gravel-bank, at depths of several feet below the present surface of the country. About this time, the Pennsylvania Railroad Co. began excavating and cutting away the gravel-beds at several points near Trenton, thus exposing large and fresh sections of perfectly undisturbed material, and affording greatly increased facilities for exploration. Dr. ABBOTT was not slow to improve the opportunities thus brought, as it were, to his very door; and he soon began to find implements in these railroad cuttings, of the same style of material and of workmanship as those previously found in the river bluffs. There was now no possible doubt as to the important fact that rude palæolithic implements are truly contained in, and throughout, this dark stratified gravel of the Delaware valley, and that they furnish probably the earliest traces of man in eastern North America.

The most interesting part of the problem, however, yet remained to be solved. Of the facts there was no question. Implements of peculiar type, large, rude, and wrought from a hard, compact argillite, are characteristic of, and confined to, this gravel. The gravel bears the clearest evidence of its deposition from flowing water, the cross-bedding, etc., being frequently very finely displayed; and its well-rounded stones and pebbles have the flattened form distinctive of river wear, and are derived from the rocks higher up the Delaware valley. But when was this deposit formed, and what relation does it bear to the geology of the region?

It was impossible not to connect these palæolithic gravel-beds with the great Ice age; and Dr. ABBOTT, as above stated, had already done so, judging the deposit to date from the vast flood of cold water that poured through the valley of the Delaware during the time of the melting of the ice-sheet of the true Glacial period. Of course, this carried back the human occupancy of the country to a very remote antiquity.

At this stage of the investigation, a somewhat related, but wholly independent, series of observations was begun and carried on by Prof. H. CARVILL LEWIS, of Germantown, Penn., in connection with the Geological Survey of that State. Dr. ABBOTT'S work had been properly archæological, and chiefly confined to the local deposits at and near Trenton. Prof. LEWIS, on the other hand, took up a line of observation strictly geological, and ranging over a wider field, in the study of the surface-deposits of Eastern Pennsylvania. It now appears that facts have been developed in this way that could not have been gained from the Trenton region alone; and thus these two accomplished workers have supplemented each other's results, and conclusions have been reached which rest on independent, yet concurrent, evidence.

In the Old World, the distinction has long been familiar to students of ancient glacial phenomena, between an earlier and a later Ice-period, —the first, a great continental prevalence of arctic conditions, with a general movement of the ice-sheet southward; and the second, a less extreme and extended development of cold, showing itself, however, in local glaciation, in which all highlands and mountains became centres of glacial action. These two periods are distinctly separated by a milder "Interglacial" epoch. But this twofold character has not been so clearly recognized on this side of the Atlantic, although some evidences of it have been coming to view of late. Among the most interesting features of the study of the Delaware valley, is the clear and satisfactory indication that it has now given of the distinct existence of the two Ice-periods, here as well as abroad.

There was nothing at Trenton to show this fact. The gravels there were plainly of Glacial age, as above stated; and that was all. But on studying the deposits of the Delaware valley lower down, near Philadelphia, the important fact comes to view that the continuation of the Trenton gravel there rests upon, and is distinct from, a series of deposits which are unmistakably those from the melting of the great ice-sheet. To Professor LEWIS is due this most interesting discovery. He has given the names of the "Philadelphia Red Gravel," and the "Philadelphia Brick-clay," to the two members into which these lower ("Champlain") deposits are divided, and has described their characteristics quite fully and clearly. Over these, and evidently later, is the dark-colored Trenton gravel, more fully developed higher up the valley, and containing these earliest human implements.

It appears, then, that we have at Trenton a deposit, ancient indeed, but not so far back in time as was at first supposed. The presence of man during the second Glacial period in Europe is abundantly familiar; and the earliest remains there found certainly take us back to the preceding Interglacial time. The relics found in the Delaware gravels, therefore, are not so ancient as those of the earlier Palæolithic of the Old World, but correspond seemingly with those of the "Reindeer Epoch," a period of cold climate, in which the animals now withdrawn to the Alpine heights and the Northern latitudes, ranged over Central Europe, and when man lived and hunted and fished in a sub-arctic life, much as the Eskimo people do to-day. Prof. LEWIS has, therefore, suggested the name "Eskimo Period," as a designation for this time. He is disposed to think that the rude people who wrought and used these argillite implements by the banks of the icy-flooded Delaware were near of kin to the present occupants of Arctic America. This view, it may be added, gains interest and force from the indications gathered from the early Northmen's recorded visits to the New England coast, at which time it would seem that the natives whom they encountered were not the Indian tribes, but a people similar to the Eskimos,—a race which had completely disappeared in the four or five centuries that passed before the English discoveries and settlements. At any rate, however, we may accept the term Eskimo period as happily and justly applied to the second Glacial epoch on this continent, now clearly distinguished.

The paper was illustrated with specimens showing implements of both types from the locality referred to.

DISCUSSION.

In reply to inquiries by the PRESIDENT and Prof. FAIRCHILD, Prof. MARTIN stated that all the stone implements now discovered are added to the main collection at Cambridge, Mass.; but nevertheless Dr. ABBOTT possesses a considerable number, many of which present well-defined forms.

The PRESIDENT expressed great satisfaction with the clear account of this interesting locality given by Prof. MARTIN. There would seem to be no doubt of the genuineness of Dr. ABBOTT'S discoveries. Rude flint implements had certainly been found by him in the Trenton gravels, but these were postglacial in date, or at least formed by the drainage of the glaciers in their retreat, and hence not older than the river gravels of Europe which contained the oldest remains of man yet discovered there. The interval between the date of deposition of these gravels and the present time could not yet be expressed clearly, but it must have covered many thousands of years. This view would be repugnant to some who held to the conventional six thousand years which have been generally supposed to include all the time of Man's residence on the earth, but no one's faith need be disturbed by it. The chronology of the Mosaic record has always been a matter of discussion and difference among scholars and theologians, over two hundred different estimates having been put on record on this subject. The Rev. ADAM SEDGWICK, a distinguished divine and geologist of England, whose authority is, perhaps, second to none, summed up his discussion of this question by saying that in regard to the dates of the Creation of the world, and the appearance of Man on the earth, the Creator had in His wisdom left us without exact information, that no clear and positive statement was made on this subject in the Scriptures, and there has always been a wide and irreconcilable diversity of opinion as to the dates of the Book of Genesis among biblical scholars.

Dr. B. N. MARTIN referred to the many proofs of Dr. ABBOTT'S discovery in the large collections he had made of the worked flints, amounting to hundreds. Since their deposit at Cambridge, they had been examined and their character confirmed by so careful an observer as Prof. LUBBOCK. Prof. H. C. LEWIS and others had also gone over the ground with Dr. ABBOTT, discovered the implements independently for themselves, and verified their distribution as exactly corresponding with the area of the Trenton gravel. His own visit to the locality, in company with his son and Dr. ABBOTT, had been exceedingly interesting, including the examination of the exact points of occurrence of the worked flints at different depths of the gravel-bank, as well as of modern Indian implements at many points over the surface, but never imbedded in the gravel. He expressed his own very clear and decided impressions as to the care and fulness of Dr. ABBOTT'S researches, and the substantial accuracy of his results.

In reply to an inquiry of Mrs. E. A. SMITH, Dr. MARTIN further stated that the objections of Prof. BOYD DAWKINS related to the original and incorrect views of Dr. ABBOTT, who had been misled by Prof. G. H. COOK'S estimate of the geological age of this gravel deposit. Dr. ABBOTT also believed he had made an important discovery in a specimen of human tooth, which he had struck with his cane out of a gravel bank, and whose rolled, water-worn condition indicated a vastly greater age.

The PRESIDENT stated that Prof. DAWKINS had never visited the locality, and had not expressed to himself any positive opinion. It was an interesting fact that, in DAWKINS' classification of the early races of men, he calls the first race the River Gravel Men, afterward followed by the Cave-dwellers.

October 22, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-nine persons present.

The Chairman of the Publication Committee, Prof. D. S. MARTIN, reported that number 13, with the Index and Contents of Vol. II., of the Annals, was now ready for issue.

Mr. G. F. KUNZ exhibited a supposed emerald from Gibsonville, Guilford County, N. C. Mr. Smith, a farmer, while ploughing on his farm in March last, turned up an irregular shaped, smooth-faced stone, the size of a hen's egg. It glittered in the sunlight. Mr. Smith took the stone to Greensboro, where a jeweller pronounced it a genuine emerald weighing nine ounces. The jeweller was also of the opinion that smaller brilliants clinging to the central stone were diamonds.

The fact was published and aroused the greatest interest among jewellers and mineralogists. A diamond miner visited Mr. Smith and offered him $1,000 for the gem. Mr. Smith refused the offer, being assured that the emerald was the second largest in the world and of immense value. He brought it on to New York and intrusted it to a banker, by whom it was ultimately submitted to Mr. KUNZ for examination. After subjecting the stone to various tests, he found it to be a crystal of quartz, penetrated by long, hair-like crystals of green actinolite or byssolite, and containing glittering rows of small cavities filled with liquid. It was only valuable as a mineralogical specimen for cabinet purposes, and was worth for such use about $5.

Mr. KUNZ also reported on the "Georgia Marvel," or the "Blue Ridge Sapphire," as it is called, which was found a little over a year ago in a brook in that State. The stone weighed about half an ounce, and was supposed to be worth about $50,000. Its discovery created even more interest than did that of the North Carolina emerald. Two well-known Southern jewellers asserted that it was genuine, and it was sent here for a crucial test. Mr. KUNZ said that after a short examination he found it to be a piece of blue bottle-glass, which had been rolled in the brook until the action of the water and gravel had polished it to unusual brilliancy; and he was obliged to glaze or enamel a piece of platinum wire with a fragment of the "sapphire" to convince the owner that it was glass.

He also exhibited fine crystals of limpid topaz, from Pike's Peak, Colorado, said to have been found in association with the amazon-stone and phenakite of that locality.

Dr. NEWBERRY exhibited and gave some description of a large collection of typical fossil fishes and leaves gathered by Mr. WILSON from the Central Rocky Mountains, at a locality about seventy miles north of the Union Pacific Railway, near Green River, Colorado. With these were associated a few fossil plants, including a fan palm, and many insects. They occurred in a fresh-water shaly limestone of Eocene age, occupying a part of the Green River basin, the whole formation being 2,500 feet in thickness.

In reply to an inquiry by Prof. MARTIN, he further stated that the insects found in the deposits at Florissant, Col., are more recent; these also include two species of birds, many plants, etc., which are evidently of later date than the fossils on exhibition.

Dr. N. L. BRITTON then spoke on the subject of

NOTES ON THE COPPER MINING REGION OF LAKE SUPERIOR.

The succession, probable stratigraphical relationship, and lithological characteristics of the rocks and veinstones of the region were described in detail, and illustrated by diagrams and a series of specimens collected during a visit of the past summer.

DISCUSSION.

Prof. O. P. HUBBARD stated that the first steamboat which navigated Lake Superior was drawn across the straits at the Sault in the year 1849. It was curious that this date was preceded in Russia, since the first steamboat navigated Lake Vega in the year 1842.

The PRESIDENT then gave a description of the geological structure at Ontonagon, in the Keweenaw peninsula, of the Porcupine Mountains, the distribution of the Potsdam sandstone, and of the underlying rocks, the Copper series, which in the Eastern States are represented by the Taconic or Cambrian slates, and on the north side of Lake Superior by the Anemikee rocks of HUNT.

Mr. C. VAN BRUNT referred to an ancient mining excavation along the south wall of a vein at Houghton. From this trench much copper had been extracted by the old miners, and charred remnants of wood and many stone tools were found at the bottom.

The PRESIDENT remarked on the ancient works of the Lake Superior region, which were much more extensive, notwithstanding the imperfect means and absence of machinery at the disposal of the prehistoric miners, than those of the whites, by whom these veins have been worked only since about the year 1847. The guide of the early explorations of the latter has been, almost invariably, the ancient works, mounds, and excavations of their prehistoric predecessors. The old works were never deep. The tools employed were rude stone mauls, sometimes very heavy, which were attached to handles by withes around a groove at the middle, and were slung by several persons; others were much smaller, and were handled by a single person. He had seen but one copper mining-tool which had been fashioned and used by them. The PRESIDENT also described the glacial phenomena of the Ontonagon region—the polish and striation of outcrops, abundant boulders, etc., and then referred to some of the most interesting papers recently read at the Minneapolis meeting of the American Association for the Advancement of Science. The papers of Mr. WM. MCADAMS were particularly important, describing his discoveries of the bones of some large, new fossil fishes in the Carboniferous limestone at Alton, Ill., the skull of the giant beaver (*Castoroides*), etc., in the Quaternary, and a large number of bones and teeth found at the bottom of the Loess or Bluff Formation; these last remains are likely to throw great light on the true character and history of the Loess.

October 29, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirteen persons present.

Prof. D. S. MARTIN exhibited a specimen of the ashes thrown out at the remarkable eruption of the volcano Krakatoa, in Java, during last August.

The PRESIDENT referred to a sermon, recently delivered in this city, in which these eruptions were cited as overturning modern geological theories, and he showed its mistake.

Dr. B. N. MARTIN exhibited a silver casting, of archæological interest, which was discovered by Messrs. LYMAN and SQUIER, in Peru, many years ago, and has recently been brought to this city. Several castings were found in one village, mostly domestic in subject, but the one exhibited presented possibly a religious form, and was so treated by the natives in whose possession it was found. On a thin, round tablet, twelve centimetres in diameter, was a figure of an Indian, with one knee bent, and a metal axe lying at his foot, facing a tree with a serpent at the base ; at his left was a pole, supported upon two forked props, beneath which was bound a human figure, face downward, over a square pile of fagots. The execution implied great skill in the prehistoric races of America.

The SECRETARY called attention to the peculiarity of the fact of the insertion of the handle of the axe in the socket.

The PRESIDENT referred to the remarkable skill in metal working of the South American and Central American races, as shown in the specimens found at Chiriqui and elsewhere ; but stated that he had never seen any one equal to that on exhibition. Other instances of their skill had been shown by the casts of figures in silver from Peru, which had been exhibited by Dr. OTIS several years ago, and the casts in an alloy of gold, copper, and silver, which had been "pickled" in some solution, leaving only the gold at the surface, and afterward polished. He described an axe of copper, from Chili, now in his own possession, which was exceedingly well wrought—better than any other he had seen. This was very ancient, and belonged to a civilization anterior to that of the present time. It had been bound to a handle with thongs of some kind, and he had never seen any American implement, of prehistoric age, which had been pierced for the reception of a handle.

Dr. A. R. LEDOUX then spoke on the subject of

THE RELATIVE SOIL-EXHAUSTION BY THE SUGAR-CANE CROP.

This communication presented an exceedingly interesting account of the systematic mode of cultivation of a very large sugar plantation in Cuba; the subdivision of its area into small plots; the plan of bookkeeping, carried on for many years, by which a careful account is kept of the treatment of each plot, the fertilizers added, the products received, and its general condition. He then gave an account of an important and very costly series of experiments, carried on under his direction, to determine the chemical composition of the soil and sub-soil, at various locations and depths, of the cane at various stages of growth, and of the fertilizers required to bring up the entire area to the best agricultural condition. One important result was the recognition of the fact that the most important constituent of the soil, soonest exhausted by the cane, was phosphoric acid; and satisfactory results had already been obtained by the addition of this substance to the soil. The experiments were still in progress on a large scale.

DISCUSSION.

Prof. W. P. TROWBRIDGE stated that on a recent journey, in company with Prof. J. D. DANA, the latter expressed the view—with which his own coincided—that, of the coming great scientific discoveries, the greatest would be in the application of chemistry to agriculture. The present influence of a scientific school or society, of greatest importance, consisted in the diffusion of scientific facts among the farmers of the country.

Rev. G. L. SHEARER remarked that a system and means provided in this direction lies in the Grange associations, now comprising a million and a half of members throughout the land. Some of these give attention to reforms in political matters, but much has also been done by others in regard to scientific education of the agricultural community, partly by the appointment of lecturers (chiefly through the Pomona Grange), who discuss many points of a scientific character. For instance, he had visited, last summer, a Grange meeting in Pennsylvania, which had been attended by thirty-five thousand people during the session of a week. It possessed various departments, one of which was a school, in which such subjects as the needs of particular soils, the fertilizers required, etc., were discussed; this practically amounted to a summer school of agricultural philosophy, and was of the greatest service to the farmers present.

The PRESIDENT observed that the scientific interest and practical benefit of the experiments conducted by Dr. LEDOUX were so demonstrable that their continuance was highly desirable. In this country we have still so much virgin soil that the proper appreciation of the work of the agricultural chemist must come later. He had himself followed the march of empire westward, and the progress of the farmers from lot to lot as they disposed of exhausted soil for fresher. Thus in New York, the oldest farms are now, after being occupied for a century, in no better cultivation than those in Iowa, which have been tilled but ten years. So far, there has been no incentive to thorough cultivation of the soil by the farmers, from the fact that they can sell their farms after exhaustion and buy virgin soil farther West at a much less price. After our people shall have reached the limit of migration they will return to the older soils, and better methods will come in vogue.

However, he had noticed already some improvement in methods of cultivation. Ohio used to be the greatest wheat-producing State, and the wheat belt was largely occupied by a race of farmers who had migrated from Pennsylvania and worked their Ohio farms more thoroughly and intelligently. Even within his own remembrance, the yield had run down from twenty-five bushels to the acre to half that quantity. Yet since then the processes had been improved by greater intelligence, and the yield had been considerably increased.

The experimental farms in Germany and other countries are doing excellent work; but they will only be properly appreciated in this country hereafter. There is a good time coming to the agricultural chemist, when there shall be a real demand for his best work. From the ignorance and apathy still prevailing, our agricultural schools have been for the most part failures ; but, with the exhaustion of the public domain, with its virgin soil, the farmers will be compelled to improve their methods of cultivation.

Mr. GEORGE F. KUNZ then exhibited the following series of minerals :

Deweylite, from the Cheever's iron mine at Richmond, Mass. This mineral is of rare occurrence there, in white masses, which resemble, and have been mistaken for, meerschaum, with occasional spots of yellow serpentine.

Aragonite (Flos Ferri), from the vicinity of Rapid City, Dakota. It is found in large groups in veins many inches wide, and equals the specimens from Styria in beauty, but its twisted stalactites are thicker than those of the latter locality.

Zircon, from Ceylon. A cut gem, weighing seven and one-eighth karats, of a light blue color by day and light green by artificial light, with an intensity and fire approaching that of a diamond.

Perofskite, from Magnet Cove, Arkansas. The mineral occurs loose in the soil in isolated crystals, or attached to groups of magnetite crystals. The original bed appears entirely decomposed, but the specimen exhibited was a mass of calcite enclosing scattered crystals of perofskite and magnetite. This gangue resembles that of the Russian locality; but at Magnet Cove the cubical form is exceptional in the magnetite crystals, that prevailing being the octahedron, with the faces of the cube more or less developed.

Wavellite, from a new locality in Arkansas. It occurs not only on sandstone, but coating crystals of transparent quartz in small green radiations, closely resembling a prehnite. Limonite is associated with it, coating the quartz in the same way, and appears to be the result of alteration of the wavellite. The large and perfect spheres of the latter show a lighter color on fracture, which distinguish it from the form which is found in Montgomery County.

Spherostilbite and *chabazite*, from Tyringham, Berkshire County, Mass. They are found in a vein of pyroxene, attached to mica. The chabazite is white, resembles very closely that of Aussig, Bohemia, and occurs in crystals from one-eighth to one-quarter of an inch in length, associated with spherostilbite. The latter is found in beautiful isolated spheres up to one-quarter of an inch in diameter, in one case coating a hexagonal crystal of dark gray mica, and rivals any found elsewhere in this country. Isolated crystals of the mineral are rare.

Iron Garnet, from Russell, Mass. These crystals are remarkably well defined, of a dull brownish black color, usually trapehedrons with the faces of the rhombic dodecahedron slightly developed. They were found in a vein between coarsely crystallized mica and feldspar, with the interstices filled with quartz. They vary in size from one-quarter to three and one-quarter inches, and are found in beautiful groups which sometimes contain from fifty to one hundred and fifty perfect crystals.

November 5, 1883.

Regular Business Meeting.

The President, Dr. J. S. Newberry, in the Chair.

Twenty-eight persons present.

Dr. Antonio di Gregorio, of Havana, Cuba, was elected Corresponding Member, and several of his published papers were presented to the Academy.

Dr. B. N. Martin exhibited specimens of copper ore, from the vein recently opened at Bloomfield, N. J., one foot and a half in width, containing twenty-seven per cent. of copper, and crossing a bed of shale impregnated with copper.

The President remarked that a large quantity of copper was ontained in the rocks of the Triassic formation, although no pay-ing vein has yet been opened. The following localities were referred to ; the vein at Bristol, Conn. : the Schuyler Copper Mine at Belleville, N. J. ; many points along and on the east side of the Alleghany belt, and in the Rocky Mountains, both on their east and west slopes ; deposits which have been worked, though with little success, as well as the concretionary ore and copper replacing wood in the Indian Territory, New Mexico, etc. These latter indicate an extraordinary impregnation of a shallow sea, in which the Triassic strata were deposited, and the copper was thrown down in association with salt and gypsum. It is a question, yet unsolved, why these Triassic rocks were so impregnated with copper. Toward the old shore of this sea, more and more silver was thrown down with the copper, until near the margin, at Silver Reef, its quantity became sufficient for working. The deposit of these ores appeared to be one of the accompaniments of the extrusion of the trap.

In reply to inquiries by Profs. HUBBARD and MARTIN, the PRESIDENT further stated that masses of native copper sometimes occurred, but usually only scales, rarely pieces up to a half pound in weight ; and that ores containing even as low an amount as five or six per cent. of copper have been profitably worked.

In the Eastern States, the impregnation of the Triassic rocks with copper was apparently one of the results of the eruptions of trap through them, and the copper was perhaps derived from the Archæan rocks below, which contained much copper, brought up dissolved in hot water. In the West, the copper was probably contained in the drainage of the old lands which formed the shores of the shallow Triassic sea, and was precipitated by evaporation. Near the Wasatch Mountains, the western boundary of the Trias, the copper was associated with considerable silver, as at the Silver Reef Mines, and both metals were probably derived from the leaching of the old land which occupied portions of Utah, Nevada, etc., and which in ancient as well as modern times was a region rich in ores.

A number of curious crystals of calcium carbonate, apparently calcite, with hexagonal form, found in clay, at Laramie City, were then exhibited by a member, Mrs. WELD.

Prof. J. S. Newberry read a paper on

THE RELATIONS OF DINICHTHYS, AS SHOWN BY COMPLETE CRANIA RECENTLY DISCOVERED BY MR. JAY TERRELL, IN THE HURON SHALE OF OHIO.

Drawings of these crania were exhibited. They showed that the head was shorter and broader than was formerly supposed, and confirmed the views expressed in the Report of the Geology of Ohio, that *Dinichthys* was closely allied to *Coccosteus*, but was a hundred times larger. The cranium of *Dinichthys* was strongly arched in life, but is flattened by compression in the fossil state. It is then triangular in outline, nearly three feet broad behind, and two feet long. The brain box was partly cartilaginous, but was enclosed in strong, continuous plates of bone. The fin rays and some of the vertebræ were ossified. The head was articulated with the body by the strongest, most complex and complete osseous joint yet found in nature.

November 12, 1883.

LECTURE EVENING.

The President, Dr. J. S. Newberry, in the Chair.

Fifty-eight persons present.

The President stated that the crystals of a mineral from Laramie City, presented at the last meeting by Mrs. Weld, had been examined by Prof. Brush, of New Haven, who reported that they appeared to consist of aragonite, although enclosing some minute rhombohedral crystals, apparently of calcspar; but that he had never seen aragonite crystals possessing the same bevelled edges. The variety was entirely new.

Dr. Hubbard W. Mitchell then delivered a lecture, illustrated with diagrams and stereopticon, upon

THE SUCCESSION OF ANIMAL LIFE ON THE GLOBE.

November 19, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. Newberry, in the Chair.

Forty persons present.

A Communication was received from Dr. H. Carrington Bolton, of Hartford, Conn., presenting two specimens of a minute gasteropod, which had been recently found in great numbers upon the flagging of the streets of that city, and were supposed to have fallen from the atmosphere.

The PRESIDENT stated that these shells belonged to the species *Bulimus lubricus*, called by Binney *Fenocyclea*. This shell was very widely disseminated throughout the country and abroad. It had not rained down, as suggested, but had probably multiplied to an unusual degree during the past summer, and was "swarming," as lemmings, butterflies, and other animals do; a mysterious migration, perhaps to escape over-crowding and the exhaustion of food.

Mr. G. F. KUNZ exhibited several remarkable specimens of Brazilian diamonds. Some were perfect spheres, one being of the size of a child's marble, and weighing over forty carats, 6.3 grammes (specific gravity, 3.5195). The latter consisted of a conglomerated mass of cubes, so bunched together as to have lost all crystalline form. The same bunching of crystals was illustrated by a spherical mass of common pyrite, and in others which revealed traces of crystalline form. This spherical shape was never produced in the diamond by rolling in streams. Another diamond of black color, weighing 1.2 gramme (sp. gr., 3.649) revealed no trace of crystalline form, perfectly amorphous. Another of gray color, weighing 1.6 gramme (sp. gr., 3.522), was also a vitreous mass, in which scarcely any crystalline form was apparent; this was also the character of a milky diamond exhibited, weighing 1.1 gramme (sp. gr., 3.522). One diamond, weighing over 6 carats, presented a table and culet, in which each alternate facet (eight on top), as well as the centre, was white, and all the other facets were a deep black. This was originally a white octahedron with a black coating; the slicing off of the four angles had produced the white faces. A crystal of South African diamond exhibited on an artificial surface of cleavage, the projection of the perfect four faces of an enclosed octahedron of the same mineral, with the corresponding impression of these faces in the slice cleaved off. A cut ruby from Siam was also exhibited, that enclosed a perfect octahedral crystal of ruby-colored spinel, about two millimeters in length. This inclusion had been considered, by the owner of the gem, as a serious imperfection, requiring removal, although it really added much to its interest and value, and the gem was in this case truly a ruby spinel.

Dr. N. L. BRITTON reported the abundant occurrence of kyanite crystals in the mica schist at an excavation near Madison Avenue and Fiftieth Street.

Dr. A. A. JULIEN referred to a locality of the same mineral near the corner of Ninetieth Street and Eighth Avenue.

Prof. D. S. MARTIN stated that it had been found in great abundance, as small crystals, throughout the schist at Forty-second Street and Park Avenue—in quantity sufficient to entitle the rock to the name, kyanite schist.

Dr. ALEXIS A. JULIEN then read a paper, illustrated by many specimens, on the subject of

NOTES ON THE GLACIATION OF THE SHAWANGUNK MOUNTAIN, N. Y.

The Shawangunk range marks the county lines of Orange County on its east, and Ulster and Sullivan Counties on its west. Its lowest summit occurs between Bloomingburg and Wurtsboro, 1,271 feet above tide water; its highest, about 1,700 feet. The lowest point in the Wallkill valley at its foot is found at the mouth of the Mongaup on the Delaware, 550 feet above the sea; the highest at Rondout, 773 feet; along this valley the Delaware and Hudson Canal has been excavated, with a descent of only 80 feet to the Delaware at Port Jervis. In this region the highest peak found is Walnut Hill, in the town of Liberty, Sullivan County, 2,130 feet above the sea.

The Shawangunk Mountain not only marks a line of upheaval and fault, branching southwestwardly from the Hudson River axis, but, along the greater portion of its course, it serves as a line of demarcation between the Lower Silurian area of the Wallkill valley on the southeast, and the Upper Silurian and Devonian terrane on its northwest side. At its upper extremity, near Rondout and Kingston, its trend is from a few degrees west of north to a few degrees east of south, but it soon assumes a southwestwardly trend, and so passes over the southern boundary of the State.

The Oneida or Shawangunk grit and conglomerate cap the range for a distance of 43 miles from the New Jersey line to the vicinity of Kingston on the Hudson, generally nearly horizontal on the summit of the mountain, dipping sometimes to the E. S. E. on its eastern flank, but generally westwardly, from 30° to 60°, on the northwest side, in the vicinity of Sam's Point. Its thickness usually varies from 60 to 150 feet, and the broken edges of the strata present mural escarpments of 30 to 200 feet in height, both in the gaps and along the eastern flank of the range. Between Bloomingburg and Wurtsboro the mountain has been pierced by a railway tunnel, 3,857 feet long, and 340 feet below the summit of the mountain, which passed first through the Hudson River shales, and then through 850 feet of the Shawangunk grit, the beds standing at an inclination of about 60° toward the northwest.

Two systems of joints occur in this stratum—the one along the strike, N. 20° E. and S. 20° W., the other transverse, N. 60° W. and S. 60° E. With the latter are connected the lodes of galena and sphalerite at Ellenville, Homowack, and Wurtsboro, associated with crystallized quartz, pyrite, and chalcopyrite.

The general construction of the mountain, with its flat cap of conglomerate, its escarpments, and its view of the Great Valley and Hudson River, is suggestive of that of Lookout Mountain, Tenn.; and there is a further analogy in the abundance of huge rectangular masses of the rock, which have separated more or less from the edge of the escarpments, along the lines of the joints, but whose movement has sometimes been so small as to be distinguishable only at a distance by the slight alteration of the angle of dip. Such movements, often attributed to the action of floods, earthquakes, or ice, have been plainly caused here, as in the enormous conglomerate blocks of the "Ruined City," at Lookout Mountain, Tenn., and the similar fantastic masses along the precipices of the Catskills, by the slow undermining effect of rain-water and frost upon the underlying strata of thinly laminated grits and Hudson River shales. Some of the great and deep clefts, which result from these movements, form the natural " ice caves " of Napanoch and other points along the range.

Mather long ago has shown that " the Mamakating and Wallkill valleys, forming the Great Valley, an extension of the Champlain and Hudson valley, from its southwestwardly trend, would be in the natural direction of the set " of the ice current down that valley. The Shawangunk range, stretching along the western boundary of the Great Valley, received the full force of the ice-pressure and movement, of which a faithful and exact record remains to us in the character of its glacial erosion.

We will consider first the records of glaciation in the surrounding region. On the east side of the range, the rocks of the Wallkill valley consist chiefly of the Hudson River shales and lower soft shales and limestones, which have retained glacial markings only in exceptional localities, and most of which are buried beneath a thick layer of drift gravels, sands, and clays of Champlain age.

Both pebbles and huge boulders of many varieties of foreign rocks are scattered through and over this layer. Thus, near Newburg, I have found rounded fragments of the Potsdam sandstone, gneiss enclosing graphite, and many kinds of granyte and gneiss, all of which must have been transported from the Adirondack region and its margin, as well as varieties of limestone which belong in the Helderberg range, near and southwest of Albany.

In Orange County, Dr. Horton observed numerous blocks of labradorite rock, rounded and very much worn, up to a weight of three or four tons, which are identical with the noryte of Essex County. These have also been traced all the way down the Great Valley to Pompton Plains, in New Jersey.

On the west of the Shawangunk range and of the Mamakating valley, the rounded hills mainly consist of graywacke and flagstones of Upper Devonian age, commonly capped by a thin stratum of conglomerate, which apparently belongs to the lower portion of the Catskill formation. This rolling surface, rarely over 1,000 feet above the sea near the Wallkill valley, rises gradually to an elevation of 2,000 to 2,500 feet to the northwestward, forming the high plateau of the centre of the State. This surface is in general but thinly covered by drift, and there is abundant opportunity everywhere to see that the surface of the rock is thoroughly planed down, grooved, and scratched.

The direction of the ice movement is shown by the following observations of Thompson and Mather, and which I have verified in the vicinity of Monticello :

Between Monticello and Bridgeville, common over all the ridges................	S. 10°–15° W.
Bet. M. and Forrestburg, common on all elevated lands.........................	S. 10° W.
Various parts of elevated lands in Sull. Co. (W. Thompson, Am. J. Sci., xxiii, 247)..	S. to S. 65° E.
Eastern declivity of mts. W. of Mamakating valley, furrows deep and distinct.......	S. 78–80° W.
South of preceding and directed toward low gap in Shawangunk mts................	S. 65° E.
Quarries at Coeymans (800-1000 ft. high)..	S. W. ?

W. Thompson found no grooves on the west side of the hills in Sullivan County, and that the grooves often ran eastward along the southern faces of the hills.

Many large boulders are scattered over the hills, in all cases of the slaty graywacke or of the conglomerate. One huge boulder of the latter material, about 20-25 tons in weight, forms a rocking-stone at a point 2½ miles west of Monticello, on the Newburg and Cochecton turnpike, at a height of about 1,400 feet above the sea. At Bridgeville on the Neversink, 4¼ miles east of Monticello, many such boulders occur, perched often on narrow ridges which run to the river, and forming a marked feature in the scenery.

In regard to the material of the transported boulders and pebbles, a less variety occurs here than on the southeast of the Shawangunk.

A locality of great interest, which I have studied with some care, is at Mountaindale in Sullivan County, at a railroad cut one-half mile west of the station. This is situated in a little cross valley standing about W. N. W. and E. S. E., through which a small stream, the Sandburg, has cut its way into the Champlain deposits, leaving a series of well-marked terraces, sometimes six or eight, on either bank, and empties into the Mamakating valley. Across this little valley, at right angles to the course of the stream—so that it diverges northeastward, and so runs around close to the rocky bluff on its left bank—is thrown a huge natural embankment, like a dam, with a steep face on its N. W. side, and a long slope to the southeast; its height may be a hundred and fifty feet. The railroad cutting passes through the upper portion of this embankment, and the section gives a good view of its constitution, at least in its upper part, for a thickness of from 25 to 35 feet. The materials are varied in kind and size, and much mixed, although a rude sorting is shown by lines at intervals of six or eight feet in depth. The pebbles are mostly small, less than six inches in diameter. Many boulders of subangular form also occur, of one to two feet in diameter, and also a number of angular blocks, from three to six feet in diameter.

The material of the smaller pebbles, up to eight inches in diameter, largely consists of red shale, mostly in subangular tabular fragments, often containing fucoids. Also sandstone is abundant, fine to coarse grained, in pebbles of all shapes and sizes. White vein-quartz occurs, rarely in fragments exceeding half an inch in diameter, as well as several other varieties of shale, a reddish white quartz sand and a very little clay. All these materials are evidently of local origin, derived from the adjacent beds of sandstone and shale, with their occasional thin veins of quartz.

The larger blocks consist of graywacke, mostly of the vicinity, but, in a few much rounded boulders, apparently from the Catskill region, and all show an arrangement with the longer diameter in the plane of stratification. The number of large boulders, two feet in diameter or over, seems to be very small in proportion to the whole material. That taken out of the cutting has been used in the construction of a neighboring railway embankment, and the laborers have left along the sides of the track the boulders of a weight too great to be easily moved. Less than a hundred boulders thus remain, of three feet or more in diameter, and this would indicate a proportion of but a small fraction of one per cent.,—as the cutting was about 600 feet long, 30 feet high, 15 feet wide below, and with sides sloping at an angle of 23°. A very large number of the pebbles and all the large boulders were thoroughly scratched and planed, sometimes with grooves a quarter of an inch in depth.

The mass appears to consist of materials swept down from the layers of till which covered the hillsides, and partly sorted and stratified by the floods which marked the beginning of the Champlain age. The locality seems to record two facts of interest :

1st. The rarity of Adirondack and other foreign material from the north in the deposits transported by ice-action through the Mamakating valley.*

2d. The occasional accumulation of glaciated till material in a mass of remarkable form, which suggests that of the terminal moraine of some small local glacier flowing southeastward from the high lands of the centre of the State.

The locality on the crest of the Range, at which I have had opportunity to study the phenomena of glaciation, is the well-known place of resort, Sam's Point. The stratum of conglomerate here is, perhaps, 100 feet thick, coarse toward the bottom, and passing upward into a coarse to fine white sandstone or grit, several yards in thickness, with gravel interspersed irregularly and in a few thin layers. The rock when altered consists of flat (perhaps flattened ?) pebbles of white quartz, generally from a half to two inches in diameter, in a small quantity of greenish-white cement ; the latter is ready to oxidize, and many parts of the weathered faces of the rock and of its joint surfaces thus assume a bright brick-red color, or sometimes brownish-yellow. The stratum overlies another of the Hudson River shales, and both are nearly horizontal in position, sometimes showing a dip of a few degrees to the northward. The upper surface of the stratum thus forms a long table-like plateau, whose surface is generally dry and covered by a thick growth of low shrubs, huckleberry, scrub-oak, etc.,† but marshy in many places. Not far to the north of the Point is a lake half a mile in length, partly occupied by grasses and white pond-lilies, and surrounded by a marsh. In passing over the surface, outcrops of overlapping conglomerate layers are constantly met with, and everywhere afford a record of the glaciation, in grooved, striated, and even finely polished surfaces. Along the edges of these outcrops and of the escarpment these glaciated surfaces have been largely eroded and effaced by a process of weathering which has scooped out rows and

* However, these materials must sometimes occur, since Mr. J. V. Morrison, of Wurtsboro', has found feldspar and mica in the drift of that vicinity.

† See notes on the Flora of Sam's Point, Bull. Torrey n. Club, Vol. x., page 121.

groups of shallow basins. The depth of these varies from a half an inch to 3 inches, sometimes reaching 15 inches, and their diameter from a few inches up to 3 or four feet. In the bottom of these basins lie many pebbles, partly those which have been loosened from the conglomerate, and partly less rounded chips which have been flaked up from the bottom, apparently by the action of frost.

So hard is the rock that it is rare to find any deep grooves. The scratches are mostly very shallow, rarely ¼ or ½ inch in depth, though often very numerous, long, and parallel. Very shallow and broad troughs, a half to one inch in depth, and several inches in width, generally occupy the polished areas and produce a gently undulating surface.

The direction of the striæ varies a few degrees on either side of northeast, as shown by the following observations noted :

S. 35° W.
S. 29° W.—abundant, very long, one-sixteenth of an inch in depth, counting 15 to a foot.
S. 41° W.
S. 46° W.—abundant.
S. 47° W.
S. 55° W.

and a few. ¼ inch in depth, S. 75° W. and S. 86° W. In following a long scratch southward, there seemed to be a tendency to curve more and more toward a point nearer the west.

The gap immediately below the Point is occupied by great rounded heaps and even hills of coarse till, made up of angular blocks of the conglomerate and sandstone. In a lower gap further to the southward, crossed by the road to the Point, a finer drift occurs, which was apparently not stratified, but, where cut by ravines running down to the westward, presented a series of 3 or 4 well-marked terraces. The interest attached to these observations depends on the fact of the high altitude of these till deposits, probably 1,000 feet above the sea, and far above the reach of the floods of the Champlain period. I had not the time nor opportunity to give them the thorough study necessary to unravel their true meaning.

I am indebted to Mr. John H. Caswell, of New York, for the following notes which he kindly made on the glacial striæ, near the northern end of the Shawangunk range, at and near Lakes Mohonk and Minnewaska. At this point, the trend of the range is from a little west of north to a little east of south. Lake Mohonk seems to occupy an irregular cleft with precipitous walls, and the horizontal surfaces of conglomerate adjacent to the lake are beautifully polished and striated in many places. Lake Minnewaska lies on the top of the range, about five miles southwest of Lake Mohonk, and occupies a shallow basin of purely glacial origin. The observations were made in September, 1878, are uncorrected for magnetic variation, and are recorded in order along the usual path taken by visitors from the hotel to the summit of Sky-Top and back.

Near Bowling Alley...	S. 10° W.	
Eagle Cliff............	S. 10° W.	taken at many different points along the path.
On the path..........	S. 10° W.	
On the path..........	S. 10° W.	
Chestnut path........	S. 10° W.	
Cope's Lookout	S. 10° W.	on the northwestern side of the mountain.
Cope's Lookout	S. 10° W.	
Cope's Lookout	S. 10° W.	
Before Newlin's Cave..	S. 10° W.	
Before Newlin's Cave..	S. 10° W.	
Beyond Newlin's Cave.	S.	
Top of Crevice......	S. 40° E.	on the southeastern side of the mountain.
Top of Crevice.......	S. 40° E.	
Sky-Top	S. 18° E.	
Sky-Top	S. 18° E.	
Giant's Workshop....	S.	Top of large flat rock at exit. This and the following observations, on the northwestern side of the range.
The Kitchen........	S. 10° W.	
The Kitchen........	S. 10° W.	
The Cottage	S. 10° W.	Large and beautifully polished surface.
The Cottage	S. 10° W.	
Road to Alligersville.	S. 40° E.	In the Rondout valley, on the northwest of the range.
Lake Minnewaska...	S. 10° W.	Furrows in front of the hotel, on the top of the mountain.
Lake Minnewaska...	S. 10° W.	

At this northern end of the range, where its own trend is about S. by E., the course of striation and the main glacial movement appear to have been about S. by W. The divergences from this direction in the instances noted, from S. even to S. E., appear in some cases to be merely local variations through valleys and around the shoulders of the range. Those on and near the summit of Sky-Top may possibly record the southeastern movement of the older and thicker glacial stream, to which reference has been more fully made in my observations on the glaciation of the Catskills.*

* Trans. N. Y. Acad. Sci., 1881, Vol. I., p. 24.

At the southern portion of the range, where it trends off decidedly toward the southwest, the glacial movement nearly conformed to the course of the valley, the upper part of the sheet scraping obliquely over the summit of the range.

The main body of the coarser detritus, gneiss, quartzyte, etc., from the Adirondacks, Helderbergs, and Catskills, borne along through the Hudson valley, was mainly diverted through the stronger glacial current which swept down the Wallkill valley. The approximate coincidence of the movement of the ice with the course of that valley, as well as the low planes—within or beneath the ice—at which the foreign boulders were borne or shoved along, have been the two causes which appear to me to have permitted little or none of this northern material to cross the Shawangunk range, even through its lowest gaps.

DISCUSSION.

Prof. D. S. MARTIN gave some account of the glaciation observed by him during a visit to Lake Mohonk, near the northern end of the range. At this point the cap of Oneida conglomerate is not less than three hundred feet in thickness. The hotel rests upon it, at the shore of the lake, which is 1,200 feet above the sea level, and it forms a continuous mass extending up to the summit of Sky-Top (altitude, 1,500 feet). He had observed the same form of bright red weathering at this locality. Near the lake, the fresh horizontal surfaces of the white quartzyte are polished like a slippery floor, which is even difficult to walk upon. He had obtained specimens of the conglomerate, showing pebbles sliced off by the glacial action.

MR. C. VAN BRUNT stated that the modified till was universally distributed, with boulders, over the area on the west of the range up to its northern termination. At that point particularly he had observed the shoulders of the ridges to be remarkably ground and scratched. He inquired whether the great masses of the conglomerate, loosened or detached along the escarpment, might not have been pushed away by the pressure of the ice.

Dr. N. L. BRITTON stated that he had visited the southern extension of the range, at High Point, which has an altitude of 1,700 to 1,800 feet. There also a small pond occurs, which is extremely shallow. The glacial striæ ran very nearly to the southwest. Not a single boulder of extraneous material was observed in the vicinity, except a small flat pebble of Helderberg limestone, which was found at a point about 300 feet below the summit.

Prof. O. P. HUBBARD inquired how the deep excavation of Lake Mohonk had been probably effected.

Dr. JULIEN replied that, judging from the general accounts of the topography, the precipitous walls and angular forms, displayed by the lake-bottom, seemed to indicate the widening out or excavation of a fissure, perhaps along a fault, and the damming up of the basin by a mass of moraine material.

Although the action of ice, as a most powerful agent of disruption of thinly bedded sandstones and conglomerates, was most decidedly marked, both in the Shawangunk and the Catskills, nevertheless the separation of the huge loosened blocks of rock, now forming the brow of the escarpment, was evidently in most cases of much more recent date, slowly effected by the gradual widening of the joints by atmospheric waters, the removal and undermining of the soft shales which lie beneath the conglomerate, and the sliding of the ponderous masses down the slope.

Dr. N. L. Britton then remarked on the discovery by Mr. Arthur Hollick and himself, of

LEAF-BEARING SANDSTONES ON STATEN ISLAND, NEW YORK.

The locality is at the southern end of Staten Island, at the base of a bluff, facing toward the Bay. The blocks of ferruginous sandstone, in which the leaf impressions were noticed, lie scattered along the beach, between tide-marks, and are mingled with pebbles and boulders of many kinds of metamorphic and sedimentary rocks, and with diabase ; these have been washed out of the bluff which here marks the most southern extension of the great terminal moraine along the Atlantic coast. This fact lends an additional interest to the locality.

The sandstone is accompanied by a ferruginous conglomerate, and was not found in place, but presents the appearance of having been thrown up on the shore, the fragments torn from a sub-aqueous outcrop. The leaf impressions noticed were but fragmentary, and insufficient for proper determination ; it is hoped that further search will reveal more perfect specimens. Impressions of twigs occur in great abundance in the rock, but little regarding the character of the plants which formed them can be learned from this source.

The occurrence of similar fossiliferous sandstones on the beaches about Glen Cove, L. I., and vicinity, has been known for some time. There they are found in precisely the same position as at the locality above described, and are associated with extensive beds of fire-clay, " kaolin," etc. The Tottenville station is not immediately on these clays, but they are found near by in several directions. That the two places mark outcrops of the same geological formation, and probably approximately the same strata, is almost certain.

The physical structure of the Glen Cove series is exactly parallel to that of certain of the clay beds of Middlesex County, N. J., which are well known to belong to the Cretaceous Epoch. In the absence of sufficient fossil evidence, we cannot state, with absolute certainty, that the two deposits are equivalent, but there is little doubt that this will ultimately be proved, and that the New Jersey and Staten Island clays, "kaolins," sandstone, lignite, etc., find another and their most northern outcrop on the north shore of Long Island. The speaker had already traced them as far as the Narrows, and intends continuing the investigation.

DISCUSSION.

Prof. D. S. MARTIN suggested that a map of these outcrops, drawn to scale, might throw light on the exact position of the Glen Cove specimens. They were remarkably like the Triassic rock, containing lignite stems, found in New Jersey, and may be drift material brought over from some such outcrop in that State.

Dr. BRITTON replied that the same specimen contained angiospermous leaves, and that no boulders of diabase were noticed at Glen Cove.

The PRESIDENT thought that more material was yet needed to render the determination of age absolutely sure. He had already exhibited similar specimens from Williamsburg, Lloyd's Neck, and Glen Cove, which enclosed large numbers of angiospermous leaves. These resemble those of the Raritan clays, but a further collection was needed to identify them, though such a result was probable. The association of clays with the sandstones at Glen Cove seems to prove the strata to be essentially like those at the mouth of the Raritan.

He further reported on some of the more interesting papers read at the recent meeting of the National Academy of Sciences.

The Academy then adjourned for two weeks, to December 3, on account of the Centennial Celebration, on November 27, of the Evacuation of New York City, in 1783.

December 3, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-seven persons present.

Mr. EDWARD F. DUSENBERRY, Dr. BENJAMIN LORD, and Prof. JOSEPHINE CHEVALIER, of the Medical College of the N. Y. Infirmary for Women, were elected Resident Members.

Lieut. ANTHONY W. VOGDES, U. S. A., was elected a Corresponding Member.

The PRESIDENT reported his receipt of a request from the American Museum of Natural History, for the removal of the Botani cal Collections belonging to the Academy, and stated that they would be brought down and stored with the Annals in the building of Columbia College.

He exhibited a series of photographs of the ruins and desolation produced by the recent earthquakes in Ischia; also, an egg of the alligator from Florida, showing the young animal just protruding its head from the shell, with the end of the tail beside the jaws; also, a portion of a placoderm fossil fish from the Chemung of Pennsylvania, described by Prof. CLAYPOLE, under the name of *Pterichthys corrugatus.*

Prof. FREDERICK STENGEL had translated, at the request of the Academy, and now read, a paper by Prof. F. FITTICA, of the University of Marburg, (published in the Annals, vol. III.)

UPON A FOURTH MONOBROMPHENOLE.

DISCUSSION.

Prof. A. R. LEEDS considered these statements of the author of very great importance. He described the constitution of the benzole-ring of Kekulé, and stated that he did not see the potency of the *a priori* reasoning of Prof. FITTICA, nor any evidence of the existence of the monobromphenole—that he had really produced such a compound. The difficulties attending the solution of this question were much greater than might be supposed, to satisfactorily determine its difference from the other compounds of bromine and phenole.

Dr. B. N. MARTIN then called the attention of the Academy to the peculiar phenomena recently occurring in connection with the sunsets, and described the brilliant crimson colors which affected the western sky before and after the disappearance of the sun.

Prof. O. P. HUBBARD had observed in the morning also, at about 6 o'clock, that the entire heavens had been dyed in the same brilliant colors from west to southeast for half an hour. He also referred to a similar phenomenon on August 20, 1831. An insurrection was then in preparation among the slaves in Virginia, where he was at that time. Its leader had arranged for the outbreak on a particular day, somewhat later than the day mentioned, but the remarkable appearance of the sky induced him to begin it prematurely at that time. Among other phenomena, the sun assumed a decided green color every afternoon for several days in succession. These facts were then very generally known and attracted much attention.

The PRESIDENT presumed that the appearances were being studied by observers of the heavens, who would yet definitely report upon them. He also referred to the facts known in regard to the locomotive appendages of trilobites, as recently discussed in an article of *The American Naturalist*, and to the discovery of tracks in Colorado.

He further remarked on the recent observations of Prof. ALEX. AGASSIZ, on the growth of the coral formation in the peninsula of Florida, and his own observations on the Gulf Coast, in confirmation of the view of the organic nature of the increase, with little, if any, assistance from elevations of the sea-bottom.

Prof. D. S. MARTIN called the attention of the Academy to the recent death, by typhoid fever, on Thanksgiving day, of Prof. ARTHUR SPIELMAN, one of the most promising Resident Members, from whom had been expected an important record of observations on the excavation of the tunnel beneath the Hudson River. He referred to the great ability, energy and activity of Prof. SPIELMAN, his remarkable engineering skill, and the great loss to society and the Academy by his decease at so early an age.

The President exhibited and described

SOME PECULIAR SCREW-LIKE CASTS FROM THE SANDSTONES OF THE CHEMUNG GROUP OF NEW YORK AND PENNSYLVANIA.

These he considered the remains of the stems of seaweeds, and compared with *Spirophyton*. Two distinct forms were shown, which he regarded as two species of a new genus, to which he gave the name of *Spiraxis;* this he defined as follows :

SPIRAXIS (nov. gen.).*

Body cylindrical or sub-fusiform, somewhat abruptly conical above, more gradually tapering below; surface traversed by two parallel revolving prominent ridges, in some species closely approximated, in others separated by an interval of half the diameter of the stem. No traces of internal structure or distinct surface-markings visible.

The two species are described as follows :

1. *Spiraxis major, n. sp.*

Body cylindrical; about one inch in diameter, terminating above in a conical summit, traversed by two strong spiral revolving ridges, which cross the axis at an angle of about 45°. These ridges are flattened or sulcated.

* Fully described and figured in the Annals, Vol. III., No. 7.

2. *Spiraxis Randalli, n. sp.*

Body fusiform; three or four inches in length, by six to eight lines in diameter; surface marked by two revolving and closely approximated ridges, which below are broad and flattened or rounded, and separated by narrow furrows, above acute and narrow, and separated by greater intervals.

From *S. major* this species may be distinguished by its smaller size, its somewhat curved or sinuous outline, and the closer approximation of the raised ridges, which are also more flattened and relatively broader.

December 10, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

One hundred and forty five persons were present.

The PRESIDENT exhibited fine specimens of terminated crystals of black tourmaline from Jefferson, St. Lawrence County, N. Y., somewhat similar to those which are found at Monroe, Conn.; also some large specimens of moss agate from Brazil, and remarked on their mode of formation. The resignation of Dr. HIGGINS, from resident membership, was read and accepted.

Dr. J. S. NEWBERRY and Prof. H. L. FAIRCHILD then presented a joint paper, illustrated with a large series of original lantern views and by specimens, on

THE GEOLOGY, BOTANY, AND SCENERY OF THE YELLOWSTONE NATIONAL PARK.

December 17, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixteen persons present.

Dr. NEWBERRY exhibited a specimen of fossil fish from Wyoming, presenting an interesting character of dentition; also a series of maps of the surveys of the route of the Northern Pacific Railroad.

The following papers were then read by Prof. ALBERT R. LEEDS:

I. THE LITERATURE OF OZONE AND PEROXIDE OF HYDROGEN (second memoir), published in the Annals, vol. III., and including—

1. Historical-critical resumé of the progress of discovery since 1879.

2. Index to the literature of Ozone, 1879—1883.
3. Index to the literature of Peroxide of Hydrogen, 1879—1883.

And also,

II. FACTS GATHERED FROM EIGHT YEARS OF PERSONAL INSPECTION AS TO THE ALLEGED DESTRUCTION OF THE ADIRONDACK FORESTS.

In this paper Prof. LEEDS urged some action of the Academy, in co-operation with the present public movement, to protect and preserve the forests of the Adirondack region.

DISCUSSION.

Prof. O. P. HUBBARD remarked that nearly fifty years ago a feeder from the Black River was surveyed and constructed to the sources of the Mohawk to *bring water* to the *middle section* of the Erie Canal, the *summit level* between the Lakes and the Hudson River; and subsequently a *canal* even was built from Booneville to Rome, in part to bring a greater supply. When the hemlock forests back of Newburg, where immense tanneries once existed, were exhausted, there was a transfer to the southern border of the Adirondacks north of the Mohawk, where a similar destruction has been going on. This region, though very favorable for grazing, is not attractive on account of the climate for general agriculture; and great proprietors, like Brown, of Providence, and Gerrit Smith, of New York, never succeeded in attracting settlers, though land was offered at a few cents an acre.

It should be considered, however, that forests can be renewed, if protected in time. In thirty to forty years a tract may be reforested with the soft and hard woods, as the experience of cultivators in foreign countries and in our land has shown—one of the former, in the last century, having planted fifty millions of forest trees on his estate in Scotland, besides what he has sown and *not transplanted, which cannot be numbered.* ("Diary and Letters of Gov. Thomas Hutchinson," 1884, p. 343.) If all small landholders, farmers, and citizens, who have only a garden, would encourage their boys to plant the seeds of apples, pears, and fruits in general, also the walnuts, chestnuts, beechnuts, butternuts, and English walnuts, maples, elms, oaks, pines, hemlock, larches—there might be, if properly transplanted, hundreds of millions of valuable trees added to our stock in forty years.

The encouragement of this industry by means of premiums given by the State is a thousandfold more important than all ever paid by our agricultural societies for large vegetables and small extraordinary crops, and would add vastly to the wealth of the State.

In the higher parts of New Hampshire and Vermont, in the latitude of the Adirondacks, great numbers of farms, on account of the cold climate and the exhaustion and washing away of the soil, are deserted, the houses and barns going to decay, and the forests are recovering the old ground, and in many parts, it is said, the annual growth is greater than the consumption, which is the best thing that can happen there.

It is not unimportant to all the inhabitants that the Adirondacks afford a home and range to nearly all the animals native to New York, and we hope the time may never come when they shall be annihilated or driven off as the buffalo has been from his entire eastern range, and when the naturalist can no longer study them in their native haunts.

Dr. MARTIN inquired how far the forests had been hitherto so utterly cut off as to render their replacement impossible.

Prof. LEEDS replied that the trial has been as yet too short and irregular to show. It was a common occurrence, where an area had been burned over, that a different growth of trees, chiefly the white and yellow birches, sprang up in place of the original forest.

Prof. HUBBARD added that the question of the differences between the succeeding and original forest growths, to which Prof. LEEDS had referred, was one of great importance, and yet needing satisfactory solution.

The PRESIDENT remarked on the importance of the subject and its claim to public attention.

There can be no question as to the damaging effects of cutting off forests. The subject has become very important in all parts of the country, since the forests were more valuable and remunerative than corresponding areas in farm lands. When the forests were cut away, the streams were dried up, the climate was sensibly altered, and the rivers became liable to sudden floods. He had encountered a notable illustration of this result. While once travelling in Kansas in a region without trees, his party encamped one night on the bank of a stream then fordable, but the next morning, in consequence of a storm, it had risen forty feet; the flood, however, subsided entirely during the course of a single day. Forests act as a blanket to protect the soil from the action of wind and sun, and at the same time as sponges to receive, retain, and slowly distribute the rainfall. In Europe the subject of forest preservation and propagation is embraced in the system of education, and schools of forestry have been widely established. Some action of the Academy is desirable in order to strengthen the hands of those who are interested in the protection of our forests.

Dr. N. L. BRITTON moved the appointment of a committee of three by the Chair, with Prof. LEEDS as chairman, to represent the Academy on the subject of the protection of the forest lands of the Adirondacks, and to memorialize the Legislature of the State to that end.

The motion was passed, and the PRESIDENT appointed as such committee, Prof. A. R. LEEDS, Dr. B. N. MARTIN, and Prof. O. P. HUBBARD, to report to the Academy on this subject.

On motion, the Academy then adjourned to January 7, 1884.

January 7, 1884.

REGULAR BUSINESS MEETING AND SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty persons present.

The resignation of Dr. LOUIS ELSBERG as Librarian was accepted, and the nomination of Dr. ALEXIS A. JULIEN by the Council to fill the unexpired term having been received, he was so elected. The resignation of Mr. HENRY P. EGLESTON and J. H. MAGHEE as Resident Members were received and accepted.

On motion by Prof. J. J. STEVENSON, the preparation of a memorial of the senior Vice-President of the Academy, recently deceased, Dr. BENJAMIN NICHOLAS MARTIN, was directed and entrusted to the following committee: Profs. O. P. HUBBARD, A. R. LEEDS, J. J. STEVENSON, and the PRESIDENT of the Academy.

Prof. LEEDS, the Corresponding Secretary, read letters of acceptance as Corresponding Members from Lieut. A. W. VOGDES of Fortress Monroe, and Prof. ANTONIO DI GREGORIO of Havana.

Prof. STEVENSON nominated Prof. WILLIAM KING, of Glenoir, Galway, Ireland, as Corresponding Member, and he was so elected.

Mr. G. F. KUNZ called attention to an erroneous statement in the January number of the *American Journal of Science* (Series III., Vol. XXVII., page 73), setting forth the discovery of herderite, at Stoneham, Me., as follows: "These crystals were found in the pockets that yielded the fine crystals of topaz described by G. F. Kunz (See *Am. Jour. Science*, Series III., XXV., page 161)." In fact, however, the herderite was not found in these pockets, not at the time, nor in the same part of the ledge. The first crystals came under his notice in October, 1883, and were found by Mr. Edgar D. Andrews. They were never taken for topaz by himself, although so mistaken by others. As he did not own these crystals, they never came into his possession, and he was able to procure only some part of them on December 12, 1883.

Mr. KUNZ then exhibited a collection of beryls and emeralds from North Carolina. The specimens exhibited were sent to him by Mr. J. A. D. STEPHENSON, of Statesville, N. C., the most earnest and successful local collector of the minerals of that State, who was the first to call the attention of the outside public to North Carolina minerals, and also that of mineralogists to the beryls and spodumene (See papers on emerald, by W. E. HIDDEN, *Am. Jour. Science*, 1881, Series III., XXII., 489; and on hiddenite, by J. L. SMITH, *Am. Jour. Science*, 1881, Series III., XXI., 128), and also to many other localities.

In a letter he states: "These emeralds occur on the property of Mr. J. O. Lackey, about one mile southwest of the Emerald and Hiddenite Co.'s property, Stoney Point, N. C., a short distance from the Lyons property (Smeaton's), and are found in a vein of black decomposed mica, associated with quartz crystals, common rutile and hiddenite. I consider the locality a promising one, although there has been but very little work done as yet."

The lot received from Mr. STEPHENSON consists of 33 crystals, 10 mm. to 55 mm. (2 inches) long, and 1 mm. to 8.5 mm. wide, and varying from colorless to a light emerald green. Nearly all have the curious saw markings in considerable numbers on each corner of the prism, and some contain simple crystals of rutile. The interest attaching to these crystals is in the fact that they are found at some distance from the Emerald and Hiddenite Co.'s property, and that between these we have the Lyons property, on which Mr. SMEATON found the same minerals, showing that the deposit is not an accidental one, and that there is encouragement for future work in this section of the State.

The PRESIDENT then exhibited a specimen of a fossil landlocked skate, or ray, from the beds of fresh water lakes of Eocene age, in Wyoming—the same locality from which he had already shown specimens of fossil fishes and plants. The rays of the present day inhabit the salt water, and there occur in great numbers. These present an extreme prolongation of the vertebral column, carrying the sting. In resh water they are very rarely found, one living species occurring in Lake Nicaragua. He also exhibited specimens of argentite and native silver from Batopilas, Mexico.

Dr. N. L. BRITTON then read the following paper:

NOTES AND CRITICISMS ON MR. GRANT ALLEN'S THEORY OF THE ORIGIN OF LEAF-FORMS.

Mr. GRANT ALLEN'S recent papers on the "Forms of Leaves" and their origin, printed in *Nature*,* and elsewhere, must have been

* Nature. Vol. XXVII., pp. 439, 464, 492, 511, 552.

read with much interest by students of natural history; and his theory there advanced, that serrated, lobed, and divided leaves have attained these forms by struggling with others for their required supply of carbonic acid and sunlight during very long periods of time, by a process of gradual change or evolution from an originally entire-margined leaf-form, has appeared to us, to say the least, ingenious.

There are, however, considerations which will not allow us to accept this attractive theory without question; to some of these I propose in this paper to allude, using familiar examples illustrative of what is presented, as well as some observations and ideas of my own, indicative of what seem to me to be more probable causes by which the modification of leaf-forms is effected than those advanced by Mr. ALLEN.

The various marginal and ultra-marginal modifications of leaves—the serrations, lobations, divisions, etc.—and their plans of venation seem mutually dependent on each other. In nearly all plants bearing non-entire leaves, we find that the primary vein system, or strong branches from it, the system of channels which conduct the main supply of sap to the various portions of the laminæ, ends in the teeth or lobes,* and, consequently, these parts obtain a greater amount of nutrition than the portions immediately around the bases of the serratures, sinuses, etc. The leaf is but an expansion of a portion of the stem, with a greater development of parenchyma; the prosenchymal elements are expanded into a reticulum, on which the parenchyma is stretched, and these woody parts, bearing the intimate relation to the marginal indentations above alluded to, should be given more prominence in a discussion of this subject than those consisting mostly of parenchyma alone, the cells in which the decomposition of carbonic acid is effected by the aid of sunlight. Mr. ALLEN has given the parenchyma sole importance in his theory, and assigned the vein system no function in the production of teeth, lobes, etc. In entire-margined leaves we find that the primary veins seldom end in the margin, but curve upward, and ultimately become united with one another, forming the closed areas known as areoles.

Mr. ALLEN'S views fail to explain the fact that the leaves of monocotyledons are almost invariably entire-margined.† Many of these plants, and the grasses and sedges in particular, grow closely packed together, the leaves of individuals overshadowing those of others and

* There are exceptions to this general statement, as in the genus *Cicuta*, where the veins end in the serratures, and in some species of *Trifolium*, where they terminate abruptly in the practically entire margin.

† There are exceptions, as in *Yucca*, *Dasylirion*, and *Aloe*, and other related genera, with filamentous or spiny projections from the leaf-margins, and *Stratiotes aloides*, L., the European "water soldier."

their own lower ones, closely approximate to, and often touching them; yet here no marginal irregularities are seen, except a mere roughening of margins and midrib. Many of the orchids and liliaceæ grow in closely shaded places with leaves of other plants packed densely around them, yet their leaves are entire. Only the palms, the highest of these endogens, bear compound leaves, but their pinnæ are entire. If Mr. ALLEN'S hypothesis were true, we should certainly expect to find marginal indentations on the leaves of most endogenous plants having this habit of growth. The monocotyledons are plants of a very old type, having appeared on the earth, geologically, long before the angiosperms,* and hence there has been very much more time for them to have undergone changes in leaf-forms, but these remain very much as they began. In their case there seems to be a perpetuation of an ancient character dependent on a primitive plan of parallel venation, which the imaginary "struggle" for carbonic acid has failed to alter.

The leaves of angiosperms hardly appear to have become more serrated and lobed since their introduction into the earth's flora at the beginning of the Cretaceous epoch. The earliest of them, as represented by specimens from the Dakota sandstones and New Jersey plastic clays, are probably not less serrated nor lobed than the leaves produced by plants of the same genera now living. That there has been a change is of course possible, although it may justly be objected, that very little is known to us of that early angiospermous flora compared with our knowledge of the present one. But we will admit that a change in this direction may have taken place from natural causes, *i.e.*, that leaves are now marginally modified to a greater extent than they originally were, although the palæontological evidence of this change is wanting.

The object of the chorophyll-bearing parenchyma of the leaf is primarily the absorption and decomposition of carbonic acid, and it effects this in proportion to the amount of stomata-bearing surface; an entire-margined leaf accomplishes this more economically than a lobed one with the same system of venation, for the surface is greater, and the *advantage* of lobes, divisions, etc., under this view is difficult to apprehend.

Again, the well-known laws of the phenomena of diffusion of gases † render it quite certain that the amount of carbonic acid in all parts

* The oldest hitherto discovered plant of probable monocotyledonous affinities is *Pothocites Grantoni*, Paterson, perhaps allied to the *Araceæ*, remains of which have been found in the Carboniferous bituminous shale of Granton, Scotland, and described in Trans. Edinb. Bot. Soc., vol. 1. Undoubted endogens occur abundantly in the Trias and Jura. No true angiosperms are known lower than the basal Cretaceous strata.

† See GANOT, Elementary Treatise on Physics, p. 135.

of the atmosphere is a nearly constant quantity. Its absorption through the stomata is certainly not rapid enough to seriously diminish this quantity; for the molecules taken up are immediately replaced by others from the surrounding atmosphere, maintaining a practically constant tension of the gas, without any action on the part of the plant. Chemical analyses of the atmosphere from widely separated localities, and under differing conditions, show that the amount varies only very slightly from one part of CO_2 in twenty-five hundred parts of air, measured by volume. And the total amount taken by plants from the air during any period is small when compared with the total quantity present—this loss being constantly replaced in various ways.

For these reasons it appears that Mr. Allen's theory is hardly in accordance with known facts, and must be abandoned if something more rational can be suggested.

It has seemed to me that the chief agency of the production of marginal indentations is to be looked for from a *mechanical*, rather than a chemical or vital cause, and this combined with more or less well-defined types of venation, no matter how originated, and also with relative amounts of sap nutrition and consequent relative vigor of different leaves on the same plant, or of those borne by young plants or shoots as compared with those of older individuals or branches.

That there is a general plan in the vein-arrangement, is apparent from the fact that in genera where some species bear nearly entire-margined, and others serrate, cut, or even compound leaves, or where this circumstance obtains in related genera,* the venation is generally similar; and this is true even of some orders.† We know also that the vein system has existed as long as the plants have; for in the *Sassafras*, *Liriodendron*, etc., of the Lower Cretaceous, it is the same as in living species of these genera, or similar, and is recognized by students of palæo-botany as a valuable means of determining genera. The origin of these various plans of venation, the "architectural ground-plans" of leaf-structures, I do not propose to discuss.

The amount of nutriment furnished the leaves by the roots is an important element in the discussion. This is relatively greatest at the time of vernation, and as other leaves appear on a growing branch or stem, above the earlier ones, part of the sap is diverted into these newer laminæ at the expense of those below; and this consideration will explain the fact that on land-plants bearing heterophyllous leaf-blades, the lower leaves are generally the most divided, although, from their earlier supply of sap, the largest. In germination the earliest leaves are mostly entire, from a similar cause. The nearer approach

* In *Negundo*, the leaflets placed together form a perfect maple leaf.

† The peculiarly characteristic venation of *Melastomaceæ*.

to entireness of margins in the younger and consequently more vigorous, better fed leaves of saplings is explainable in the same manner. This is well exemplified in some of our native oaks, particularly in *Quercus coccinea*, L., *var. tinctoria*, Gray, and often in *Quercus nigra*, L. This varying supply of sap-nutriment then produces variations in leaf-forms, and it is not improbable that these may now, and in past time have become specifically permanent, and here we may have one potent cause of the production of marginal modifications.

The mechanical cause of the origin of leaf-forms which long ago suggested itself to me is simply resistance to cell-formation by the medium in which growth takes place, be this air or water.

Let us first consider the case of submerged leaves, which are notably the most cut and divided of all, remembering that the density of water is many times that of the atmosphere. We may conveniently divide these into three classes: (1) plants whose natural habitat is moist ground, but which sometimes (by an unusually wet season, or other causes) have their lower leaves covered by water; (2) plants growing naturally in the water with their lower leaves submerged, their upper ones exposed to the air, either floating or immersed; and (3) plants wholly submerged.

Mr. ALLEN has stated that "gases are not very abundant in water, as it only holds in solution a limited quantity of oxygen and carbonic acid."* Certainly the quantity is small compared with the mass of water; but although water can dissolve only $\frac{26}{1000}$ of its volume of oxygen, there is enough of this gas to support a more redundant animal life than exists on the land. As to the actual amount of carbonic acid dissolved in waters, there is little exact information, as this substance is not determined in ordinary water-analysis. However, "in the autumn of 1859, W. A. MILLER found that a litre of Thames water at Woolwich contained 63.05 c. c. of dissolved gases, of which 48.3 c. c. was carbonic acid; and at Kingston, a litre from the same river contained 52.7 c. c. of dissolved gases, of which 30.3 c. c. was carbonic acid."† If river water contains this percentage, ponds, and particularly partially stagnant waters, in which the greatest quantity of submerged plants are found, certainly contain much more, water being capable of dissolving its own volume of CO_2.‡ It would appear then that Mr. ALLEN has underestimated the percentage of carbonic acid in waters; the percentage certainly far exceeds that carried in the atmosphere.

(1.) The first class of water-plants, to which I have above alluded, is well exemplified by *Sium cicutæfolium*, Gmelin. In this plant the

* The Evolutionist at Large, Humboldt Library, Vol. II., No. 26, p. 10.

† See "Water Analysis," by J. ALFRED WANKLIN, M.R.C.S., p. 90.

‡ GANOT, Elementary Treatise on Physics, p. 136.

naturally pinnate leaves with serrate pinnæ become much incised and laciniated by mere submergence alone, without the necessity of invoking evolutionary processes through intermediate forms; and this is wholly due to lesser amounts of parenchymal development, for the vein system is practically alike in the two forms of leaves. Here there is evidently a greater resistance offered to the formation of tissue by the denser medium, water, in which it takes place, and the chlorophyll-bearing cells forming the stomata-bearing surfaces are restricted to narrow bands bordering the stronger veins. I have twice observed this fact.

(2.) *Ranunculus multifidus*, Pursh, some forms of *Ranunculus aquatilis*, L., and *Proserpinaca palustris*, L., are good examples of my second class; and here the same arguments hold good, for, as I have repeatedly observed in *Ranunculus multifidus*, Pursh, and the *Proserpinaca*, it depends entirely on the depth of water and the consequent relative amount of submergence of the plants, how many of the leaves are dissected into narrow lobes, and how many remain normal. In the yellow *Ranunculus*, moreover, we find plants growing on shores, and not at all submerged, bearing only normal leaves; and this character is so well marked that this form has been given the rank of a variety in the Manuals of Botany (*var. terrestre*). In both *Ranunculi* the dissected lobes of the sub-aqueous leaves are somewhat prolonged by the stronger growth at the ends of the main veins as compared with that of their lateral branches. In all such leaves the formation of cellular, stomata-bearing tissue is reduced to very small amounts by the resistance of the water.

Another kind of dicotyledonous water plants may here be noticed. I refer to the *Nymphæaceæ* and the genus *Limnanthemum*. These bear nearly always entire-margined leaves,* the growth taking place at the contact of air and water, where the resistance is very small. Another interesting feature of these plants is the existence of thin, delicate, submerged leaves on *Nuphar parvulum*, Smith,† and *Limnanthemum lacunosum*, Griseb.‡ In these leaves the failure to produce the normal amount of parenchyma is evidenced in a reduction of the number of layers of cells, the resistance here causing a diminution of growth vertically instead of laterally.

(3.) In plants bearing leaves all normally submerged there is less direct evidence of the manner and cause of their capillary origin. *Hottonia inflata*, Ell., *Ceratophyllum demersum*, L., and *Proser-*

* In *Cabomba* we have small, entire margined, floating leaves, and large, dissected, submersed ones. In one or two species of *Nymphæa* the leaf is somewhat dentate.

† GRAY, Manual, p. 57.

‡ Bull. Torr. Bot. Club, x., 34.

pinaca pectinacea, Lam., are good examples of this class. If we accept as true the proposition that leaves were originally entire, we must assume some system of change from less divided-leaved progenital species, not by a search for carbonic acid, as Mr. ALLEN has imagined, but caused primarily by resistance offered by the water.

The origin of the multiform leaves, borne by plants whose natural habitat is dry land, is much more obscure. The theories advanced by Mr. ALLEN certainly will not answer. But taking the facts before mentioned in regard to the variable amounts of nutriment received from the roots, together with the existence of a well-defined system, a venation, and the fact that all vegetable growth is affected under the atmospheric pressure of fifteen pounds to the square inch—certainly an appreciable amount of resistance, and also against the attraction of gravitation—I think we have data which will explain some, if not all of the marginal modifications of leaves.

Mr. ALLEN'S papers on this subject have been widely, and very generally unfavorably criticised.* I do not here propose to offer other objections to his theories, or his style of imaginative evolutionary deduction, although there are many statements in the papers here alluded to, which should be seriously considered before accepted as exact.

DISCUSSION.

Dr. SCHÖNEY observed that agriculturists give no clue to the cause of this variation in leaf structure. The Japanese maples have been found capable of a wide modification. However, experimental cultivation has not thrown light upon the causes of these changes.

Miss E. G. KNIGHT stated that in the fern leaves the ribs correspond to the interspaces between the veins. In *Salisburia* all the terminal leaves and all the older leaves are much more laciniated.

Prof. DAY suggested that plants growing in loose sand, and thus liable to be covered by sand and earth, were found apt to be divided.

Mr. C. F. COX said that he had given some attention to a similar subject, and that, if any criticism were to be made upon the paper just read, he thought Dr. BRITTON had confined himself too exclusively to the merely mechanical or physical view of the matter, and had not allowed sufficient weight to physiological considerations, particularly in reference to the differences between the shapes of aerial and of aquatic leaves. It seemed evident that the parenchymal tissue was spread out upon the fibro-vascular skeleton for the purpose of expos-

* See W. T. THISTLETON-DYER in Nature, XXVII., 54; notes by F. O. BOWER, *ibid.*, 552; note by Sir JOHN LUBBOCK, *ibid.*, 605, where he indicates his opinion that the cause of lobing is a mechanical one; note by E. M. HOLMES, *ibid.*, XXVIII., 29; also, L. P. GRATACAP, in Bull. Torr. Bot. Club, June, 1883.

ing a certain amount of cellular structure to the surrounding air or water, with relation to the favorable operation of either one or both of the great physiological functions—the assimilative and the metastatic processes. Since in nature the employment of material, like the expenditure of energy, is directly proportioned to some necessary end to be attained—there being neither waste nor deficiency,—we are forced to the conclusion that the differences in at least the *quantity* of leaf substance have an essential connection with the varying physiological requirements of plant life; and when the problem of leaf-forms is fully solved, it can hardly be doubted that here, also, physiological causes will be found to be the most potent and the most important. We know already that, as to their structure, the partially submerged plants of the order Nymphæaceæ stand upon a dividing line between the fully aquatic and the strictly terrestrial orders, the conditions of their environment necessitating certain adaptations of material means to physiological ends,—as, for example, the apparent transference of the epidermis with some of its organs (stomata) exclusively to the upper side of the leaf, and of some other organs, usually external (trichomes), to the intercellular air passages, which are uncommonly large. These peculiarities of structure are plain indications that physiological functions, which are performed by certain forms of leaves growing in the air, may require a change in the forms of the leaves when growing partially in the water; and they establish at least a strong probability that totally submerged leaves become entirely incapable of performing some of the functions of aerial leaves, and consequently differ from them in both structure and shape. It is therefore quite likely, as Prof. DAY has suggested, that the submerged filiform leaves have reverted to a more fibro-vascular and less cellular structure, simply because of a lack of physiological use for a greater parenchymal system, by reason of the nature of their habitat.

Dr. BRITTON stated that he had not combated the idea of the influence of an insufficiency of carbonic acid in the water.

Mr. COX further remarked that the stomata were almost wanting in submerged leaves.

The PRESIDENT observed that the plants which check the progress of drifting sand are chiefly the Gramineæ. Others, which grow in sand, have broader leaves—*e.g.*, the *Cucurbitaceæ* (watermelons), several species of *Abronia* in the Far West, etc. Experiments could be made which would throw much light on this subject, *e.g.*, by means of tanks of water containing varying amounts of carbonic acid, or by growing plants under pressure, etc.

The forms of leaves were so infinitely diversified as to constitute an almost inexhaustible subject of study, and the cause or causes of this diversity have not yet been investigated with the thoroughness and philosophical method through which the truth will be discovered if within our reach. Certain broad generalizations could be made in regard to the forms of leaves, which were based upon striking and suggestive facts, but the explanations offered were for the most part mere speculations. As a general rule the submerged leaves of aquatic plants were dissected, while the emerged or floating leaves were broad. This is true not only of the cases cited by Mr. BRITTON but of many others in the recent flora, and it had prevailed through all geological ages. When a boy he discovered that the well-known plant *Sphenophyllum* of the Coal flora had dimorphous foliage; the lower leaves were capillary, constituting many of the species of the genus *Asterophyllites*, while the summit leaves were broad wedge-shaped; and on terminal branches carrying such leaves, the genus *Sphenophyllum* was founded. From these facts he inferred that this was an aquatic plant growing in the lagoons of the Coal marshes, with only its terminal branches and leaves exposed to the air. In a paper read before the American Association in 1853, these facts were given and illustrated by figures in the Report of the Proceedings of that meeting. Ten years later the same facts were reported by the Belgian palæontologist, Coemans, as discovered by him.

The functions performed by the emerged and submerged leaves of aquatic plants are evidently different. They are exposed to different media, air and water, and the differences in form and structure evidently hinge upon the differences in the media, and in the functions performed, the blades of the emerged leaves are both exhalent and absorbent organs, exhaling moisture and oxygen and inhaling carbonic acid, sometimes oxygen, and often absorbing water; the submerged leaves have probably a more limited range of function, are simpler machines, and they have less to do and that of a simpler kind. The pressure of the water may determine the form of the leaf, but it can hardly be accepted as counting as a mechanical impediment to the formation of parenchyma; for in some submerged plants, such as *Myriophyllum ceratophyllum* and *Ranunculus aquatilis*, the leaves are so numerous that the area of parenchymatous surface must be as large as in almost any aerial plant. The thread of prosenchyma in a submerged leaf filament bears perhaps as small a ratio to the parenchyma which encircles it, as the skeleton does to the parenchyma of an emerged leaf.

Among terrestrial plants the most striking and yet unexplained difference of form is observable; for example, the coniferæ as a rule have extremely narrow leaves and derive their German name of *needle trees* from their acicular form. But to this general rule we have striking exceptions in the broad leaves of *Gingko* and *Phyllocladus*. On the other hand *Ephedra*, like many other desert plants, is almost without leaves. In the ferns and umbelliferæ also we find the foliage very much dissected, almost as much so as that of aquatic plants—why, no one has yet given us a reason.

It has been suggested that the earlier forms of leaves were simple, and that they have become compound by variation in descent. The ancient history of plants, which I have studied with much interest, gives no support to such a theory. The groups of terrestrial plants which earliest assumed importance were the conifers and the lycopods, but they have retained practically the same forms of foliage from the earliest times to the present; the living *Lycopodium dendroideum* being almost an exact copy in miniature of the Lepidodendra of the Coal Measures, while the Mesozoic and Palæozoic conifers exhibit the same scaled or acicular leaves that characterize the most abundant conifers of the present day. The Gingkos of the Mesozoic age generally had more divided leaves than the *Salisburia* of the Tertiary and present times; but on looking over the entire field, it is impossible to detect any progressive tendency to simplicity or complexity in the foliage of the coniferæ. The cycads, of which the golden age was the Jurassic, have always been characterized by pinnate fronds with often narrow pinnules; but their first development was in the Coal flora in the form of *Cordaites* and *Noeggerathia*, in which the leaves were broader than in most later species.

The monocotyledonous plants, the grasses and palms, the yuccas and pandanus, have, as a general rule, narrow leaves and a parallel nervation, for which no adequate explanation has been offered; while some of the lilies and most of the arums have broad leaves of a totally different structure.

The broad-leaved angiosperms begin in the Cretaceous, and speedily acquire pre-eminence in the vegetation of the globe. We now have the life history of this group pretty well outlined in the elaborate figures and descriptions of the Cretaceous and Tertiary floras, but we look here in vain for any law of development in leaf-forms. Among the earliest plants are the magnolias, remarkable for the simplicity of their leaves, their entire margins, and their camptodrome nervation. With these are oaks, generally with toothed, but only later cut and lobed leaves; willows, with simple leaves like those of the present day; *Liquidambar*, with species in the Cretaceous and Tertiary, having leaves with broader lobes than the living one, and yet not decidedly different; Aralias, with digitate leaves, and *Platanus* and *Sassafras*, with broadly lobed leaves, were conspicuous elements in the earlier angiosperm flora, but they were essentially what their representatives are at the present day. The facts, which I have observed in my study of fossil plants, compel me to reject any system of evolution as an explanation of the observed diversity in leaf-forms.

January 14, 1884.

SECTION OF GEOLOGY.

The President, J. S. NEWBERRY, in the Chair.

Thirty-two persons were present.

The resignation of Dr. I. I. HIGGINS, as Resident Member, was accepted, and Dr. LOUIS M. CHEESMAN, of Trinity College, Hartford, Conn., was elected a Corresponding Member.

A paper was read by Mr. B. B. CHAMBERLIN, illustrated by a series of specimens, on

FIELD WORK IN LOCAL MINERALOGY.

As our city extends its boundaries, the levelling of rocky elevations, the opening of avenues and railways, and the construction of sewers, afford continued opportunities for the local collector to pursue his investigations and enlarge his store of trophies in this interesting branch of natural history.

The region beyond the Harlem River will now receive more attention than hitherto.

Some of the more noticeable results of the writer's visits to various localities in and about our city, during the past two years, may be stated as follows :

Ripidolite.—This variety of chlorite is abundant at the dolomyte beds in the vicinity of Morrisania, especially at 145th Street and St. Ann's Avenue.

It is concentrated near the surface of the dolomyte, in layers varying in thickness from a half inch to perhaps five inches. The color is generally of a dull blue, and occasionally of an olive green. The body of the deposit is a mass of folia or scales, usually not over half an inch in diameter. The dolomyte immediately adjacent to the deposits of ripidolite is mostly of a friable character and darkish in color, varying from a dull violet to brown.

A new locality for a local mineralogist which has lately attracted my attention is the marble quarry on Jerome Avenue. Here the deposit of the above-named mineral is exhibited in a striking manner. The layers are at times greatly distorted.

Aggregations of the folia occasionally approach crystalline forms—perhaps quite as near as the tender nature of the mineral will allow under prevailing circumstances. These crystal masses, when scattered over the white dolomyte, afford the collector pleasing contributions to his cabinet, rarely surpassed by any of our local specimens.

The history of this ripidolite formation is worthy of a more complete investigation than it has yet received.

The Jerome Avenue quarry may be announced as a new locality for *Tremolite.*

It is to be hoped the supply may be considerable, as the Kingsbridge locality has long since been abandoned.

After gleaning in the above locality specimens of ripidolite and tremolite, the collector will perhaps add to his stores what fragments of *Quartz* may fall in his way. Most of these display drusy surfaces in yellowish and brownish tints, due to the presence of iron. Others are clear and brilliant, the crystals of a larger size, but showing pyramidal faces only. One specimen, showing an association of *Blende* and *Rutile*, indicates that a keen eye may be used to advantage in future observations, as the work of quarrying progresses.

Associated with the beds of dolomyte in North New York appear masses of *Actinolite* rock, furnishing crystals of considerable merit. The forms are long and slender, in color an olive green. Good terminations are quite abundant.

Within the past year further progress has been made in removing the rock masses at 120th Street and Fourth Avenue. The delicate blue *Tourmalines* (probably the *Indicolite* referred to by Prof. Webster) may occasionally be obtained in limited quantities.

The mineral sometimes appears a mere cloudy spot of sky-blue tint, easily recognized.

Also noticeable at this locality is the *Orthoclase*, of a deep red color, especially brilliant in the vicinity of certain lines of fracture.

The varieties of Mica obtained by the writer in our neighborhood are thus far ten in number.

Among the latest obtained is a *Muscovite*, of decidedly grass green tint, found on Ninety-third Street near Eighth Avenue, also near the Convent on 127th Street west of Eighth Avenue.

At the Jerome Avenue Quarry I found traces of a delicate *brown mica*—peculiar to the dolomyte beds. That found near Morrisania is of a deeper color. Near the latter locality I have secured some interesting finely shaped crystals of muscovite, also fragments of *Biotite.*

Staten Island is noted as one of the chief localities of minerals of the amphibole family. The list has not hitherto embraced *Mountain Leather;* I have the pleasure to report finding specimens during the past summer at the iron mine near Clifton

It may be described as consisting of interlaced fibres of asbestos, the leathery tint due to impurities.

A number of visits have been made to the quarries at Weehawken. The trap rock of this locality affords specimens of a mineral, the nature of which has not yet been ascertained. It is possibly of a chloritic nature. One is reminded of the investigations of Prof. ISRAEL C. RUSSELL on certain hydro-carbons found by him near Plainfield, N. J., also of the mineral of the Connecticut trap dikes described by G. W. HAWES under the name "Diabantite."

The specimens obtained at Weehawken are light in weight and readily disintegrated. One variety is black in color—resembling asphaltum—the other is of a steel-blue tint.

At the northern extremity of the quarries is found a close-grained trap known as *aphanite*, which exhibits interesting illustrations of radiated structure, and rounded forms with conchoidal fracture, peculiar to concretionary developments of certain minerals.

In the drift overlying the trap I was successful in finding some remarkably good specimens of *Graphite*, much superior to any yet obtained in the vicinity of our city.

DISCUSSION.

Dr. JULIEN remarked that the dark chlorite, however carbonaceous in appearance, owed its color entirely to mineral matter, according to all analyses yet made. It belonged to the group of so-called minerals—delessite, diabantite, etc.—whose want of uniformity in composition and absence of crystallization marked them as transformation products in the alteration of the original augite, etc., of the diabase. The specimens of decayed micaceous mineral exhibited were identical in appearance with Jefferisite, Culsageeite, etc., a series of more or less oxidized forms of an altered chlorite from Pennsylvania and North Carolina, to which a long list of unnecessary new names had been recently given.

Mr. G. F. KUNZ observed that the darker form of chlorite found at Weehawken differed much in appearance from that found elsewhere in the range. Some of it was light green in color, but this was as dark as a hydro-carbon and very brittle, evidently consisting of portions of the rock, thoroughly altered.

Mr. CHAMBERLIN further stated that radiated forms of this chlorite were often seen.

Dr. BRITTON had noticed faults in the rock, at 117th Street and Fifth Avenue, at right angles to the bedding, and lined with a slickensides of chloritic material.

A paper was then read by Dr. JOHN S. NEWBERRY, illustrated by lantern views and a map, on the subject of

THE EROSIVE POWER OF GLACIER-ICE, AND ITS INFLUENCE ON THE TOPOGRAPHY OF NORTH AMERICA.

(Abstract.)

Ice being a comparatively soft substance, seems at first sight incapable of doing much toward the wearing away of solid rock or changing topography. But the facts observed in connection with all glaciers prove that ice is a powerful eroding agent. Where several hundred or several thousand feet in thickness, as some glaciers have been, the ice rests upon the underlying surface with a weight of hundreds and even thousands of pounds to the square foot. Such a mass in motion, impinging against obstacles, has often crushed and removed them, gathering beneath it fragments of all sizes, from sand to boulders ; these have been the instruments of powerful grinding action, which over great surfaces has planed down the rocks, removed or rounded over asperities, filled valleys with debris, and thus produced a marked effect upon the topography. Local glaciers broaden and deepen the valleys in which they move, and having a positive excavating power, have often increased the irregularities of topography ; while broad, continental glaciers have produced just the opposite effect, as we have evidence on a stupendous scale. Over all that portion of North America lying north and east of Bismarck, St. Louis, Cincinnati and New York, the surface bears marks of extensive erosion by ice, consisting of planed, scratched, and undulated rock surfaces, the inscription made by glaciers and nothing else, and sheets of transported material, which has been brought a greater or less distance from the north southward. This sheet of drift material extends from the Banks of Newfoundland, which are formed of glacial debris, over Nova Scotia, Canada, New England, New York, Northern Pennsylvania, over most of Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota. From the British line it extends northward, parallel with the Canadian Highlands, probably to the Arctic Sea. Over all this area, which embraces not less than a million of square miles, the surface of the eroded rocks is covered with a sheet from ten to three hundred feet in thickness, averaging thirty or forty feet of glacial debris, boulder clay, boulders, gravel, sand, etc., all of which have been moved a greater or less distance southward. North and east of the Canadian Highlands, which extend from Labrador to the great Lakes, and then to the Arctic Sea, the country has been but partially explored ; yet it apparently everywhere bears evidence of having been covered with glaciers, and it would

thus seem that in the culmination of the Ice Period, the whole country from Greenland to Bismarck, St. Louis, Cincinnati and New York, was covered with snow-fields and sheets of ice. The ice also seems to have been thick enough to overtop the highest mountains in all this region; hence it pressed upon the underlying rocks with a weight of from 50,000 to 300,000 lbs. to the square foot, and having been also in motion and underlain by sand, gravel, and boulders, during the thousands of years of its continuance, it wore away the surface rocks in places hundreds of feet, and, as it retreated, left behind it the great sheet of debris which it had scraped off and moved southward. In the advent and decline of the Ice Period local glaciers occupied in succession different portions of the glaciated area, and there did their special work in deepening valleys and excavating lake basins. In the far West during the Ice Period, the more elevated portions of the Rocky Mountains, the Wasatch and the Sierra Nevada, were occupied by glaciers as far south as the 36th parallel. North of the Columbia the glaciers reached the sea, and all the Puget Sound region was a basin filled with ice. In Southern Colorado and in California, about the Yosemite, the evidences of glacial action are as striking as anywhere else, and thence northward are almost continuous to Alaska, where great glaciers now exist.

The erosive power of ice has been positively denied by a number of American geologists, Prof. J. P. LESLEY, Prof. J. D. WHITNEY, and others; but the facts cited, as well as others, show that ice is, over the region it occupies, a much more powerful eroding agent than water. The streams which drain glaciers are always turbid from the quantity of sediment they receive, through the grinding action of ice resting on sand and stones.

The streams which drain the glaciers of the Cascade range in Washington Territory—the Cowlitz, Puyallup, White River, etc.—are opaque and milky the year round; while other streams, fed only by rains, are turbid only at intervals when the rains are unusually heavy. In the Alps, all the streams which flow from the glaciers are so white from the sediment they transport that their water is called *Gletscher Milch;* and the opalescence of the lakes into which these streams flow is due to the fine particles ground up by the glaciers and held in suspension. Measurements have been made of the amount of solid material transported by these glacier streams, and it is shown to be much greater than that carried away by mere rain-fed rivers. For example, the stream which drains the Aar glacier carries off daily 280 tons of sediment, and that which drains the Justedal glacier of Norway removes 69,000 cubic metres of rock annually; and these are only partial measurements of the eroding power of two small glaciers.

January 21, 1884.

SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty persons were present.

Mr. G. F. KUNZ exhibited two specimens of corundum from North Carolina—the one a crystal of 13 grammes—the other, weighing 3.15 karats, cut *en cabochon*, probably the most perfect star sapphire ever found in the United States. Both were of a rich light brown color, very compact, and resembled a variety of sapphire from the "Hill of Precious Stones" in Siam.

A paper was then read by Prof. H. L. FAIRCHILD, illustrated with the lantern, on

METHODS OF ANIMAL SELF-DEFENCE.

DISCUSSION.

The PRESIDENT remarked on the character of the dentition in the sabre-toothed cat, *Machairodus*, of which the canines of the upper jaw project seven or eight inches, and were curved, compressed, and sharp-edged. In the Tertiary age such teeth were common to many carnivorous animals not closely related, and seem to have been instruments fitted and employed for reaching the vital parts of other animals especially protected by bony armor. In ancient times, a constant competition had been going on between the means of offence and defence. This was well illustrated by the strife now maintained between the weapons and armor of men and ships in human warfare. Some of the ancient animals were better provided with means for attack and defence than any in later times—for example, the mail-clad ganoids and spine-bearing sharks of the Devonian and Carboniferous seas, the formidable teeth and claws of *Megalosaurus* and *Lœlaps*, and the thick bony plates and enormous spines for defence of *Stegosaurus;* also the great canines of *Machairodus*, and the impenetrable carapace of the contemporaneous *Glyptodon*. In the latter case the huge armadillo was probably vulnerable only at the throat, and the sabre-like teeth of *Machairodus* were probably used to penetrate that part.

Geology furnishes many examples of the nice adaptation of means of defence among the herbivorous animals against the weapons of the carnivora, but it is a remarkable fact that we find very few rudimentary and imperfect organs of this sort. This is one of the many mysteries of the geological record, that the successive steps in the development of means of offence and defence should be so rarely found, and it is one of the difficulties of Darwinism as the theory o the universe. Incomplete organs of offence and defence would often be inoperative and useless, like a bridge which is of no value whatever if it only partly crosses a stream. The horns of a bull can be of little service, till they project from the head and are well progressed on the road to maturity.

In geological history there is recorded a well-marked progress in the character and efficiency of the devices for offence and defence. Taking for example the placoderms of the Devonian for our starting-point, as these are the earliest well known fishes, we find them encased in armor which would bid defiance to all offensive weapons; but it was so much of a load to carry that they must have been inactive and unenterprising animals. In the Carboniferous age the placoderms had given place to the scaled ganoids and sharks, which were less protected by armor but more active. These continued their reign till the middle of the Cretaceous, when the teliosts, like the trout and salmon, took possession of the waters. These latter are but moderately provided with means of offence, and their thin and flexible scales afford little protection against attack; and yet they have practically taken possession of all rivers, lakes, and bays, and far outnumber other fishes in the open sea. By what means these small and light armed troops gained so complete a victory over their armor-clad predecessors, we can only conjecture; but, it is probable, because they possessed greater intelligence and activity, their superior nerve-power being more than an equivalent for the passive protection of spines and bony plates. In the competition for the food supply which has apparently been the chief struggle of life, the quick-witted and quick-moving teliosts would circle around their slower rivals, and, by devouring their food, create a desert in which they starved.

Similar facts may be observed in the history of the changing fashions in regard to offensive weapons and means of defence among animals, including Man. A large number of the Carboniferous sharks were provided with formidable spines; now only a few sharks and the chimæras retain their spines, but these greatly diminished in size, and more ornamental than useful. So, a century ago, every gentleman wore a small sword, which he was only too ready to use. Where this fashion was general it became universal, for an unarmed man, in a crowd who carried arms, was quite at their mercy.

In the middle ages all warriors were clad with mail; but this, to be an effective defence, was so cumbrous that, if the occupant of one of these steel prisons was so unfortunate as to be thrown on the ground, he could hardly, unaided, recover himself. Now all this system of defence has been abandoned, and celerity of movement and improved weapons have made the light-armed troops of to-day far more effective.

In the competition between the iron-clads and improved projectiles, which has been in progress during the last twenty years, we have a parallel instance of the reciprocal influence of improvements in the means of attack and defence.

Prof. W. P. TROWBRIDGE remarked on the interest of this subject. As an instance, the box-turtle had a perfect protection in his shell, which could only be destroyed by being dashed against a stone. But the very difficulty in such cases had often called out the ingenuity of animals. Crows have been often seen by him in Puget Sound dashing mussels against the rock, by dropping them from a height of twenty or thirty feet.

The immeasurable superiority of Man was shown in his absolute power of overcoming all obstacles by his intelligence. No animal can resist his power and will. This absolute power of Man to provide, both for his defence and for the destruction of the lower animals, renders it difficult to believe in his origin by development from them.

January 28, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present to listen to the first lecture of the Course of 1884, by Prof. J. W. POWELL, of Washington, D. C., on

THE MYTHOLOGY OF THE INDIANS OF THE SACRAMENTO VALLEY.

At the conclusion of the lecture, on motion by Prof. O. P. HUBBARD, a unanimous vote of thanks was passed to Prof. POWELL.

February 4, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-five persons were present.

Mr. S. LOWELL ELLIOT was elected a Resident Member, and the resignations of Messrs. I. L. CLOSE and THOS. A. CLARKE were accepted.

A paper was read by Dr. J. S. Newberry, illustrated by lantern views and botanical specimens, on

THE BOTANY, GEOLOGY, AND RESOURCES OF THE COUNTRY TRAVERSED BY THE NORTHERN PACIFIC RAILROAD.

February 11, 1884.

The President, Dr. J. S. Newberry, in the Chair.

Forty persons were present.

The following memorial notice of the late Vice-President of the Academy, Dr. Benjamin N. Martin, was read by the Secretary:

The Committee appointed to prepare a minute, with *Resolutions*, respecting the death of Prof. B. N. Martin, submit the following Report:

Benjamin Nicholas Martin, S.T.D., L.H.D.,

born at Mt. Holly, New Jersey, on October 20, 1816, was graduated from Yale College in the Class of 1837. He made profession of the Christian faith while at College, and entered the theological seminary at New Haven immediately after graduation. After supplying the pulpit of the Carmine Street—now West or Forty-second Street Presbyterian—congregation for nearly two years, he became pastor of the First or Russel Congregational Church of Hadley, Massachusetts, where he remained until 1847. His labors were attended with signal success, and his memory is still cherished by the older families of each congregation. While in New York, he had married Miss Louisa C. Strobel. The climate of Hadley proved unsuited to her health, so that in 1847 he resigned his charge. He became pastor in 1848 of the Fourth Presbyterian congregation of Albany, New York, but retained the charge for little more than a year. This was his last regular pastorate.

He remained in Albany during the following three years, devoting himself to general study. During his years of labor as preacher and pastor, he studied earnestly in theology and metaphysics; but, during these years at Albany, his associations gave opportunity to gratify his native bent toward the natural sciences, which he did not fail to improve to the utmost. In 1852, he was called by the University of the City of New York to fill the Chair of Logic and Philosophy, which then covered nearly all branches of mental and political science, with not a little of literature. From that time, until the day of his death, his name has been prominent in connection with almost every good work. His influence has been felt in all directions. He was an effective worker in the Evangelical Alliance, the American and Foreign Christian Union, the Society for the Prevention of Crime, and the New York Academy of Sciences.

In 1862, Columbia College conferred on him the degree of S.T.D., and, in 1869, the Regents of the University of the State of New York bestowed on him the degree of L.H.D.

Prof. MARTIN'S married life lasted for forty-one years, and has been rightly described as well-nigh ideal. Mrs. MARTIN'S death, in April, 1883, was a terrible blow; but her husband was not of those who sorrow without hope, and his patience while thus stricken was a proof of his Christian fortitude. The separation, however, was short, for on December 26, 1883, he died of acute bronchitis, dying, as he had lived, full of faithful, cheerful trust in his God, whom, with singleness of heart, he had served for full fifty years. The only issue of the marriage was one son, who is still with us, and whose labors in the service of the Academy are second in importance only to those of his father.

Professor MARTIN was a faithful member of this Academy; his services were equally effective and unostentatious. It is no exaggeration to say that the Academy owes very much of its prosperity to his exertions. His quick and generous recognition of merit in the younger members—his kindly words of encouragement, on occasions when keen, and perhaps deserved, criticism was chilling hope, will not be forgotten by some whom he thus kept in the way of study.

Professor MARTIN'S acquirements were remarkable. He began his studies in science when most of the branches, now so important, were in their infancy. With rare power he seized the salient points in each subject, and, with careful, systematic study, he kept himself well abreast with the advances of the succeeding thirty years. He was not an expert in zoology, or geology, or mineralogy, or molecular physics; but he was so well grounded in the general principles of each that no geologist, or zoologist, or mineralogist ever conversed with him for an hour without gaining some new conception, without feeling broadened, without feeling that he had talked with one who had reached the higher planes of philosophy. This breadth of information gave him wonderful power as an instructor in metaphysics—as an instructor in any branch. He was encyclopædic himself; he made his students so also. Other instructors taught their specialties, but Professor MARTIN, in addition to his own work, taught the student to gather all together, to assort the information, and to put away every fact in its own place along with those related to it. So, the thoughtful student, when done with Professor MARTIN'S immediate instruction, went away a well-furnished man, often surprising his seniors in age and acquirements by his stock of general information, so well assorted and so easily available.

That Professor MARTIN was a great thinker, his published essays prove; that he was a great teacher, more than a thousand pupils affirm; but more than thinker, more than teacher, he was great in those higher attributes which gain for a man not merely the respect, but also the love, of those with whom he is brought into contact. Though knowing no fear of man in his defence of principle, his great heart was overflowing with kindness. Throughout his life, his was a fitting exemplification of the religion which commands—"Do ye unto others as ye would that they should do to you." Like his great Master, he literally went about doing good. When he conferred a favor, he imposed no obligation; he demanded not gratitude, and, therefore, seldom failed to receive it. Wherever good could be done, he was there to do it. He visited the sick in hospitals; he carried sunshine into many a dreary tenement; he lifted the load from many a weary heart. He believed, in his practice, that "pure religion, and undefiled, is to visit the widow and fatherless, and to keep one's self unspotted from the world."

J. J. STEVENSON, for the Committee.

REMARKS.

Rev. Dr. E. P. THWING expressed a deep sense of his own personal loss. Dr. MARTIN was a many-sided and well-developed man; a gentleman by birth, by instinct, and by culture. In his early life he took a pulpit in a New England village, not far from Dr. THWING'S birthplace, and became prominent for his useful service. He also had a successful intellectual contest with an older clergyman of that place, a man of great dignity and weight, in which the youthful and the aged athletes were compared to a sword-fish and a whale. The young preacher's mind was clear, incisive, brilliant, and grew with years in strength and moral power. Dr. THWING desired to offer also a father's grateful tribute to the faithfulness of Prof. MARTIN as an instructor and example to his own two sons in the University. Happy indeed was he who taught by his life as well as with his lips. Dr. THWING had been associated with his lamented brother for years as a clergyman, in clerical bodies. To know him was to love him. He expressed profound interest in certain experiments in the science of Psychology. But the work of the scholar, the teacher, and preacher, was suddenly ended. We would drop, however, this garland of amaranth on his fresh grave, in full assurance that his unending life, his unimpeded activities, go on in higher spheres, and that, some day, we, too, would be with him there.

Prof. J. P. TROWBRIDGE remarked on the universal deep feeling, throughout the ACADEMY, of the loss of Dr. MARTIN. It was almost impossible to give full expression to the general sorrow. He was in all respects a remarkable man, distinguished for his constant interest in the ACADEMY, and for his retiring modesty and ability. The loss was an irreparable one. He seconded the motion proposed.

Mr. E. P. HALLOCK expressed, in behalf of himself and of Prof. CHAS. A. JOY, the former President of the NEW YORK ACADEMY OF SCIENCES, their deep sorrow at the decease of Dr. MARTIN.

The PRESIDENT desired personally to add his tribute of respect and affection to the memory of Dr. MARTIN, and to present his testimony to the great loss his death was to all those attempting to support any educating, elevating effort in the city of New York. These only could understand the difficulty of a struggle, in such a commercial centre, against the over-riding influences which surround them. He had felt, on hearing of this death, that it was an irreparable misfortune, not only to the ACADEMY, but to New York—so long had Dr. MARTIN been engaged in every enterprise connected with good in this city. His life was a precious one. He felt personally the loss of the refined, tender, gentle, and also intellectual influence which Dr. MARTIN had always exerted. No one more fully represented the type of a Christian gentleman. No one in this city had become more endeared to his friends than he, although others might be more publicly known. This was a loss, indeed, in which the feelings were too deep for words.

It was voted to place the memorial on the files of the ACADEMY, and the PRESIDENT then presented, in behalf of the Committee, the following Resolutions, which were read by the Secretary:

Whereas, An inscrutable Providence has removed by death Prof. BENJAMIN N. MARTIN, D.D., First Vice-President of the NEW YORK ACADEMY OF SCIENCES, and one of its most honored, useful, and loved members; as a tribute of respect and affection, the ACADEMY adopts the following Resolutions:

Resolved, That the ACADEMY OF SCIENCES, in common with every good cause and every elevating and philanthropic enterprise in the city of New York, by the death of Dr. MARTIN has suffered an irreparable loss, and has been deprived of a wise counsellor, an efficient worker, an accomplished scholar, a faithful friend, and a Christian gentleman.

Resolved, That, though he has gone from among us, we should be grateful that we were so long permitted to enjoy his society and receive the benefit of his co-operation ; and we have the satisfaction of knowing that the good work he has done and the shining example he has left will be enduring and will constitute a noble and imperishable monument.

Resolved, That, as a permanent record of our sorrow at his death, and as an expression of our esteem and affection, these Resolutions be included in the minutes of the ACADEMY, and published in the Transactions.

These Resolutions were then unanimously adopted.

A paper was then read by Prof. JOHN K. REES, on

THEORIES IN REGARD TO THE CAUSES OF THE RECENT RED SKIES.

DISCUSSION.

Prof. J. P. TROWBRIDGE remarked that the theory of volcanic dust appeared to him to be the most rational of all proposed.

As to the possibility of the distribution of the volcanic dust of the eruption of Krakatoa over so vast a district, he would recall some analogous phenomena. He remembered, some years ago, seeing a few trees on fire in Michigan. Within a few days afterward the forest was in flames over a large territory, and shortly after that there was alarm at Newport, R. I., and other places on the eastern coast, because the atmosphere was rendered so dark by smoke that artificial light was required during the daytime. The smoke had evidently been floated over the intervening area, in some upper stratum of the atmosphere, and descended in certain places.

The spread of the volcanic dust was probably due to the high prevailing atmospheric currents, apparently in great atmospheric curves, which would account for the course of these currents.

He could not assent to the theory of cosmic dust. In that view, the phenomena should have been simultaneous, and not locally different in time.

As to the descent of the volcanic dust, its rapidity would depend upon the diameter and weight of the particles, as well as the force of the upward and downward currents. Thus, in the deposit of the silt of the Mississippi, the upward and downward currents within the body of the stream tend to keep the particles of silt long in suspension.

Mr. B. B. CHAMBERLIN referred to the lemon-yellow color which frequently succeeded to the red glow, and produced very interesting results, generally rendering the lighter clouds pea-green, and the heavier ones olive. A little later he had noticed that the steam from the steamers in the harbor assumed a beautiful lavender color, while the smoke from the chimneys was colored like the clouds.

The PRESIDENT supported the view that the red glow was due to the diffusion of volcanic dust rather than cosmic matter, and gave several illustrations of the abundance of particles of solid substance in the atmosphere. Smoke, which consists of minute particles of carbon, sometimes covers whole States, and obscures the sun's light. During the last summer he had traversed a great area on the Pacific coast, where, for several months, smoke from forest fires in a specially dry season had concealed all distant objects. The blue color of the sky is supposed to be due to floating particles, and the haze which prevails for days and weeks with a cloudless sky, in autumn, is nothing but dust and smoke. The accumulation of volcanic dust on ships at sea, hundreds of miles from the craters from which it had issued, is an exhibition of the possible wide diffusion of such material.

The system of circulation of the atmosphere favors the spread over the whole world of dust thrown into the air in the tropics. The movement of the surface from west to east in the rotation of the globe is about one thousand miles an hour. The atmosphere, resting on the earth, moves with it, but not quite so fast. It lags behind at the surface five or six miles an hour; at a greater elevation, perhaps much more. This causes the great equatorial wind current, which flows from east to west in a belt, some thirty degrees in width, along the equator. At the same time the air in the equatorial belt is heated, rarified, and rises, to be replaced by the cooler northeast and southeast trade-winds which blow in along the surface of the sea. This causes a great movement of the atmosphere from the equator in a series of vertical circles toward the poles. As a consequence of this system of atmospheric circulation, whenever a discharge of dust takes place from a volcano like Krakatoa, in the equatorial belt, the dust is, in the first place, carried upward in the ascending currents of the heated zone, is carried westward by the equatorial current, and distributed toward the poles by the outflow from that zone. Hence, it is easy to see that the dust of Krakatoa might in time pervade the atmosphere over all the earth's surface.

February 18, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-three persons were present.

The resignation of Mr. CHARLES H. TRASK as Resident Member was received and accepted.

There were exhibited by Mr. G. F. KUNZ, two images, the *Llama* and *Vicuña*, from the interior of Peru.

They weighed six ounces each and were both of solid silver, with the exception of the bodies, which were filled with some earthy material. The *Llama* had evidently been acted upon by substances in the soil which left the silver in a remarkably pure state, and the workmanship on this figure, especially the hair reproduction, was very fine.

The *Vicuña* was not of as pure silver, and was in a very good state of preservation.

Mr. KUNZ explained that a famine in the interior of the country had caused the graves to be despoiled of many thousand ounces of ornaments, which were carried to the seacoast and there sold for their weight in silver and gold.

In speaking of the lapidary work done in agate, jade, and chalcedony at Oberstein and Idar in Germany, many articles made and sold there were described, and some perforated carnelian ornaments were exhibited, in which the perforations were round at one end and over one inch across, ran to an acute point, and varied in length from 2½ to 4 inches. They are sent to the interior of Africa, and sold at from four to five cents each, and are there worn by the natives.

A jade pendant was shown, over 1½ inch long, being one of a lot of over 200 lbs. of jade made up and sent to New Zealand. Mention was made of a mass weighing nearly 300 lbs., to be used for the same purpose. The cost of making these ornaments at Oberstein was about 40 cents each, which was much less than they could have been made for by native or skilled New Zealand labor.

There was also exhibited an oval carnelian disc, that had been shaped for cutting by chipping with a small hammer ; this chipping is equal to any that can be seen on American stone antiquities, and the entire cost perhaps one cent.

Some onyx beads were also shown, that in London or Ceylon would bring from £10 to £20 sterling per string, and were here made for as many dollars.

Mention was made of an American who achieved a fortune by importing the *Elephantum dentalium* from the Red Sea and selling it to our American Indians.

These instances illustrated the far-reaching influences of modern commerce in the most remote regions of the earth, and also the increasing difficulty in determining the genuine character of supposed aboriginal work in jade, chalcedony, etc.

The PRESIDENT regretted that the history of the silver images exhibited by Mr. KUNZ was not known, as they were probably of considerable antiquity.

They were imitations of two species of South American animals, one the *Llama*, the other the *Vicuña;* the fibre of the wool was very truthfully represented, and great freedom and variety were shown in the general work. Dr. F. N. OTIS formerly had some silver images of great interest brought from Peru, and now in the Blackmore Museum at Salisbury, England, to which he had presented them. In Colombia and on the Isthmus, Chiriqui, etc., the natives had made articles of a similar kind. Señor URICOCHEA, a gentleman who lived many years at Santa Fé de Bogota, had told him that a class of professional gravediggers and treasure-hunters existed there, who employed gangs of Indians in their work, and he had seen twenty-five pounds of gold images melted up to pay these employees. Some of the articles from Chiriqui had been treated by a process of pickling, the alloy of gold and silver having been digested in a solution and afterward polished.

As to the arrow-heads, there are still some tribes of Indians at the West who chip their arrow-points.

In Oregon he had formerly visited tribes who were armed only with beautiful bows and arrows, the shafts being constructed of reeds and the points of obsidian. The latter were very slender, so that they were broken and destroyed by a single use. Gen. FREMONT had obtained some beautiful examples of these, and had two of them made to be worn as ear-pendants by his wife. These were made without a blow, being chipped by crimping the obsidian against a piece of soft material, either metal or wood, held in the hand. Little force, but much skill and experience, were required in this manufacture.

The PRESIDENT exhibited a beautiful specimen of grouped crystals of argentite, from the Batopilas mine, Mexico.

Mr. KUNZ stated, in regard to the silver images, that, two years ago, five thousand dollars worth of such articles, made of gold and silver, were melted up at a refinery in this city.

Dr. A. A. JULIEN reported the results of his microscopic examination of the volcanic ash of Krakatoa, from a specimen fallen upon the deck of a vessel off the coast during that eruption. The material is almost entirely angular, only a few of the larger grains showing such slight rounding of angles as might have been produced by mutual attrition. During their short period of aërial transport, there seems to have been little contact between the particles of this ash. It appears wholly made up of a colorless obsidian, showing the usual optical behavior of a glass, with the exception of occasional pale lines of refraction. These are due to an almost universal fibrous structure, or penetration of an amorphous glassy groundmass by fine parallel lines. The fracture has been strongly influenced by this structure, so that many particles have linear forms, which, in association with their fibrous structure, make them resemble in ordinary light the grains of some mineral with strong cleavage. About one-third of the ash consists of minute particles, not exceeding a few thousandths of a millimetre in diameter. The measurements of the diameters of the particles of the greater portion, *i.e.*, about two-thirds of this ash, are given (A) in the table below, in fractions of a millimetre. For the sake of comparison, there are also given (B) the measurements of the fine reddish angular sand of the Sahara, consisting almost entirely of glassy, milky, and reddish quartz, and a little chalcedony and chert, and (C and D) of two samples of a fine dust, evidently derived from the Sahara, which fell a half century ago upon the deck of a vessel, fifty miles off the coast of Africa. The sample C consists of round grains, largely cellular, composed of glassy and milky quartz and of chert, chalcedony, and foraminifera. The sample D was mostly made up of angular particles of glassy and milky quartz, chert, and chalcedony, intermixed with coarser rounded grains of the same.

	Range.	Average.
A. Gray ash of Krakatoa, greater portion.	0.01 —0.09	Less than 0.03
B. Fine red sand of the Sahara.........	0.075—0.30	0.075—0.125
C. Coarse dust from vessel's deck......	0.20 —0.74	0.25 —0.36
D. Fine dust from vessel's deck........	0.07 —0.35	0.10 —0.18

It will be seen that the particles of the Sahara sand are, on an average, from two to four times as large as those of the ash of Krakatoa, but that those of the dust C are from eight to twelve times as large, and those of the dust D, from three to six times as large. As the specific gravity of obsidian (2.3 to 2.5) is decidedly less than that of quartz (2.5 to 2.8), it would not be astonishing that the exceedingly fine particles of the ash should have suffered a vastly wider transport.

The PRESIDENT observed that he had recently heard much said on the subject of the origin of the "red skies," in opposition to the supposed absurdity of so wide a transport of the ash of Krakatoa, but there was no other known source of such pulverulent matter, and there could be no doubt that the volcanic ashes might be transported any distance. The known system of atmospheric circulation would favor it. It would not fall, because it would have to stem an opposing current. Prof. LOOMIS has pointed out the existence of a dry belt on either side of the equator, and the need of air from the tropics, coming over the water, *e.g.*, the Gulf of Mexico, and so coming northward, loaded with moisture, to be here deposited as rain. Thus anything thrown into the atmosphere in the region of ascending currents could be readily carried up.

Mr. F. COLLINGWOOD exhibited a sample of curiously corroded iron wire. He had been called upon to examine the cables of the Suspension bridge at Pittsburg, built about twenty-four years ago by the elder ROEBLING, and to superintend the repairs. The cables, where they enter the anchorage, were enclosed in heavy canvas, filled solidly with coal-tar which had been boiled and treated with quick-lime. A brick wall was then built on each side of each cable, and the whole space between these and around the mass of wire and coal-tar was filled with cement mortar. Over this was a layer of heavy flag-stones laid in cement, and over this the flags of the side-walk. In some way, in the lapse of time, a considerable portion of the tar at each cable end had disappeared, and the cavity thus left contained in every case a dirty brown liquid, in *some* cases nearly filling the cavity. The mystery was whence the liquid came. One theory was that the coal-tar had undergone a slow distillation by the heat of the sun, striking on the flagging above. The liquor contained various salts of ammonia, among them the sulphide being quite prominent. His own idea was, that the high temperature acquired during a hot day would make the tar very liquid, and it would then (as was found) penetrate the brickwork and leave a cavity.

This cavity would be filled with air, which, at the high temperature of a summer's day, would be expanded and a portion forced out. This would be pumped in again by the cooling down which takes place at night ; and, when the air was highly charged with moisture, a part of this would be condensed and remain in the cavity.

This would account also for the sulphur, which is no doubt diffused in sensible amounts in the atmosphere of Pittsburg from the large coa consumption. The wire seizings were $\frac{32}{1000}$ of an inch in diameter, an were in many places rusted through. There were several wires rusted off in each cable. Nearly all the exterior wires in each strand were corroded somewhat, and it was thought best to cut and repair about 500 of them. The masonry was cut out, and tunnels built so as to afford ready access to each cable in the future. The cables were unwrapped for about 15 feet outside of the masonry and every wire thoroughly cleaned. In every case, before putting on the wrapping again, the cables were saturated with boiled oil and white lead.

Where the strands separate on entering the anchorages they were completely enclosed in paraffine, as it would hereafter be difficult to paint them at those points.

As to the ways in which the wires were attacked, they were three: First: As if acted upon by an acid, showing clearly the so-called "fibre" of the wire. Second: A roundish, black-looking lump of hard scale would be found, which, when knocked off, would leave a deep pit in the wire. This scale was largely composed of sulphur, and resembled a sulphide of iron. Third: In a few cases the "skin" of the wire was corroded through in a narrow slit, and then the whole interior eaten out, much like the decay of wood at the heart. This was not often seen, but might easily have been overlooked.

Professor W. P. TROWBRIDGE inquired whether the wire had been examined at any portion of the catenary, and also whether there was anything known in reference to the lifetime of the bridge; and suggested that a single wire broken or rusted would make a weak point in the cable.

Mr. COLLINGWOOD replied that the damage to the wires did not extend more than two feet from the anchorages in any case. The cables had been examined at the points where they passed over the towers, and at several intermediate points, and (with the exception of damage to the wrappings, which was easily repaired) the *wires*, on which the strength of the bridge depends, were intact. Experiments for tensile strength and stretch were made on both old and new wire, using an accurate gauge, registering to the $\frac{1}{10000}$ of a foot, and the stretch, reduction of area at point of rupture, and strength were practically identical. The paint was found defective at many points on the cables, and, to insure a perfect covering, the old paint was shaved off and two heavy coats of new put on. There is no reason why the bridge should not last a thousand years, if properly cared for in the future.

The PRESIDENT remarked that the atmosphere in Pittsburg was charged with sulphuric acid, and that this acid-water was certain to make its way into the cable through any crevice, and soon destroy the iron. No mere decomposition of any hydrocarbon could yield so large a quantity of water as that found. The dark product of the decomposition of the wire was probably the simple sulphide of iron.

The subject was further discussed by Professor TROWBRIDGE.

The PRESIDENT announced the death of Professor ARNOLD GUYOT on February 8th, and briefly sketched his character and the principal incidents of his life. He was born in Neufchatel, in

1807; educated at Neufchatel, Stuttgart, Carlsruhe, and Berlin; graduated in 1835, and studied theology; spent the years 1835 and 1839 in Paris; was Professor of History and Physical Geography at Neufchatel from 1839 to 1848. In common with his associates AGASSIZ and DESOR, he entered earnestly upon the study of the Alpine glaciers, when the fact of their former great extent was made known by CHARPENTIER. He took, as his special duty, the study of the distribution of Alpine boulders and the former reach of the glaciers. This study was continued during seven years, and the results were embodied in a large detailed map, which, unfortunately, has never been published. The publication of the observations of AGASSIZ, GUYOT, and DESOR was begun in the "Système Glaciére." Only one volume was printed. In 1848, GUYOT came to the United States, and, in 1849, published a volume with the title "Earth and Man," which was an abstract of a course of lectures delivered by him in Boston, in the French language, and translated by Professor FELTON.

He was then employed by the State of Massachusetts and the Smithsonian Institution, to organize a system of meteorological observations and publish a manual of directions for observers, in 1850. In 1851, he published a volume of meteorological and physical tables. In 1855, he was appointed Professor of Geology and Physical Geography at Princeton, where he remained until his death. During his vacations he studied the structure of the Alleghanies from Maine to Georgia, publishing a summary of his observations in the *American Journal of Science* for 1861. Between 1866 and 1875, he published a series of school geographies and maps, for which a medal was awarded at the Vienna Exposition in 1873. The personal character of Professor GUYOT was singularly pure and sweet. He was not only respected, but loved, by all his students and associates, and a large circle of scientific friends. He probably had not an enemy in the world. He was remarkably methodical and industrious in his habits, had a clear and logical mind, and every year made some important contribution to the stock of useful knowledge possessed by man. No just estimate of the value of his scientific work can be given in few words. He is, perhaps, more widely known by his connection with the study of the Alpine glaciers, which resulted in the discovery of an Ice period in the world's history.

Only a small part of his work on this subject has been given to the public over his own name; but the contributions which he made to the general result attained by the Swiss geologists were no less important than those of any other, and he deserves an equal share of the honor which belongs to so grand a work.

February 25, 1884.

ANNUAL MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-five persons present.

The Secretary read the minutes of the last Annual Meeting, which were, on motion, approved.

The Recording Secretary, Prof. O. P. HUBBARD, reported that there have been held nine meetings of the Council and thirty-two of the Academy. The attendance on the regular meetings and lectures has been fully kept up. The communications to the Academy were 73, 36 oral, 37 written, and fully illustrated by specimens, lantern views, etc. They might be classed as follows: Arts, 1; Archæology, 2; Chemistry, 11; Biology, 1; Engineering, 1; Geology, 15; Mineralogy, 26; Mining, 2; Natural History, 8; Physics, 6. A full course of public lectures was delivered. The roll of Resident Members has been changed by the resignation of eleven, the death of six, and the addition of only one.

The Corresponding Secretary, Prof. ALBERT R. LEEDS, reported that, in addition to answers sent to various letters of inquiry, he had notified eleven persons of their election as Corresponding Members—this being the total number elected during the year 1883—and had received letters of grateful acknowledgment from these gentlemen, and had duly presented their letters to the Academy. Also, that the vacancy created in the list of Honorary Members by the death of Prof. FRIEDRICH WÖHLER had been filled by the election of Prof. MICHEL EUGÉNE CHEVREUL.

The following Report of the Treasurer, Dr. JOHN H. HINTON, was then read:

NEW YORK ACADEMY OF SCIENCES *in account with* JOHN H. HINTON, *Treas.*,
FROM February 21, 1883, to February 25, 1884.

Dr. — *Disbursements.*

To George Gregory, Printer	$737 80
" Spectator Co., Printers	444 66
" Lecture Committee, for lectures	112 70
" Prof. D. S. Martin, for editing Annals,	100 00
" Academy of Medicine, one quarter's rent	106 25
" Miss L. R. Weeks, from Oct. 1, 1882, to June 1, 1883, addressing wrappers, etc.	77 04
" A. Woodward, work in Library	41 94
" Prof. D. S. Martin, express, postage, etc., etc.	64 55
" Prof. O. P. Hubbard, express, postage, etc.	5 26
" Temporary investment of Samuel Sloan's Patron Fund in a Chesapeake and Ohio B. Bond	98 12
" John Cornelius, for collecting $1,253	125 30
" John H. Hinton, Treas., postage, etc.	20 00
	$1,933 62

***Receipts.* — Cr.**

Balance from February 21, 1883	$20 06
From Annual dues	1,315 00
" Subscriptions to Annals by members	252 00
" Sales of Annals by Prof. D. S. Martin	19 82
" Initiation fee of one member	5 00
" Interest on U. S. Bonds	164 00
" Samuel Sloan, Esq., to become a Patron	100 00
" Mrs. Esther Herman to Publication fund	25 00
" Prof. A. R. Leeds to Publication fund	25 00
	$1,925 88
Due Treasurer	7 74
	$1,933 62

JOHN H. HINTON,
Treasurer.

The Treasurer explained the large cost of obtaining the annual dues of members, by means of the paid collector, and on motion it was

Resolved, To send a notice to the members, urging prompt payment.

The Librarian, Dr. A. A. JULIEN, reported that he had received on his appointment, January 7, 127 books and pamphlets, the accumulated accessions. Since that time, 114 parts have been received, amounting to 241 up to date, all of which have been numbered, their titles recorded in the Accession Catalogue, and exhibited before the Academy. The entire Library is in good condition and order, and now amounts to about 7,000 volumes and parts. Of these, about 1,400 volumes and parts now remain unbound, and the sum of fifteen hundred dollars is urgently needed for this purpose. An annual appropriation of five hundred dollars is required for the binding of the accessions of each year, and would insure the preservation of valuable works from injury by handling.

The report of the Publication Committee was given by the Chairman, Prof. D. S. MARTIN.

The last two numbers of Vol. I. of the Annals have been issued since the last annual meeting; the Index of Vol. II. was published last summer; the first and second numbers of Vol. III. were distributed last fall, and the third and fourth numbers of that volume will be issued during the coming spring. The delay has been due to the lack of papers offered in the summer, and to difficulties connected with the correction of the proofs. Vol. II. of the Transactions and the Indices of Vols. I. and II. have been published.

The election of the officers of the Academy for the coming year then took place, and the following persons were elected :

President—J. S. NEWBERRY.

First Vice-President—D. S. MARTIN.

Second Vice-President—A. C. POST.

Corresponding Secretary—A. R. LEEDS.

Recording Secretary—O. P. HUBBARD.

Treasurer—J. H. HINTON.

Librarian—A. A. JULIEN.

Councillors—G. N. LAWRENCE, LOUIS ELSBERG, E. C. H. DAY, W. P. TROWBRIDGE, H. L. FAIRCHILD, C. VAN BRUNT.

Curators—B. G. AMEND, C. F. COX, B. B. CHAMBERLIN, N. L. BRITTON, A. H. ELLIOTT.

Finance Committee—T. B. CODDINGTON, PHILIP SCHUYLER, THOMAS EGLESTON.

The PRESIDENT then made remarks upon the condition of the Academy, its library, etc.

He then presented an appeal, received from a committee headed by Prof. ALPHEUS HYATT, of Boston, in favor of the erection of a monument to BARRANDE, as a testimony to the remarkable palæontological work accomplished by him, while the nominal secretary and intimate friend of the late Count de Chambord. He was a favorite of fortune above most scientific men, distinguished for his industry and thoroughness, and has already erected a splendid monument to himself in his published works. He has given us a library of palæozoic life, and he deserved everything said in his praise for his perseverance, industry, and even genius, and was entitled to any further memorial which scientific men should see fit to raise. Still, it was true that many other able men, like GUYOT, without such advantages, have done a vast amount of useful work which often remains unpublished. It was unfortunate that no memorial was possible for such a man as GUYOT, though the best monument would be the publication of his great map of the ancient Swiss glaciers and the accompanying description of his labors in that field.

March 3, 1884.

REGULAR BUSINESS MEETING AND LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large East Lecture Room was well filled by the audience.

Mr. B. EDSALL and Dr. S. S. FRIEDRICH were elected Resident Members.

The following *Resolution* was passed :

"That all the meetings of the Academy shall be advertised in two public journals until the summer adjournment."

Prof. D. S. MARTIN read by title a paper by Mr. W. G. BINNEY :

III. NOTES ON THE JAW AND LINGUAL DENTITION OF PULMONATE MOLLUSCS.

The PRESIDENT then introduced Prof. D. CADY EATON, of New Haven, Conn., who gave a lecture, illustrated by lantern views, on

CHRISTIAN ICONOGRAPHY, AS ILLUSTRATED IN THE CATHEDRALS OF THE MIDDLE AGES.

On motion, the thanks of the Academy were presented to Professor EATON.

March 10, 1884.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty persons were present.

An invitation was received to send a delegate to the third annual meeting of the ROYAL SOCIETY OF CANADA.

Letters of resignation from Messrs. C. F. IMBRIE, W. LE CONTE STEVENS and J. K. FUNK were read and accepted, and Mr. JOHN G. BRANNER, of Scranton, Penn., a geologist to the Pennsylvania Geological Survey, was elected a Corresponding Member.

Mr. G. F. KUNZ exhibited some very small crystals of quartz, found in the Bear River region, Idaho, and Fort Defiance, Arizona, where thousands of miners are looking for diamonds. These crystals of quartz resemble those of that mineral, from their rounded and, apparently, octahedral form, which is due partly to the mode of crystallization, the two sets of pyramidal planes of the terminations closely approaching each other, and partly to abrasion by rolling in streams.

The PRESIDENT had found quartz crystals of the same form in the Shell Creek range, in Eastern Nevada, scattered in thousands through a trachytic rock, as well as in a similar rock of the Black Hills. He had examined the material washed from the sands of Upper California in search for platinum. In this a diamond of the weight of five-eighths of a karat had been found, and one even larger.

A paper was then read by H. CARRINGTON BOLTON, Ph.D., of Trinity College, Hartford, illustrated by a series of specimens, on

RECENT VISITS TO "SINGING BEACHES" IN SCOTLAND AND AMERICA.

[Abstract.]

The speaker stated that, since the paper by his co-worker, Dr. ALEXIS A. JULIEN, on the "Singing Beach of Manchester, Mass.," had been read before the Academy, he had continued his investigations, and proposed now to give an informal personal narrative of his experience in search of "singing beaches," with some of the results.

His attention was first directed to the curious natural phenomenon known as "musical sand," at a casual visit to Manchester-by-the-Sea, in August, 1882. On making inquiries of distinguished naturalists and geologists at home and abroad, both in person and by letter, and by a long search in State Geological Reports, without result, he found that the phenomenon had been generally overlooked, though it seemed to him worthy of study. He has since that date travelled many thousands of miles and written scores of letters in search of "singing beaches."

The peculiar squeaking sound made by walking over the dry sand at the Manchester beach has been already described in these pages. Tingling sensations in the toes and fingers, when kicking or stroking the sand, are also noticeable. The acoustic property of the sand is best demonstrated by rubbing between the hands a double handful, which then gives out three or four (perhaps, five) musical notes on a rising scale. The sounds can be heard over one hundred feet. When the sand is removed from the beach it often loses its acoustic properties.

In July, 1883, the speaker visited Eigg, a small island of the Hebrides group, on which occurs a wonderful "singing beach," discovered by Hugh Miller about 1850. Eigg is an interesting island from an historical point of view, having been the scene of a terrible massacre in the sixteenth century; it is also most interesting to a geologist on account of its lofty peak of pitchstone and other features. The beach itself is about 1,200 feet long, and all the sand possesses marked acoustic properties. The neighboring rocks are Oolitic sandstone. On the mainland, nearly opposite Eigg, at Ardnish, another locality of sonorous sand occurs, which, however, the speaker did not visit.

The next singing beach examined by Dr. BOLTON was on Lake Champlain, near Plattsburg, N. Y., for the clue to which he is indebted to Prof. ALBERT R. LEEDS. At this locality the sand possesses the acoustic properties to a moderate degree; at least the sounds were not so loud as at Eigg, but this may have been due to the damp weather which prevailed about the time of his visit. A notice of this locality was published in *Science*, for November 30, 1883.

Two localities of singing sand were visited by the speaker on Chesapeake Bay, one about ten miles from Norfolk, Va., and the other near Fortress Monroe. Again the damp weather was unfavorable, and only small areas of sonorous sand were found at the first locality, and none at the second, though it has been reported as occurring there in the summer season. On Chesapeake Bay the areas of sand having sonorous properties occur in the midst of ordinary sand beaches of great extent, and, since the eye cannot distinguish the sonorous from the non-sonorous sand, the existence of the former is hardly recognized, save by local fishermen and natives of the region.

The experience gained on the visits to these five beaches led Dr. BOLTON to believe that sonorous sand is far more common than supposed; so he called to his assistance the services of Mr. S. I. KIMBALL, Superintendent of the U. S. Life Saving Service, who kindly sent out in his own name a circular, prepared by Dr. BOLTON, addressed to the 200 keepers of Life Saving Stations in the United States. From these keepers letters and samples are now frequently arriving. Already forty-six (46) localities of sonorous sand have been reported, at various points on the Atlantic coast, from Maine to North Carolina, and on Lake Michigan. The speaker stated he had a list of 66 localities in all, including foreign.

In conclusion, Dr. BOLTON said he had not attempted to include in his remarks accounts of many foreign localities on his lists, and that he hoped on some future occasion to give the Academy particulars of the remarkable hills in Arabia Petræa and in Afghanistan, already alluded to in a previous communication. The microscopic examination of the samples of sand collected not being as yet completed, he is unable to advance as yet any satisfactory theory as to the causes of the singular phenomenon he has attempted to describe. Since the acoustic properties are not confined to any particular variety of sand (calcareous, quartzitic, and feldspathic sands alike are sonorous), the problem is a difficult one. It is possible that different causes are in operation at different localities. Information as to new localities, and samples of sand, are earnestly desired by the author of the paper and by his co-laborer on the subject, Dr. ALEXIS A. JULIEN.

During his remarks, Dr. BOLTON opened a jar of the sonorous sand which he had collected at Manchester-by-the-Sea on September 5, 1883, and which had remained tightly closed since that date. On rubbing this sand briskly between the palms of his hands, a sound was elicited which was distinctly audible to all in the audience. This experiment established the fact that the sand will preserve its acoustic properties when hermetically sealed.

DISCUSSION.

Dr. A. A. JULIEN reported provisionally on his microscopic examination of the sonorous sands. As to the materials of which they are composed, they may be the following : limestone and recent corals, as in the Sandwich Islands ; nearly pure quartz, as on Lake Champlain ; quartz, with some feldspar, as at Manchester, Mass. ; quartz, with a little iron-ore and garnet, as on the shores of Lake Michigan and along our Atlantic coast, south of New England ; and quartz with a small intermixture of chert, as in the Hebrides. The form of the grains may be largely angular or tabular, as at Manchester ; more or less rounded, as at nearly all the localities mentioned ; or even nearly spherical or oolitic, as on Lake Champlain. The texture may be cellular, in part, as in the Sandwich Islands and the Hebrides, but is in most cases compact and solid.

Sounds ordinarily heard in nature may originate in animate agents —animals and plants—or in inanimate objects. In the latter, the agencies which produce sounds may be classified as physical, *e.g.*, the rending of rocks or ice by frost ; electrical, *e.g.*, the lightning ; chemical, *e.g.*, the decomposition and explosion of pyrites ; mechanical, *e.g.*, movements in bodies of air, *i.e.*, the winds, or movements in water, the waves and surf ; and volcanic action. There are also sounds of greater rarity which are produced in mineral matter, such as by falling blocks of rock, the flowing of lava-streams, and the special subject under discussion, the motion of loose sands by the winds, waves, or animate agents. The louder and common sounds in nature thus originate in a variety of causes, and it seems probable that more than one condition is concerned in the modification of those heard in the sonorous sands. Various modes of vibration may be produced by the grating of cleavage planes, as in the Manchester sands, or the slipping of curved polished surfaces, as in many other instances ; but the reverberation within minute cavities may be also involved in the peculiar and louder sounds which have been heard in the sands of Kauai and Eigg, which contain cellular grains, and the same may be found true in the similar sands of Arabia and Nevada.

Prof. H. L. FAIRCHILD inquired whether a loss of the sound occurred on the removal of the Manchester sand from that locality, and whether the power of emitting the sound was retained by the sand in a dry room.

Dr. BOLTON stated that he had found that the sonorous sand of Eigg had lost its peculiar property when carried a few weeks in a cloth bag. He had baked the sand of Manchester in an oven, but found that it did not then regain its sonorous character.

[Dr. BOLTON here tested again the sample of sand from Manchester, which had emitted the sound a half hour before and had been since lying exposed to the dry air of the warm room, but the sand now refused to emit any sounds whatever.]

Mr. CHAMBERLIN suggested that such sand might emit louder sounds by its fall from a height.

A VISITOR stated that he had lived eleven months on the shore of Costa Rica, on the Caribbean Sea, about seventeen miles south of Greytown, in longitude 86°, while engaged in laying out a railroad, in the year 1864. He was the only European at that locality. While lying in bed at about eleven o'clock, one evening in February of that year, he was very much surprised by a peculiar sound from the solitary sea-beach outside of the house, which resembled the footsteps of a person approaching. Wondering whether it was caused by some native, or by an animal, such as an alligator, he rose, took his machete, and went out. The sound had ceased, the full moon was shining upon the beach, but no person or cause of the sound could be observed. The following night, at about the same hour, curious sounds again arose outside, sometimes like a low roar or like the barking of a dog, and which seemed to come from the distance of about fifteen yards, near the water-line. He went out and shouted, searching in vain for the workmen who had broken the rules by leaving their huts. On his return to the house, the barking sound was repeated, sometimes resembling the voices of two men conversing, and he thought himself possibly under the influence of some auditory delusion. The following night, a sound broke forth like that of hundreds of loud voices in the air, sometimes like that of singing, sometimes like the stringing of chords. Looking afterward for an explanation of these sounds, he found that the sand of the beach overlaid a stratum of massive coral reefs. At this point a tongue of land jutted far out from the coast-line, and, when the water retired at low tide, he could walk out a considerable distance upon these reefs. He found the whole beach and this coral stratum to be fissured all around the promontory by very deep clefts, and then concluded that the slapping of the water against the rocks, in the hollows beneath the beach, had probably caused these sounds of rushing, barking of a dog, the stringing of instruments, and the sounds of voices in the air. At present, he questioned whether a sonorous variety of sand might not also have been involved in this curious phenomenon.

March 17 1884.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-four persons present.

Dr. N. L. BRITTON made some remarks, illustrated by a series of specimens, on the subject of

OBSERVATIONS ON THE GEOLOGY OF THE VICINITY OF GOLDEN, COLORADO.

DISCUSSION.

The PRESIDENT referred to the immense collection of the fossil plants which had been made at Golden, by Prof. LAKES, and purchased for the museum at Cambridge, Mass. Many of the plants, chiefly of the upper series and Tertiary age, have been studied by LESQUEREUX, who has published a large volume on the subject. Nevertheless, all these studies have covered only the beginning of the extensive flora which is represented at this locality. Palms must have abounded there in great numbers, variety, and large size, the country having once been overgrown by a vast forest of these trees. There were also other trees, some yet to be identified, *e. g.*, one unknown conifer, of which a trunk, twelve feet in diameter, is now standing at Florissant, in the vicinity of Golden.

Dr. JOHN S. NEWBERRY then presented, with lantern illustrations,

NOTES ON A VISIT TO SOME OF THE SNOW-PEAKS OF OREGON.

March 24, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Eighty-five persons present.

Mr. G. F. KUNZ stated that while unpacking some specimens of fluorite from Amelia County, Va., he had noticed the display of phosphorescence, a pale greenish light, by the mutual attrition of the specimens, the same being excited also by the warmth of the hands ; by the heat of a candle this phosphorescence was increased, and on a red-hot stove became a deep emerald green. A specimen that phosphoresced in warm water was also shown. In Phillips' "Mineralogy," edition of 1823, a specimen of fluorite is mentioned, which yielded light by the warmth of the hand. He had since examined fluorite from over a dozen localities and had found that only chlorophane yielded phosphorescent light by attrition.

The attrition causing phosphorescence, Mr. KUNZ said, was new, and as the same result was produced by chlorophane from Branchville, Ct., it was said to be a new distinguishing characteristic between chlorophane and common fluorite, as in the case of pectolite from Bergen Hill, distinguishing it from the fibrous zeolites and other associated minerals.

A paper was then read by Mr. F. COPE WHITEHOUSE, M.A., with lantern illustrations, entitled :

The Topography of Egypt between 28° and 30° N. L., from original surveys made in 1882 and 1883, with special reference to the erosions—200 feet—of the Qerun and Reian Basins, and the two natural eminences (+650), to the west of the Kom El-Kashab (+950), of the same height as the summits of the pyramids of Gizeh.

[Abstract.]

On March 3, 1882, I went into the desert about fifty miles west of the Nile Valley and seventy-five miles southwest of Cairo, to examine the neighborhood of a hill, hitherto unvisited, known to the Arabs as the Haram. "Haram" is "Pyramid." This hill is not a pyramid nor is it pyramidal in appearance, although the buttes of horizontal limestone commonly assume a conical form. Nor is there any pyramid in Egypt (with one insignificant exception) to the south of the point where the Bahr Jousuf, which branches from the Nile at Siut, turns into that Western Oasis which has been identified with Pithom and the land of Goshen. Being without any European servant or companion, I could only satisfy myself that this hill of limestone streaked with gypsum was in a valley considerably below the level of the Nile. On April 4, I visited the Eastern part, and Mr. FLINDERS PETRIE, who accompanied me, assured me that it was not less than 250 feet below the level of the Nile, or about 180 feet below the Mediterranean. If filled with water, it would have the shape shown on the accompanying maps. This valley is not marked on any map prior to my autograph map, published in the June Proceedings of the Society of Biblical Archæology (1882). My belief in its existence was due to the ancient records of a Lake Mœris containing a pyramid-island, and a *mu amenti nti mar*, "the water of the lake of the West," with a canal ascribed by tradition to the patriarch Joseph or to a King Mēn. The lake or *Birket* marked on the map in the northern half of the same depression is stated in the books as about the level of the Mediterranean. On March 12, 1883, I ran a line of levels, aided by an Italian engineer, M. GASPERONI, with instruments furnished by the *Cadastre*, between the highest level of recent alluvial deposit and the lake. It proved that the surface of the lake was at least 44.94 *m.* below the valley of the Nile. I had previously made soundings in the lake, but the imminence of a dangerous storm (*Khamsin*) prevented my satisfying myself that I actually found the deepest place. At all events the bottom of the lake is not less than 150 feet below the Mediterranean. These observations, correcting the error of LINANT and LEPSIUS, were published in the *Revue Archéologique* (June, 1882). An excellent section had been published by Dr. SCHWEINFURTH from a survey made by ROUSSEAU PASHA, in 1880 (Zeitschr. O. f. E. Berlin), and ASCHERSON had also found a point in the Eastern part of the Wadi Reian 188 feet below the Nile, but these observations had not been duly noticed. My observations (1882) were wholly independent in motive and results. On March 22, 1882, having examined all the heights near Cairo, I was satisfied that the pyramids might have been natural hills.

The imminence of the outbreak under Arabi prevented my obtaining the customary facilities, and the government notified me that I must go alone. Still, it seemed to me of so much importance to obtain a section on lat. 30° that I started. Fortunately Mr. PETRIE, at that time at Gizeh, was willing to accompany me, and the section and map are based upon his entirely trustworthy measurements. These results are not only interesting as showing the varied character of that part of the earth's surface, hitherto a blank or an error; but it suggests the strategic importance of this region between Mœris and Memphis, and gives a reason why the pyramids of Gizeh should have been built or shaped out of hills on the left bank of the Nile. There is no doubt that the ancient account of Lake Mœris is substantially correct, and the restoration of the Southern Basin ought not to be far distant. The strategy of Alexander founded Herat in B. C. 327, as "the gate of India." The Hyk-Sos, who are said to have obtained a peaceful conquest over the native Egyptians, saw the agricultural, commercial, ethnic and strategic importance of the deep lake with two canals encircling its upper plateau so near to the Nile Gate of the Mediterranean, Bab-el-On or Cairo.

March 31, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience occupied the East Hall, and a lecture was given, illustrated by a collection of stone implements and lantern views, by Dr. ALEXIS A. JULIEN, of New York, on the subject of

A SEARCH FOR FLINT IMPLEMENTS IN THE ANCIENT GRAVELS OF AMIENS.

April 7, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons were present.

Mr. L. P. GRATACAP was elected a Resident Member; the name of Mr. W. B. PARSONS was transferred to the roll of Corresponding Members, and the following members were elected as

FELLOWS OF THE ACADEMY:

W. P. TROWBRIDGE,	Dr. L. JOHNSON,	B. B. CHAMBERLIN,
F. G. WIECHMAN,	J. L. WALL,	Dr. A. CLARK,
A. H. ELLIOTT,	J. K. REES,	F. C. T. BECK,
H. L. FAIRCHILD,	W. H. RUDKIN,	Dr. C. S. BULL,
Mrs. E. A. SMITH,	J. F. RANDOLPH,	H. DUDLEY,
Dr. L. SCHÖNEY,	W. G. LEVISON,	J. J. CROOKE,
C. VAN BRUNT,	W. E. HIDDEN,	Dr. E. S. F. ARNOLD,
N. L. BRITTON,	C. F. HOLDER,	F. A. SCHERMERHORN,
G. F. KUNZ,	Dr. A. HADDON,	E. N. DICKINSON,
L. H. LAUDY,	A. R. GALLATIN,	B. BRAMAN.
R. P. WHITFIELD,	A. D. CHURCHILL,	

The death of Mr. THEOBALD FROHWEIN, a Resident Member of the Academy, was announced, as well as that of M. TICCINO SELLA, President of the Accademia dei Lincei of Rome, Italy.

The Recording Secretary was, on motion, requested to send letters of condolence to the relatives of the deceased in these and all future cases of the death of members.

The Academy directed the appointment of a committee, consisting of the President and Recording Secretary, to represent the Academy at the public meeting, to be held on the following Wednesday evening, to take measures in behalf of the preservation of the forests of the Adirondacks.

Mr. G. F. Kunz exhibited a human head, carved apparently from a boulder of red sandstone, which was found on Staten Island, Richmond County, N. Y., half a mile from Fort Scott, one mile from South Beach, and 200 feet from the Staten Island Railroad. It was found by two gardeners, buried in a blue clay, under the roots of some bushes. The head shows an indentation from the blow of a pick and a few other recent markings, but otherwise appears to be ancient.

He also exhibited a boulder of rock crystal from Alaska, weighing 3.6 kgr., which was remarkably clear and pellucid, contained some fluid-cavities distinct to the eye, had a rolled surface on one side, and was reported to occur in some quantity.

The President remarked that the carved head displayed unusually good modelling, but still some features which suggested the Indian countenance. Its value as an antique depended upon its authenticity, in regard to which more proof was desirable.

Dr. A. A. Julien called attention to a critical note by Mr. Henry W. Haynes, in the last number of the *American Antiquarian* (Vol. VI., No. 2, March, 1884, p. 137), with whose general views he entirely agreed, but took exception to the closing paragraphs:

"But however long ago it may have been 'in the dark, backward abyss of time,' the palæolithic man, a savage hunter, armed with this rude axe of roughly chipped stone, once dwelt in the valley of the Nile, as well as in that of the Somme. President Warren claims to have 'great respect for the palæolithic man,' and can hardly find words to express his admiration for the marvellous skill exhibited by him in fashioning 'the prehistoric arrow-head.' But unhappily, in point of fact, 'the palæolithic man' was no more capable of making a stone arrow-head than he was of building a pyramid."

In reply to the statement in the last sentence quoted, Dr. Julien exhibited several specimens of chipped arrow-heads and lance-heads from the lowest gravels of St. Acheul, one of which had been dug out before his eyes. Such remains were not common, chiefly, perhaps, from the difficulty of distinguishing objects of such small size, fragile nature, and rude type among the flint-nodules, but there were many such on exhibition in the museums at Abbeville and Amiens, the Blackmore Museum at Salisbury, etc. There were even several arrow-heads figured by BOUCHER DE PERTHES among his first finds in the first volume of the "Antiquités Celtiques et Antédiluviennes," 1849, Plates XXIX. and XXX., described in Chapter XIX. The form of the arrow-heads was sometimes that of simple, rude flakes, slender and wedge-pointed, but a more characteristic and unmistakable variety, represented by the specimens exhibited, was heart-shaped, *i.e.*, triangular, with a basal indentation or nick. The evidence M. DE PERTHES had brought forward, and fully illustrated in all the volumes of his work, of the discovery of rudely formed Palæolithic knives, awls, augers, hammers, saws, etc., had been fully confirmed by later examination of the oldest gravels. In the valley of the Somme, at least, the Palæolithic inhabitant was far more than a "savage hunter," and found in the flint a material easily chipped into many useful forms beside that of a "rude axe of roughly chipped stone."

The PRESIDENT remarked on the beautiful arrow-heads of obsidian, which had been used by the native tribes in the Western territories, and which he had especially admired in a tribe in Oregon. He also called attention to an article in the same number of the *American Antiquarian*, on the subject of recent explorations in Assyria, which had given us very important additions to our knowledge of the ancient civilization of that valley.

A paper was then read by Mr. WILLIAM L. ELSEFFER, C. E., on the subject of the

HYDRAULICS OF THE MISSISSIPPI FROM CAIRO TO THE GULF.

DISCUSSION.

The PRESIDENT observed that the question was one which affected the larger portion of the United States. He had made a journey last winter with a portion of the Commission on the Mississippi River Improvement, and found, in conversation, that there was considerable difference of opinion in the Commission and among the experts. The problem was one altogether novel and untried. Without trial, by actual experiment, the people will not be satisfied. Major POWELL, of the Geological Survey, had proposed to meet the evil of the inundations at the sources of the river, by diverting the surplus water of the upper tributaries, on the west slope of the Mississippi basin, into channels for irrigation of the arid plains of the central plateau of the continent. Such an artificial supply of water is sorely needed at the head-waters of the Missouri, if all the resources of that great area are to be brought out. It might, of course, be a question, whether this arid area could be more usefully employed if put into crops than as used at present for a grazing ground. Still the arid region lies at the headwaters of such rivers as the Arkansas, Red River, etc., where there is no great surplus of water in the streams themselves, where their flow is constant and rarely attended with floods of any magnitude. Only in the valley of the Mississippi, the great oscillations in the flow of water take place. It is entirely different with the tributaries from the eastern slope. Thus the Ohio has been, and might still be, considered a grand channel of commerce, but it has now become almost worthless on account of the oscillations of the stream, and railroads, built along its banks, are entirely supplanting the cheaper form of transport by navigation. These rivers, the Ohio, Illinois, Wabash, Kanawha, Monongahela, Alleghany, Cumberland, Tennessee, etc., throw into the Mississippi basin an enormous amount of surplus water to produce devastating floods. The plan proposed by Major POWELL will not therefore afford adequate relief. No system of irrigation, merely from the western tributaries of the Mississippi, will affect the problem, while, in regard to the eastern, no feasible method—such as constructing vast storage reservoirs near their head-waters—can be devised or carried out, with any sum which even the nation can command. The subject must, therefore, be attacked simply as a problem in hydraulic engineering. The beneficial consequences, from a successful restraint of the flow of the river, would be almost incalculable, in preventing the present devastation, and in converting the stream into a stable channel of commerce, to serve as an outlet of the surplus products of the Mississippi Valley. The inhabitants of all parts of the country must be more or less concerned in the ultimate solution of this question. If Mr. ELSEFFER can propose appropriate methods, and can show that the present plans are fallacious, he will be a benefactor not only to that portion of the United States, but to the whole country.

Mr. ELLIOTT desired a clearer explanation of the statement of the author that, even if the flow of the river should be rendered straight and uniform by the present plan, the stream would soon resume its former condition.

Mr. ELSEFFER promised to give a full explanation of this point in a succeeding paper.

April 14, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons were present.

Dr. N. L. BRITTON exhibited specimens of the wild liquorice bean of Brazil, which was poisonous to animals.

Prof. CHARLES B. WARRING, Ph.D., of Poughkeepsie, N. Y., then read a paper on

THE UNIFORMITY OF GEOLOGICAL CLIMATE IN HIGH LATITUDES.

(Abstract.)

Geologists have confined themselves, in reference to ancient climate, to finding the cause of the remarkable warmth in polar regions. But there is another question of equal importance, perhaps even of greater. I mean the question of uniformity, not of heat merely, but of light and actinic force. That there was summer warmth is unquestionable. Was there winter warmth correspondingly high? Were light and actinic force crowded into a brief summer, or were they distributed through the year with a near approach to equality, as happens now in low latitudes?

The only means of answering these questions is found in the records of plant and animal life.

Their more obvious teachings are startling enough. Magnificent forests of magnolias, cypresses, and a hundred other species, flourished in Spitzbergen, and even farther north, as late as the Miocene, while in earlier times identical species were found from the extreme north to the equator. To this all geologists agree. The living forms to which those species were most closely allied are peculiarly sensitive to changes of temperature.* So far, therefore, as it is possible to judge the past from the present, there must have been a warm and uniform temperature almost to the poles.

It may be said that no very certain conclusions can be drawn from these facts because the identical species are no longer living, and perhaps they may not have been so very sensitive to cold as are their low-latitude successors. While there is some force in this, we must not give it too much weight, for all progress in the world's past history rests upon the belief that, in general, corals in Palæozoic times indicate such conditions as exist where we now find corals; saurians, where we now find saurians; magnolias, where we now find magnolias; tree-ferns, where we now find tree-ferns; and so of other organisms. In fact, we have no other principle to guide us. But we have direct proof of the warmth of climate in the Miocene in Arctic regions. In latitude 78° 56′ N. (in Spitzbergen), amid a Miocene flora remarkable

* If Huxley's Homotaxy is true, the same species lived first in high latitudes and then in low, or *vice versa*. The important point for my present purpose is that the same species flourished in regions where life conditions now are so extremely unlike.

for luxuriance and variety, was found one species, *Libocedrus decurrens* (Heer), which is yet living with the redwoods of California; and another yet remains on the Andes of Chili, while a third, according to Dr. GRAY, is the common taxodium or cypress of our Southern States. In Greenland, lat. 70°, were found magnolias and zamias.* All the teachings of palæontology, especially as to the earlier periods, are that there were then no zones of climate, and that there were warm arctic seas all the year round. The evenness of temperature is most extraordinary. Such a flora and fauna cannot exist where there are great variations of temperature. Yet in these same regions, the sun, if the earth's axis was inclined as now, was shut out for more than four months, while for four other months it poured down without cessation. Were a four months' night to settle down now upon the torrid zone, the accumulated heat would soon be radiated into space, and when the sun returned, no living thing would remain to greet it.

It will help us to realize the enormous effect, if we remember that the cold of our winters in our own latitude is due simply to the change from long days of summer to the short ones of winter, plus the change in altitude of the sun; but how much greater would be the cold if the sun went for four months below the horizon.

It may be said that the cold was mollified by the latent heat of the surrounding ocean, and by the influence of oceanic currents. But the same capacity for giving off heat exists now, and the same currents still flow; yet in Spitzbergen, a not large island, surrounded by a broad expanse of water, the cold is most intense. The specific heat of water has not diminished; so far as that is concerned, the ocean does as much now as then to make the winters there mild, unless there is less warm current. The effective cause of Gulf and other streams was then, as now, the difference in temperature between low and high latitudes. If that were nothing, there would be no current at all. A small difference would produce some current, a greater difference would produce a more rapid one. And this is true whether the currents are due directly to this cause, or indirectly, through the medium of aërial currents. In geological times the difference of temperature was much less than it is to-day; hence it seems within the bounds of truth to say that the ocean currents then were no greater than they are now.

Whatever warmth-producing influences existed in Spitzbergen and in other high latitudes, their effect was no greater in winter than in summer. Admitting it to have been as great—a matter of reasonable doubt—the temperature, as the days grew shorter, must have fallen until it reached a point at which the loss of heat by radiation into

* Dana's Man. Geol., revised ed., pp. 514 and 526.

space just equalled what was brought in by ocean and aërial currents. Calling the heat from these sources A, and that from the sun B, the summer heat must have been A + B. The difference between the seasons at the present day is enormous. It could not have been small at any time. Yet, somehow, "through the whole hemisphere—and we may say the whole world—there was a genial atmosphere for one uniform type of vegetation, and there were genial waters for corals and brachiopods." *

The influence of light upon vegetation is one of the clews which may lead to important results in the study of these ancient problems. At the present time the mode of applying the actinic forces varies greatly in high and low latitudes. In Spitzbergen, for example, the sun shines uninterruptedly for four months, then the days begin to grow shorter, till finally a night sets in, lasting four months. In low latitudes, the supply of chemical rays is continuous for only about twelve hours, and then ceases for a night of not greatly different length.

Light is as necessary to plant life as heat, and its evidence, as to whatever it is capable of testifying about, is far more reliable; for only the inclination of the earth's axis can affect the length of the days, while the flow of the Gulf Stream and other ocean currents, the lay of the land, and the arrangement of the land and water, have a great effect upon temperature.

The influence of environment on plants and animals has been shown by Mr. DARWIN and his followers to be very great. Unfavorable environments cause old species to disappear, and the new species, whatever their cause, are in harmony with the environments amid which they have their birth. It seems, therefore, incredible that in Palæozoic and much later times, species, identically the same, could "have flourished luxuriantly," for example, in Spitzbergen and Florida, for millions and millions of years, unaffected by such great differences in the mode of supplying the chemical rays necessary for their very existence. The argument becomes stronger when we reflect that during those years there were, from period to period, enormous changes in species—in some cases entire extermination †—new ones taking their place; yet everywhere, from the tropics to the poles, in each period one type was found. Identical species were found in all latitudes.

It seems, if possible, still more incredible that in later times, say in the Miocene, species should originate in Spitzbergen and Upper

* Dana's Manual Geol., p. 352. See also, in same work, all the earlier "Climates."

† See Dana's Manual, "*Exterminations.*" I quote one statement, page 485: "Not only every species, but also every Mesozoic genus, with perhaps one or two exceptions, became extinct at or near the close of the era."

Greenland, and thence migrate to low latitudes without change of character, if—to say nothing of temperature—the manner of supplying solar influences was then as different in the two regions as it now is.

It certainly was to be expected, if plants are to be affected by their surroundings, that natives of high latitudes, adapted to continuous months of sunlight and of darkness, would fail to endure the altered conditions, or else would exhibit indications of changes in structure to correspond to the altered requirements.

This belief is strengthened by the fact that "in receding from polar toward equatorial latitudes, the Alpine or mountain floras really become less and less Arctic." * The only changed conditions in such cases are those due to the difference in the length of days and nights.

Another corroboration is afforded by the peculiar structure of a conifer found standing in lat. 72½°,† and microscopically examined by Sir WILLIAM HOOKER. It differed remarkably from all other conifers known to him. Each annual ring consisted of two zones of tissue; the inner, narrow, of a dark color, and formed of slender woody fibres with few or no discs upon them; the outer, broader, of a pale color, and consisting of ordinary tubes of wood fibre marked with discs, such as are common to all coniferæ. These characters were found in all parts of the wood. They suggest, he says, the annual recurrence of some special cause which modified the first and last made fibres of each year's deposit; and this cause he thinks is found in the peculiarity of an Arctic climate, where the days were at first very short—a few hours only of sunshine. Then the first and imperfectly developed fibres were formed. As the days grew longer, the solar rays at last became continuous, the woody fibres became more perfect, and were studded with discs of a more highly organized structure than are usual in the natural order to which this tree belongs.

The absence of such structure in Spitzbergen, 5° further north, if established, would strengthen the conviction that such days did not occur there in the much earlier times, to which its trees belong.

Since Arctic climate, in those early periods, was warm through the year, it follows that—with the earth's axis inclined 23½°—the plants of Spitzbergen and other equally high latitudes must have spent four months of each year in darkness, and surrounded by a moist and warm atmosphere. Modern vegetation, so placed, bleaches and dies; could the result then have been different, if the axis was inclined as now?

Undoubtedly, a flora might have been specially organized for such

* Quoted approvingly by Mr. Darwin, in Origin of Species, from Mr. H. C. Watson.

† See account in *Climate and Time*, pages 264 and 265.

conditions, but all through the earlier ages there were no special floras for different latitudes. One type prevailed everywhere.

The marvellously luxuriant foliage of the Arctic trees has excited the surprise of LYELL and others.

It is a matter of common observation that plants receiving the full intensity of the sun's rays have smaller leaves than their fellows of the same species which are somewhat protected. It would seem as if nature compensated for the inferior intensity of the solar rays by giving more surface to be acted upon. Since the intensity of the sun's rays varies as the cosine of the latitude, it is evident that, while the length of the day in Florida and Spitzbergen would be the same, with the sun all the year on the equator, the intensity of the light in the former would be almost twice as great as in the latter. Hence, if the earth's axis was in fact nearly, or quite, perpendicular, and if, in some way, the temperature was kept the same, we ought to look for greater size of foliage—greater "luxuriance"—in very high latitudes than in low.

The existence of annual growth-rings in the early exogenous plants is not proof of the existence of seasonal changes, for such rings may be formed several times in a summer, or not all, or once in several years. I have seen a hard and woody stem of *Chenopodium album*, less than four months from the seed, with eight well-formed rings. A woody Phytolacca, according to Dr. Gray, makes at least twice as many layers as it is years old. The Cycads require several years to make one. The orange and lemon, in greenhouses where the temperature is kept uniform, form layers as regularly as do our forest trees. The mangrove, which grows between high and low-water mark on the sea-shore in tropical regions, forms well-marked rings. In its case there is no seasonal change, either from warm to cold or from wet to dry. Hence I infer that the presence of these layers, or growth-rings, is not due to influences connected with the seasons, and, therefore, has no bearing upon the question of the inclination of the earth's axis.*

I think we may say that the teachings of geology are what they would be if the earth's axis was in those times nearly or quite perpendicular to the ecliptic, providing that in some way the temperature was kept sufficiently high.

Nor is it any argument against the axis having formerly been in that position that no traces are found of such a cataclysm, when it changed to its present obliquity, as would have attended an equal change in the geographical position of the poles. The latter would have necessitated a great overflow of the ocean, while a change of inclination, if

* For a fuller discussion, see Am Jour. Sci., 1878, Article XIV., entitled, "Is the Existence of Growth-rings in Exogenous Plants Proof of Alternating Seasons?"

at all gradual, would produce no visible effect. All it could do was to affect the length of days and nights, and, consequently, introduce seasons. These changes, if they occurred, would have registered themselves in changes in the plants and animals of high latitudes; while in low latitudes no perceptible effect would have been produced, and, consequently, the species would continue as they were before. Geology teaches very clearly that in high latitudes there did occur toward the end of the geological record a complete disappearance of old species, while in low latitudes they were unaffected.

The conclusion toward which these facts point would be readily accepted, were it not for reasons derived from another source than geology. Astronomers say that a permanent change in the inclination of the earth's axis is impossible, so far as any force is concerned which is known to science. But, as this is equally true of many other things which have actually been done, it is not an insuperable objection. "No force known to science" can vivify matter, yet living beings are all around us.

There are only two theories as to the existence of our world. The one attributes it to an Omnipotent Intelligence, that, for His own purposes, made the universe, and, by His wisdom and power, brought it through stages of development, some of which we have been able to recognize, and some so far to understand as to class them with others, and then, having named the order in which the events are arranged, call it "law," and sometimes think we have thereby comprehended it.

The only theory of the solar system on mechanical principles is the nebular hypothesis in its several forms. In all, the earth and moon were once one body, revolving, of course, on one axis. At some remote time they separated. But no force of avulsion, whether the moon was left behind as the mass contracted, or whether, as has been more lately held, it was thrown off by the great centrifugal force after the earth had become solid, and then was gradually pushed back by the influence of the friction of the tidal wave, could affect the plane of rotation or the direction of the axis of either. On mechanical principles, the moon, when it left the earth, moved in the plane of the earth's equator, and the axis of the earth and the moon and of its orbit were parallel to each other. The normal position of the three was perpendicular to the ecliptic. But now the axis of the moon is inclined $1\frac{1}{2}°$, and that of the earth $23\frac{1}{2}°$. Very evidently, either the earth's axis or the moon's has changed. The moon's axis is now nearly in the normal position. Hence I conclude that it was the earth's axis that changed.

Astronomy, therefore, proves too much. It proves that the present condition is not eternal, that normally the axis was perpendicular to the ecliptic, and that once in any position it can never change* "by any force known to science." To all of which those of us who are not astronomers can only answer—What you say may all be true, but, nevertheless, the axis has been tilted over to 23½° by means of some force not known to science. And if we cannot tell how it occurred—an inability which extends to a great many things besides this—our business is to discover, if we can, when it occurred. It is not a question of possibilities, but of chronology. The uniformity of biological conditions in high and low latitudes indicates that the present obliquity had not been attained in Archæan, or in Palæozoic, or in Mesozoic times. A similar uniformity prevailed in the Tertiary till toward its close; then comes a blank of unknown length, during which the Glacial epoch came and went, and then, when the record again begins to be legible, there are, for the first time in the world's history, indications of zones of climate and of alternating seasons. This seems to fix the date of the increase of axial obliquity as corresponding to the Glacial epoch.

It requires no argument to show that a perpendicular axis would account for the otherwise inexplicable evenness of ancient climate. Ocean currents might bend the isotherms, but at any place the temperature, whatever it was, would be the same all the year. The hours of light and darkness would be the same everywhere.

This kind of uniformity is, however, compatible with great cold, and does not touch the question of a warm polar climate. Many theories have been proposed to account for the remarkable temperature. Six or seven are ably treated by SEARLES V. WOOD, Jr., in the *Geological Magazine* for September and October, 1876, and by Dr. CROLL in *Climate and Time.* Dr. CROLL'S theory differs from those. To it there are what seem insuperable objections. I have discussed this theory somewhat fully in *Penn Monthly* for June, July, and August, 1880, and shall not now repeat.

Professor WHITNEY has lately put forth another explanation, in which he attributes the preglacial warmth to the sun itself being hotter. All conclusions in regard to the sun's former temperature must be hypothetical; but if it be a gaseous body, as suggested by Professor YOUNG, it has been growing hotter all the time it has been condensing.† To this, as to all other theories heretofore advanced, lies the objection that they ignore the uniformity which is such a remarkable feature of geological climate.

* There is a small secular change of obliquity going on now, but it oscillates about a mean position.

† A fact discovered by Mr. J. H. Lane. See *American Jour. Science*, July, 1880; also, Newcomb's Astronomy, page 508.

Mr. MEECH has shown that with a perpendicular axis polar regions would receive during the year less heat than they do at present; hence Dr. CROLL infers that with such an axis polar climate would be less genial than it now is. This would be true if temperature depended solely on the amount of heat received. But, as everybody knows, it depends far more upon the amount of heat retained. Greenhouses are often uncomfortably warm when the temperature without is near freezing. The solar rays readily enter through the glass, and are absorbed by the floors, walls, etc., while the heat which they radiate back is unable to escape. Professor TYNDALL has shown that many substances possess this property, and among them are aqueous vapor and carbonic acid gas.

The amount of carbonic acid in the atmosphere must have been far greater in ancient times than now, for all the graphite, coal, lignite, etc., now in the earth's crust once existed in that form. With the beginning of plant life a process of elimination commenced. It continued till near the end of the Tertiary, when the amount taken out by living forms and that restored by their decay became equal—a condition which still exists.

The carbonic acid was then, as now, uniformly diffused, and it acted as glass does in a greenhouse. It kept the heat in, and, consequently, the atmosphere itself grew warmer. This increased its capacity for moisture, and that, in its turn, helped to retain the heat.

In this, I think, lies the cause of the warm polar climate, those otherwise cold regions being protected by this warm "double blanket." Prof. TYNDALL says: "The removal for a single summer night of the aqueous vapor which covers England would be attended by the destruction of every plant which a freezing temperature could kill."

Besides the carbonic acid and water vapor, there were probably other gases and vapors in the atmosphere. Ammonia produces 13 times the effect of CO^2, and marsh gas 4½ times. Whatever there were of these, they tended to increase the potency of that "warm blanket."

The amazingly slow change of temperature—many millions of years to reduce it from that of the Archæan to that of the later Tertiary—finds reasonable explanation in the effect of these gases and vapors. Prof. TYNDALL has shown that, commencing with a vacuum, and adding a small number of very small increments, the absorption is sensibly proportional to the increments, but as the quantity increases, the deviation from proportionality augments (*Heat a Mode of Motion*, page 356); at length a condition is reached in which further increments produce very little effect.

The converse of this is very important. Commencing with a large amount of the gas or vapor, a very great number of decrements will be needed to produce any sensible effect; then a less number, and so on, until toward the end, when the decrement needed will be small and the effect comparatively large. Hence temperature changes should have been at first, and for a long time, very slow, and afterward much more rapid. All we know about what did occur is derived from the study of the plants and animals and noting what changes occurred among them; the results of such study appear to be in harmony with what we should expect. The peculiar life of the Palæozoic lasted several times as long as that of the Mesozoic, and that several times as long as the peculiar life of the Tertiary, and in the Tertiary itself the changes were most rapid of all.

It is also very suggestive that while the changes in the plants and animals in the earlier periods were world-wide, the changes in the Tertiary were more and more confined to high latitudes, as if the cold were settling down from the poles toward the equator. This was to have been expected if the early polar warmth was due to that "warm blanket." If this was growing thinner, it might be long before any sensible effect was produced; but when it did appear, it would first manifest itself near the poles, where so much depended upon the heat's being retained.

With this in view, there is no difficulty in seeing why the flora of temperate America and of Europe and Asia should have their origin in very high latitudes, since, while light and actinic force were always fitted for them, it was there a temperature first appeared which was adapted to their needs.

The amount of carbonic acid possible in the atmosphere without destroying life is not known, but according to Prof. REMSEN of Johns Hopkins University, present animals can breathe an atmosphere containing five per cent. of that gas, "without experiencing serious or even disagreeable effects." This is one hundred and fifty times, and more, the present amount. With animals specially adapted to it, I see no reason why the quantity might not in those days have been very much greater than five per cent.

The Glacial Epoch, and the subsequent Warmth.

The "warm blanket" having been so greatly reduced, the perpendicular axis was permitted to produce its natural effect, and the climate "became less genial than now." The cold, moreover, was intensified by high latitude uplifts. We may get some idea of the result if we imagine New York State, for example, elevated to a considerable height, and if the sun never rose any higher than it now does on the 21st of March. All present vegetation would die out, and if the conditions as to elevation continued to the north of us, it would not be necessary to go far to find perpetual snow. For snow once fallen or ice once formed, would never melt, but, accumulating through the ages, would force its way south by its own weight, until it reached so far below the true snow line as to be melted.

Such uplifts to-day, the atmosphere remaining as it is, and the earth's axis again becoming perpendicular, would bring back the Glacial epoch.

The warmth of the Champlain was due to a reversal of these conditions. From some cause the axis had attained its present obliquity, this of itself rendering the climate of polar regions more genial, while the depression of the land below its present level, and the consequent extension of ocean surface, greatly aided and accelerated the result.

A moderate and comparatively local uplift, mostly confined to the eastern continent, would account for the minor Glacial period which seems almost confined to that part of the world.

Subsequent changes of elevation left us the climate of to-day.

SUMMARY.

1. The early warmth was due to the "blanket" of carbonic acid, aqueous vapors, and probably other gases and vapors.

2. The uniformity—lack of seasonal changes, and the equality of light and actinic force—was due to the axis of the earth being nearly or quite perpendicular.

3. The slow fall of temperature at first, the more rapid fall in later times, and the cold of the Glacial epoch, were due to the gradual purification of the atmosphere, and, with reference to the cold, to great high latitude uplifts.

4. The return of warmth was due to increased obliquity of axis, and to high latitude depression of the land and consequent extension of the ocean.

5. The Champlain warmth was due to the extreme depression.

6. The minor Glacial epoch was due to comparatively sudden and local elevation.

7. Present climate is due to present arrangement of land and water and to the introduction of seasons, or, in other words, to the present relation of day and night.

The influence of vapors and gases on climate was pointed out by Prof. TYNDALL and others. Several have proposed a change of inclination or of geographical position, as a solution of the climatic problem. DANA and others have spoken of the high latitude uplifts and the subsequent depression. The theory in this paper weaves all these and many other facts into one theory in which each bears a definite and important relation. In its entirety I claim it as new, and as differing widely from all that have preceded it.

DISCUSSION.

The PRESIDENT stated that he had been led to think that not quite so much uniformity of climate had prevailed in former periods as is often supposed. A very warm temperature had existed at the north in Tertiary times. However, there had been also great variation in lower latitudes, ranging from tropical heat to a very cold climate when the ice overspread the land. But no evidence had been shown that these temperatures were synchronous. A remarkable fossil fauna of tropical character had been discovered by BONPLAND in Bogota; but we were not in possession of facts permitting us to assert that these ammonite deposits of South America were laid down at the same time as those in the North. There was, on the other hand, considerable evidence of the occurrence of alternations of climate. High tides of temperature had existed certainly in different parts of the globe, but there was no evidence that these had occurred at the same time. Thus the discovery of bodies of floodwood, left by earthquake waves at high points on different coasts, would be no evidence that these were deposited by the same flood over the whole globe.

In Palæozoic time, comparatively moderate irregularities in temperature had prevailed, the sea being more uniformly distributed over the surface. During the Carboniferous period, the temperature was moist and equable, producing a luxuriant vegetation, but favorable also to the preservation of vegetable deposits. At the present day, peat accumulates in the greatest quantity wherever the climate is cool, moist, and equable—therefore, not in the tropics, where the wood is burned up under present conditions, and where it was not accumulated during the Coal-period.

The plants of the Cretaceous were similar to those of the present day; many genera in fact were identical with those now growing, *e.g.*, the sassafras, magnolias, liriodendrons, etc. There was no evidence of a tropical vegetation in the early Cretaceous. Later, however, palms and other tropical forms began to appear. The climate was in general of a temperate character.

The Tertiary deposits were characterized by a luxuriant though not tropical vegetation, such as is found in warm climates at the present day. Thus the deciduous cypress now reaches as far north as our Central Park in this city, but its natural habitat is further south. In

Tertiary times, it grew in Greenland. In Alaska, oaks once flourished whose leaves were twelve to fifteen inches in length. The leaves of trees were, as a whole, smaller than in the tropics, where at the present day the largest leaves are found, such as those of the banana, etc.

This flora, growing in a mild climate, was mostly destroyed by the Ice period. This great change was probably caused by some cosmic influence, and not by the elevation of high lands in the Arctic. In the Tertiary age, the northern lands were deeply furrowed by valleys opening into the sea, thus producing the fjords to which the fimbriated appearance of all the northern coasts has been due. There is evidence of the occurrence of a great flood which afterward transported the material from which the Champlain clays were separated, the finest sediment having been deposited in bodies of still water. These clays were synchronous with the coarser deposits of gravel and boulders, on the higher lands. The elevation of the sea-level, indicated by the Champlain deposits, amounted to about 100 feet at New York City, 200 feet at Albany, 500 feet at Montreal, 800 feet at Labrador, 1,000 feet at Davis Strait, and finally reached, in the Champlain clays of Polaris Bay, a height of 1,600 to 1,800 feet above the sea. All these clays contained the remains of Arctic shells, and these implied a low land level during the latter part of the Ice period.

There is a difficulty in accepting the idea suggested by Prof. WARRING, that the axis of the earth was then perpendicular to the ecliptic. No change in the constitution of the atmosphere could permit the existence of a high temperature in the Arctic and its absence in tropical regions.

In the Cretaceous period, anterior to the luxuriant vegetation of the Tertiary, a climate and vegetation of a temperate character had prevailed here. The increase of carbonic acid in the atmosphere would make conditions incompatible with these facts. It has been shown that a vast amount of carbonic acid has been also withdrawn to produce all the deposits of limestone ; this would involve an enormous percentage in the constitution of the original atmosphere of the globe. To meet this difficulty, WINCHELL had suggested that there had been a constant addition of carbonic acid to the atmosphere from space. Sir HENRY SIEMENS had also suggested, in *Nature*, about a year ago, the constant addition of both aqueous vapor and carbonic acid from space.

We have testimony from the astronomers in general opposition to the view of any change in the axis of the earth; they have almost unanimously pronounced against the probability of this idea. One or two of the evidences, which have been cited, of the former existence of a very high temperature at the north, are fallacious, *e.g.*, the abundant growth of corals. There is no evidence that a high temperature was required to produce these coral masses. It was true that the corals were aggregated together in such a way as to imply a luxuriant growth, and that, at the present day, all the evidence tends to show that reef-building requires a warm climate. It was found that, on the land nearest to the coral-reefs of the Devonian seas, tree-ferns grew, which were of as large size as any now growing in the tropics.

Since Palæozoic times and the formation of the present topographical features and the interruptions of the great oceanic current, the changes which have occurred may indicate cosmical interferences of some kind. In conclusion, he would only suggest that the problem was very complicated and required the consideration of many facts.

Prof. WARRING stated that the view he had offered did not indicate a uniformity of climate over the twelve months. He had wished to direct attention merely to the absence of the changes of the seasons in former geological periods.

The PRESIDENT remarked that the alternations of temperature on this continent often reached 100° of Fahrenheit or more at the same locality during a single year. This indicated the endurance by our vegetation of a great range in changes of temperature. In our winter the temperature often drops 25° in a few days. This was a greater trial to the vitality of a plant than a steady cold. He could not imagine that the economy of plants would be greatly affected by polar conditions.

Prof. HUBBARD remarked on the wide variations in temperature which frequently occurred in the latitude of Boston, sometimes amounting to 142° at that city.

Prof. WARRING called attention to the peculiar kinds of plants which thrived in Miocene and earlier times. Their fellows in tropical latitudes, at the present day, were very sensitive to changes of temperature. So far as concerned the doctrine of environment, how could plants so entirely unlike have been developed under such different conditions ?

The PRESIDENT pointed out that some plants of the northern Tertiary have even now a wide range ; thus, the Sweet Gum, though found over our continent, is far more abundant in Louisiana. The Sassafras has also a very wide range, extending from Canada to the Southern States, even into Texas. The Magnolias, which are found in the fossil state, are not identical with the species of the present day ; but the modern species, the cucumber tree, has now a wide range. There were vast numbers of plants in the Tertiary of the Arctic which have since disappeared. As the climate became severe, with the approach of the Ice period, they retreated southward. As it became again milder, only a few survived and once more returned. Thus, the Sequoias were found fossil in numerous species, reaching to the Arctic Sea, spreading over the continent in luxuriant forests, consisting of magnificent trees, but of these only two species now survive.

April 21, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience occupied the East Hall.

Professor F. W. PUTNAM, of Cambridge, Mass., delivered a lecture on

RECENT DISCOVERIES IN THE PREHISTORIC MOUNDS OF OHIO.

April 28, 1884.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present.

Professor H. CARRINGTON BOLTON, of Hartford, Conn., read the following papers, which were illustrated by many specimens :

I. THE "SINGING BEACHES" OF THE BALTIC.

The speaker stated that, since presenting his first paper (on March 10th), he had received intelligence of thirteen additional localities of sonorous sand on the Atlantic coast, chiefly in New Jersey and North Carolina.

The late Dr. MEYN, in his "Geological Description of the Island of Sylt," mentions briefly the occurrence of sonorous sand on the Island of Bornholm, an island belonging to Denmark, in the Baltic. Since the quartz sand of Sylt does not have these acoustic properties, Dr. MEYN jumps to the conclusion that this quality of sand may be used to distinguish that of Tertiary and of Jurassic origin. This is obviously an error, resulting from attempts to generalize on a single observation. The acoustic quality of the sand is entirely independent of its geological horizon.

Through the kindness of Professor S. F. BAIRD, Secretary of the Smithsonian Institution, we obtained samples of sonorous sand from

Colberg, Prussia, accompanied by a letter from Dr. G. BERENDT, Professor of Geology in Berlin. Dr. BERENDT states that the sand of the Baltic coast of Prussia has the peculiarity under consideration in many localities, but only transiently. Small tracts which squeak under foot on one day fail to do so on the following day, and new places are at times endowed with the acoustic properties. Hence, he attributes the cause to a crust left by the retreating tide, which is only temporarily coherent. Such phenomena occur on the Kurische Nehrung and on the Samländische Strande of East Prussia. He rejects MEYN'S views above reported.

Sonorous sand occurs on the largest scale on Kauai, one of the Hawaiian Islands. The sand forms a dune 100 feet high, and when disturbed slides down the incline, producing a sound as of distant thunder. This sand has been examined, microscopically, by Dr. JAMES BLAKE, who found it to consist mainly of portions of calcareous sponges and coral, all more or less perforated with minute holes, tubes, and cavities. A small proportion of crystalline silicates, augite, nepheline, etc., is also present. Dr. BLAKE ascribes the sound to the reverberations excited by motion of particles within these minute cavities. Through the kindness of Rev. JAS. W. SMITH, M.D., of Kauai, we have received samples of this sand, and through the Smithsonian Institution larger samples of the same. These are now under further examination. All but five per cent. proves to be soluble in cold dilute acetic acid.

II. SONOROUS SAND-HILLS OF ARABIA AND AFGHANISTAN.

From a very early period travelers in Asia have heard rumors of mysterious sounds issuing from sandy wastes and hills, which they commonly regarded as fables. The Emperor BABER describes briefly such a sand-hill as early as the 15th century. The first European to publish an account of one of these localities was Dr. U. J. SEETZEN, a Russian traveler who visited in 1810 the since world-renowned Jebel Nakous or Mt. of the Bell. This hill of sonorous sand is situated on the Gulf of Suez, a few miles north of Tor. The speaker stated he had collected for the first time the narratives of six several visitors to this region, viz., of Dr. SEETZEN in 1810, Mr. GRAY in 1818, EHRENBERG in 1823, Lieut. WELLSTEDT in 1830, Professor HENRY A. WARD in 1855, and Professor E. H. PALMER in 1868. On comparing carefully the accounts given by these travelers, the speaker came to the conclusion that they had visited three and perhaps four different localities within a given region north of Tor and on the east shore of the Gulf of Suez. The discrepancies as to distance of the place from the sea, its height and its general character, are so great that they can be explained in no other way. On writing these views to Professor WARD, he replied in a letter acknowledging their correctness. All the travelers, however, concur in describing quartz sand resting on an incline and possessing very great sonorous power. Agitation of the sand causes it to slide down the incline, and, as it moves, a noise resembling at first a humming, then a roaring, increasing in volume until it is likened to distant thunder. Professor PALMER noticed also the production of a slight sound by sweeping portions of the sand rapidly forward with the arm, which, moreover, caused a peculiar tingling sensation in the operator's arm. All the observers agree in noting the perfect dryness of the sand, and Professor PALMER thought the heated sand issued louder sounds than that in the shade. The Arabs residing in Tor ascribe the sounds to strokes by a priest on a *nakous*, or gong, calling his fellow-monks to prayers in the monastery concealed within the bowels of the earth.

Two wonderful sand-hills have been described by travelers in Afghanistan. One, forty miles north of Cabul, was visited by Sir ALEXANDER BURNES in 1837; the second, 150 miles south of Herat, near the borders of Persia, was visited by Capt. EVAN SMITH in 1870–72. The general characters of these places resemble those of Jebel Nakous, and the sounds emitted by the moving sand are similar. Reports have been made of a sonorous dune in Nevada, twenty miles south of Stillwater, in Churchill County. This dune is said to be 100 feet to 400 feet high and four miles long; when agitation of the sand starts it sliding, a noise is produced like that from telegraph wires fanned by a breeze.

The localities in which sonorous sand is found may be divided into three classes: *first*, sea and fresh-water beaches, where all the sand possesses the sound-producing quality permanently, as at Eigg, Manchester, Plattsburg, etc.; *secondly*, sea-beaches where small tracts of the sand possess acoustic properties transiently, as along the Atlantic coast, in New Jersey, North Carolina, and on the Baltic; *thirdly*, sand-hills in the interior or otherwise, whose steep slopes give rise to acoustic phenomena of great magnitude, as at Kauai, in Nevada, and at Jebel Nakous and Reg Ruwan.

Investigations to determine the true cause of the sonorous property of sand are in progress. Any information concerning new localities, and samples from the same, will be received very gratefully.

May 5, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present.

Mrs. A. C. Ketcham and Dr. R. H. Lamborn were elected Resident Members.

A paper was then read by Dr. Louis H. Laudy, illustrated with apparatus, experiments, and lantern-views, entitled

PHOTOGRAPHY—PAST AND PRESENT.

May 12, 1884.

Section of Geology.

The President, Dr. J. S. Newberry, in the Chair.

Thirty-seven persons were present.

The President exhibited specimens of vanadite, descloizite, and a large suite of polished colored marbles from Vermont.

Mr. G. F. Kunz exhibited specimens of a remarkable chlorophane from Amelia County, Va., phosphorescent by friction, the heat of the hand, etc.

The President, in discussing the subject of phosphorescence, referred to the specimens of luminous limestone from Utah, which he had exhibited at a former meeting. It had been reported that the blows of the pick upon this substance had kept the tunnel continually illuminated. This phenomenon, being a novel one to the miners, had caused them great alarm lest the mine might be getting on fire.

A paper, illustrated with a suite of specimens, was then read by Mr. Arthur H. Elliott, on

THE COLORED MARBLES OF LAKE CHAMPLAIN.

DISCUSSION.

In reply to inquiries, the author stated that he had found no sulphides in these marbles. In regard to their durability as building stones, he had observed that their weathered surfaces looked remarkably hard and apparently very fresh. In Burlington, a few buildings had been erected from the Willard's Ledge stone and seemed to present good evidence of its durability. At the Swanton quarries all the surfaces had been freshly uncovered, and the weathered edges appeared sharp. In Swanton a church had been erected some years ago, and the stone was well preserved. Fossils have been observed in the black marble.

In regard to the cause of coloration, some varieties are brecciated (the "dolomitic breccias" of Hitchcock), and in these the coloring material is generally oxide of iron, but in the Isle La Motte marble carbonaceous matter produced the color, the percentage of water and organic matter amounting to 1.40.

The PRESIDENT exhibited a large collection of similar colored marbles from Vermont, and remarked that he had studied and reported upon them at the Centennial Exposition.

One variety from Plymouth has not yet entered into commerce. The demand for the colored marbles was increasing with the growing luxury of the times and the appreciation of their beauty by the people. However, it was likely that the lighter-colored marbles would always be more extensively used, in the proportion of one hundred to one, than the colored. The Winooski was already in general use, though worked with difficulty on account of its density and its high content of silica, this substance being sometimes present in geodes. It had been often used, mistakenly, in this city for pavements, doorways, etc., but, like all the colored marbles, it both weathered and wore unequally, in consequence of its veins, etc. A most beautiful collection of colored marbles had been exhibited from Maryland, rivalling any that had been used by the ancients in the Old World. Very few of these had yet been worked and polished, but many very brilliant specimens had been shown at the Centennial Exposition. In the far West, wherever the limestones have been affected by metamorphism, marbles occur in exceeding abundance, *e.g.*, in the Rocky Mountains and the Sierra Nevada. They occurred also along the Alleghanies, as in West Virginia and Tennessee. In Vermont, at Rutland, white marbles occur of very great importance. At Pittsford, also, a heavy bed of marble occurs, 450 feet in width, the stratum standing nearly on its edge. In this vicinity some of the marbles have been used for building.

He also exhibited a specimen of black marble, veined with white, from Southern Nevada. This rock had evidently been shattered, and the crevices infiltrated by white carbonate of lime. Iron oxide, sometimes as a greenish silicate, was the almost universal coloring matter of the limestones.

But recently native tin had been discovered in the Black Hills; in fact, from the diamond to coal, the resources of that country were ample. So, too, the black marbles of the West will be ready when there will be a demand for them.

In the Old World, the colored marbles, in an enormous series, came into use at an early date. Many of the quarries, known to the Greeks and Romans, are indeed as yet unknown to us; but many have been re-discovered even quite recently. The locality of the *rosso antico*, used in Rome by the Etruscans, before the time of the Romans, was still unknown to us. This material was used for a great number of purposes, commonly as mouldings, as we now use wood. Another unknown locality, though probably in Belgium, was that of the black marble, *nero antico*, of the Egyptians. The Romans scoured the world for black marbles. The best collection of specimens of fine marbles could now be made, not by going to the marble-quarries but to the crumbling monuments of Rome. A collection of a thousand specimens, all different, had been made by an architect of Rome. Nowhere else now did such a variety exist.

The white marbles are also now growing into greater favor for many purposes. It was exceedingly important that the vast variety of building materials now brought into New York City should be thoroughly investigated.

Mr. ELLIOTT remarked that he had seen some small pieces of statuary, made from the Pittsford marble. The material was very beautiful and translucent.

The PRESIDENT observed that really good statuary marble was exceedingly rare. For the Pentelican marble of the ancients we have yet no substitute. The material of the layer of statuary marble of West Rutland was very beautiful but rather tender. At Pittsford, also, an exceedingly interesting variety was found, white, strong, and of excellent quality. Other varieties of cloudy, blue, dove-colored, and banded marbles had been recently discovered, which were very beautiful.

May 19, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience occupied the East Hall.

Prof. H. CARVILL LEWIS, of Philadelphia, Pa., delivered a lecture, illustrated by drawings and lantern-views, on the subject of

THE GLACIAL EPOCH IN NORTH AMERICA.

May 26, 1884.

SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-three persons were present.

The resignations of Messrs. CHAS. A. NASH, T. WOLCOTT, and Dr. W. G. WYLIE, as Resident Members, were then accepted.

A paper was read by Mr. E. A. CURLEY on

BEES AND OTHER HOARDING INSECTS : THEIR SPECIALIZATIONS INTO MALES, FEMALES, AND WORKERS.

DISCUSSION.

The PRESIDENT referred to the many investigations by DARWIN and others, in reference to this mysterious action. The subject was by no means exhausted. It seemed probable that the diminution of food, by decreasing the reproductive organs, would tend to result in the decrease of the number of perfect action. In view of the sterility of the neuters, in bees and ants, their reproduction and continuance appeared mysterious and unaccountable, unless an extremely artificial condition of society had been reached among them. If the mother could feed the larva in such a way as to incapacitate, intentionally, the greater number of the young, this method would produce the actual result. This could have been reached only by a long and curious process of development.

In New Mexico occurred the honey ants—those in which the production of honey was increased. They were fed by the others, grew, and were ultimately and systematically slaughtered as food by the other ants. Twenty-five years ago, he had some of their hives opened and brought them home. These have been since studied by Rev. Mr. McCOOK and others. We cannot reconcile a process like this in harmony with many known views.

The sterility of ants and neuters was indeed an utterly incomprehensible fact. It was possible to imagine that it could be effected by some artificial process, as it were, by a dose of medicine supplied by the mother of the hive, or possibly by some modification of their food. A bridge which fails to cross the stream has no right to exist ; so also, any phenomenon which shows no evidence of derivation from gradual growth of some beneficial influence.

The increase of food does not, as a rule, increase the fecundity of the plant or animal. A certain narrowness or limitation of food sometimes tends far more to increase the rate of reproduction. For example, in the tropics, the floral beauty is comparatively less prominent than in the temperate zone or far north, because not so dependent upon the co-ordinate work of the insect. Many evidences occur to every biologist to indicate such facts as these, in which the general tendency, explained in the Darwinian hypotheses, is in progress.

A paper was then presented by Dr. J. S. NEWBERRY, illustrated by drawings and lantern views,

ON THE ORIGIN OF PUGET SOUND, AND ITS CONNECTED SYSTEM OF TIDEWAYS.

June 2, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-seven persons were present.

It was voted to adjourn the business meeting to June 9, in order to act on business to be proposed by the Council.

The PRESIDENT exhibited specimens of crocidolite from South Africa, of native iron in basalt, from Greenland, and of fossil star fishes from the Devonian of Europe.

Mr. G. F. KUNZ stated that the crocidolite had originally the hardness of 4 or 5, but the individual fibres of crocidolite have been all encased or coated with ferruginous quartz, making the hardness of the mineral about 7—virtually a quartz-catseye. Mr. GREGORY, of London, first worked the vein in the year 1866. The mineral being in some demand, two expeditions had been sent to procure it, and in consequence the locality had been well examined, and tons of the material procured. This resulted in the loss of many thousands of dollars by the dealers, who invested largely in it at six dollars per karat. It is now sold at twenty-five cents per pound in quantity.

The PRESIDENT remarked on the character of the alteration, which had been accompanied by an increase in the amount of silica and the addition of water. He then exhibited specimens of realgar from Felsobanya, Hungary, of square prisms of humboldtilite, in slag, and of spines of *Gyracanthus tuberculatus* (?) Ag., from the Coal-measures at Lesmahagow, Scotland.

Mr. G. F. KUNZ then exhibited a collection of gems, some from the famous Poniatowski collection, which had been offered for sale as veritable antiques in the London market. He also displayed other specimens and machinery, in illustration of his paper on

A NEW PROCESS OF CUTTING INTAGLIOS AND CAMEOS, SO AS TO PRODUCE THE FINER EFFECTS OF THE ANCIENT GLYPTIC WORK.

DISCUSSION.

A MEMBER called attention to the interesting fact, recorded by Pliny the Younger, of the emerald of the Emperor Nero, which had been cut in the form of a double convex lens.

The PRESIDENT remarked on the great interest of historical records connected with engraved gems, as illustrated by the ancients. Schliemann's discoveries of engraved gems had accumulated largely with the progress of his excavations.

The work of the engraver was carried on in the most early times of history. The number of ancient gems, represented in the work of KING on this subject, indicates that this was then a very common form of art. The great hardness of their material has resulted in their frequent and often perfect preservation for long periods. Gems were cut long before the discovery of the diamond, corundum being commonly used for the purpose, in powder. There was even reason to believe that the first architectural excavation and piercing of granyte had been effected by this means. The ancient Pelasgic monuments show evidence of having been fashioned by means of bronze tools and this mineral in powder. In piercing holes, a tempered solid rod had evidently been often employed; the principle of the diamond-drill was therefore very ancient.

A paper was then read by Mr. EDWARD W. MARTIN, illustrated by lantern views, on the subject of

PHOTOMICROGRAPHY—PROCESSES AND RESULTS.

DISCUSSION.

Dr. JULIEN called attention to certain present limitations of the process, and to new methods and apparatus recently proposed to obviate these difficulties.

The PRESIDENT remarked that hereafter lantern slides will be brought into use to display and illustrate the infinitely little as well as the infinitely large. The problem of a satisfactory microscopic attachment to the lantern still remained unsolved at present; only one or but a few persons can well see the same microscopic object at one time. The electric light was full of promise in this direction, whether by means of storage batteries or of some method for the generation of electricity near or at the lantern, but it was, as yet, too much of a fixture. The satisfactory accomplishment of the application of microscopic augmentation to lantern slides, as to other objects, would be of great benefit to the educational world.

June 9, 1884.

Adjourned Business Meeting.

The President, Dr. J. S. Newberry, in the Chair.

Fifty-five persons were present.

Dr. J. H. Ripley, Dr. Robert B. Talbot, and Mr. Lucius Pitkin were elected Resident Members. The report of the Council was read.

On motion, it was *Resolved*, that the President and Secretary be authorized, at their discretion, to give the required notice of the termination of the contract with the Trustees of the American Museum of Natural History, concerning the Academy's library deposited in the Museum, when another suitable place shall have been provided.

After a full exposition by the President of the relations of the parties to this contract, and the possibility of bringing the library to a locality more convenient of access by the members of the Academy, it was further voted—

That the President and Secretary are also authorized, on the termination of the said contract, to provide a new depository for the library which shall best combine conditions the most certain for its care, security, and independent use.

The Council recommended that a Committee be appointed to solicit contributions for a publication fund to meet immediate wants and the future needs. After discussion it was voted that a Committee of twelve be appointed by the Chair for this purpose.

The following Committee was so appointed :

J. McDonald,	A. J. Todd,
J. D. Warner,	Mrs. V. K. Hascall,
C. Van Brunt,	G. F. Kunz,
L. Schoeney,	A. A. Julien,
Mrs. H. Hermann,	H. L. Fairchild,
Mrs. E. A. Smith,	C. F. Cox.

Professor FAIRCHILD represented the need of information among the members of the Academy and the public, in regard to its history and the character of its work. After discussion, it was voted—That the Secretary be authorized and requested to prepare a short manual of the origin, history, and work of the Academy, to meet this want, and that he be further authorized to associate with himself any other members in co-operation for this purpose.

Rev. Dr. E. P. THWING then spoke on the artistic uses of the trance state, by which fixity of posture and graduated intensity of motion may be created, controlled, and preserved by the photographer, painter, or sculptor. Photographs were exhibited, illustrating the relations of the magnetic state, the supreme condition of voluntary life, to the plastic arts, painting, sculpture, gesture, etc. A greater fixity of condition might thus be obtained for photographic representation than by the usual iron head-rest.

Mr. P. H. DUDLEY then exhibited a series of photomicrographs of wood sections (*Juglans nigra, Catalpa speciosa,* etc.), $\frac{93}{100}$ of an inch in diameter, taken by lamplight on eight by ten inch bromo-gelatine plates, with a magnification of about ten thousand diameters.

Mr. G. F. KUNZ presented a cut sapphire gem from Ceylon, whose color was nearly white, but became entirely blue on rotation; a cut zircon from Ceylon, with remarkably high lustre, like that of the diamond, and a weight of over thirty karats; a moonstone, containing a series of hairlike lines (rutile) and rows of fluid-cavities on certain planes, resulting in a strong reflection of light on the cabochon surface; and two lip ornaments from Brazil, the larger consisting of beryl. He also referred to the supposed discovery of diamonds—in one case, 15 karats weight—in Wisconsin, as reported in Western journals. He exhibited gravel from the so-called diamond-mine, but doubted the discovery of the three diamonds said to have been found there.

Mr. J. D. WARNER stated that there had been considerable discussion on the honeycomb. One school of philosophers had constantly pointed out the honeycomb as an evidence of design; inasmuch as it had been mathematically demonstrated that in its construction there was the least amount of waste in material and space, combined with the greatest amount of strength and capacity. Another school had attacked this position with the assertion that the cell fitted the body of the bee, and that the bee in working was necessarily obliged to plaster up the cell in opposition to the plastering of adjacent cells; so that symmetry was the result, and this gave us the hexagonal system of the honeycomb.

As the cells are merely mechanical receptacles for honey, the idea was suggested that this work might be done by machinery and the time of the bees thus saved for the more legitimate work of collecting the honey. With this in view, the conception of utilizing the old honeycomb was made practical by shaving off the caps of the cells, and then by centrifugal action the honey would be thrown out, leaving the honeycomb to be filled again.

Still, as the old honeycomb was needed for showing the genuine character of the honey, the invention of man reached out to construct the honeycomb for the bee, and succeeded in obtaining the backing and part of the sidewalls of the cells by punching sheets of wax. The first punch was of the form of a cross-section of the cell. This did not serve the purpose, as they were often split at the corners, and a punch of three lines diverging at angles of 120° was used. Such punches, combined in series in a machine, and operated by slightly shifting the rows to and fro, produced a comb foundation, having cells on each side.

The first year more than forty thousand pounds of these foundations were made. The cell walls were one-sixteenth of an inch in height, but enough material was put in the wall to construct the whole height. The bees would commence at the bottom and thin the walls, pushing them outward, and, by continuing this thinning operation, the whole material was utilized. Again, when the cells were made five to the inch, the bees used them for bee-bread; when made six to the inch, the receptacles were used for honey.

The President presented a series of lantern illustrations and described

THE SCENERY OF THE ROCKY MOUNTAIN PARKS.

The Academy then adjourned to the first Monday in October.

LIST OF THE SUBSCRIBERS

AND HOLDERS OF RECEIPTS AS SUBSCRIBERS

TO THE

OLD BUILDING-FUND OF THE LYCEUM.[1]

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Anthon, Wm. H.
Aspinwall, Wm. H.
Aymar, J. G.
Bailey, J. J.
Baker, C.
Barker, P. G.
Barron, T.
Beers, J. D.
Boorman, J.
Bradhurst, J. M.
Brown, J.
Brown, S.
Bruce, G.
Bruen, G. W.
Cary, H.
Cary, S. T.
Cary, Wm. F.
Clark, R. S.
Clarkson, O.
Cochran, R. J.
Colden, D. C.
Coles, J. U.
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Cooper, Wm.
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Coster, J. H.
Coster, J. G.
Coster, Washington.
Cramer, C.
Crary, J. S.
Crary, P.
Curtis, B.
Davis, Chas. A.
De Kay, James E.
De Kay, G. C.
Delafield, Joseph.
Denning, Wm. P.
De Rham, C.
Devan, T. T.
Dodge, J.
Dorr, G. B.
Dorr, S. F.
Douglass, G.
Douglass, W.
Downer, S.
Dudley, H.
Faile, E. G.
Faile, T. H.
Feuchtwanger, L.
Field, H. W.
Fish, Hamilton.
Fitch, A.
Fleming, A.
Foster, A., Jr.
Francis, J. W.
Gebhard, F.

(1) See By-Laws, page 9, Chapter II.

Gibson, J.
Glover, J.
Goodhue, J.
Graham, Chs., Jr.
Graves, E. A.
Greenfield, J. V.
Grinnell, H.
Grosvenor, S.
Haggerty, James.
Haggerty, John.
Halsey, J. C.
Halsey, S. A.
Hamilton, A.
Harmony, P.
Harris, E.
Heard, N. T.
Heckscher, C. A.
Heckscher, E.
Hicks, H. W.
Hicks, J. H.
Higginson, S.
Hoffman, L. M.
Hoffman, M.
Hone, J. P.
Hone, P.
Hosack, D.
Hosie, J.
How, C. W.
Howland, G. G.
Howland, J. H.
Howland, S. S.
Hoyt, Henry.
Hull, O.
Hunt, J.
Jay, Ann.
Jay, John.
Jay, John, Jr.
Jay, John C.
Jay, P. A.
Johnson, Wm.
Johnston, J.
Jones, D. S.
Jones, Ed. R.
Jones, Geo.
Jones, J. J.
Joseph, J. L.
Kearny, P., Jr.
Kemble, Wm.
Kermit, R.
Kernochan, J.
King, J. G.
Lawrence, C. W.
Lawrence, Wm. A.
Lee, D.
Lenox, James.
Le Roy, J. R.
Lord, R. L.
Lord, Thomas.
Lorillard, J.
Lorillard, P., Jr.
Low, C.
Ludlow, T. W.
Ludlum, N.
M'Cracken, H.
Mackie, J. F.
March and Benson.
Marshall, J. R.
Mason, J.
Mauran, O.
Minturn, R. B.
Minturn, R. R.
Morgan, H. P.
Moore, Wm.
Moorehead, J.
Morris, Gouverneur.
Mott, S. F.
Moulton, C. F.
Murray, J. B.
Myer, G.
Norrie, A.
Oakley, S.
Ogden, J. D. P.
Olmsted, F. W.
Packer, Wm. S., Jr.
Parish, D.
Paulding, N.
Pearson, J. G.
Pell, F.
Penfold, E.
Post, A.
Post, J. W.
Prime, Edward.
Prime, Frederick.
Prime, Rufus.

Rankin, R. G.
Ray, Richard.
Ray, Robert.
Remsen, E.
Remsen, P.
Richard, G.
Rhinelander, Wm. C.
Robbins, G. S.
Rogers, G. P.
Ruggles, S. B.
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Russell, Wm. H.
St. John, J. R.
Sanderson, E. F.
Satterlee, L.
Schenck, P. H.
Schermerhorn, P.
Schieffelin, H. M.
Schroeder, J. F.
Schuyler, R.
Sheldon, F. H.
Sheldon, H.
Smith, G. G.
Smith, J. A.
Spofford, P.
Stewart, A. T.
Stout, A. G.
Strong, P.
Stuyvesant, P. G.
Suffern, T.
Sutton, G.
Swartout, S.
Swift, Wm.
Tailer, E. N.
Talbot, C. N.
Tappan, A.
Tileston, T.
Tillotson, R.
Thompson, A. R.
Thompson, M. E.
Throop, E. T.
Tomlinson, W. A.
Torrey, P.
Van Rensselaer, J.
Van Rensselaer, S.
Varrick, A.
Verplanck, S.
Wade, E., Jr.
Wagstaff, A.
Ward, S.
Wetmore, D. W.
White, W. A.
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Wolfe, John D.
Woodruff, J. O.

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(1) See By-laws, page 12, Chapter VII.

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PRIME, FREDERICK E.
PRIME, TEMPLE.
SLOAN, SAMUEL.
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*SUCKLEY, GEO., M.D.
VAN NOSTRAND, H. D.
*VAN RENSSELAER, ALEX.
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WHEATLEY, CHARLES M.
WOLFE, Miss CATHERINE L.

RESIDENT FELLOWS AND MEMBERS OF THE ACADEMY.

(O.) Original Subscribers.
(P.) Patrons.
(F.) Fellows.

		ELECTED.
Abbott, Frank, M.D.,	22 W. 40th Street.	1878
Adams, J. W.,	155 Congress St., Brooklyn.	1876
Agnew, C. R., M.D. (F.),	266 Madison Avenue.	1867
Allen, J. A., Prof.,	Am. Mus. Nat. Hist.	1874
Allen, T. F., M.D.,	10 E. 36th Street.	1876
Amend, B. G. (F.),	320 E. 19th Street.	1866
Am Ende, Chas. G., M.D.,	Washington St., Hoboken.	1874
Arnold, E. S. F., M.D. (F.),	53 W. 38th Street.	1880
Bailey, James M.,	11 West 28th Street.	1868
Barker, Fordyce, M.D. (F.),	24 E. 38th Street.	1867
Beach, Alfred E.,	261 Broadway.	1871
Beck, Fanning C. T. (F.),	65 E. 66th Street.	1868
Bernachi, Charles, M.D.,	36 W. 28th Street.	1878
Bickmore, Albert S., M.D. (F.),	Am. Mus. Nat. Hist., 77th St. and Eighth Avenue.	1873
Bien, Julius,	16 Park Place.	1876
Biggs, Charles,	548 Broadway.	1878
Blakeman, Birdseye,	753 Broadway.	1876
Bolles, Albert S., Hon.,	2 Nassau Street.	1881
Bolton, H. C., Prof., Ph.D. (P.) (F.),	Trinity Coll., Hartford, Ct.	1867
Bower, W.,	53 Fulton Street.	1870
Braman, Benj. (F.),	117 E. 30th Street.	1881
Brevoort, J. Carson, LL.D. (P.),	Brevoort Pl., Brooklyn, L. I.	1840

		ELECTED.
Britton, N. L., Ph. D. (F.),	School of Mines, Columbia College.	1880
Bronson, Willett,	20 Exchange Place.	1877
Brownell, Silas B. (F.),	3 Broad Street.	1869
Brown, John Crosby,	59 Wall Street.	1867
Bull, Charles S., M.D. (F.),	47 E. 23d Street.	1876
Burnett, Chas. P.,	Elizabeth, N. J.	1885
Caswell, John H. (F.),	11 W. 48th Street.	1869
Chamberlin, B. B. (F.),	247 W. 125th Street.	1875
Chandler, Chas. F., Prof. (F.),	School of Mines.	1865
Chevalier, Miss Josephine,	128 Second Avenue.	1883
Chittenden, L. E. (F.),	41 E. 65th Street.	1874
Christern, F. W.,	37 W. 23d Street.	1876
Churchill, A. D. (F.),	School of Mines.	1882
Clapp, George P.,	27 Madison Avenue.	1878
Clark, Alonzo, M.D. (F.),	23 E. 21st Street.	1832
Close, S. L., M.D.,	48 E. 31st Street.	1877
Colby, Chas. E.,	School of Mines.	1883
Collingwood, Francis (F.),	Elizabeth, N. J.	1871
Conklin, W. A.,	Arsenal Build'g, Cent. Park.	1869
Conkling, Alfred R.,	27 E. 10th Street.	1876
Cooper, Edward, Hon.,	12 Washington Square.	1867
Cotheal, Alexander J. (P.) (F.),	62 W. 36th Street.	1847
Cox, C. F.,	68 Broadway.	1876
Crane, Albert,	1514 Broadway.	1877
Croly, Mrs. J. C.,	171 E. 71st Street.	1878
Crooke, John J. (F.),	165 Mulberry Street.	1867
Crosby, Howard, Rev. Dr.,	116 E. 19th Street.	1878
Da Costa, B. F., Rev. Dr.,	20 W. 25th Street.	1882
Daly, Charles P., Hon. (F.),	84 Clinton Place.	1868
Dana, Wm. S., Lt.Cr., U.S.N.,	146 W. 14th Street.	1877
Davies, William G.,	146 Broadway.	1876
Dawson, Benj. F., M.D.,	8 E. 15th Street.	1876
Day, Austin G.,	120 Broadway.	1878
Day, E. C. H., Prof. (F.),	145 East 127th Street.	1868
Dederick, E. H.,	18 Maiden Lane.	1877

		ELECTED.
Denison, Chas. H.,	140 Nassau Street.	1882
Devoe, Fred. W.,	P. O. Box 460.	1882
Dewitt, Wm. G.,	88 Nassau Street.	1884
Dickerson, Edward N. (F.),	Staats Zeitung Building.	1879
Dickinson, Henri D.,	200 E. 50th Street.	1881
Diehl, Mrs. Anna Randall,	222 W. 23d Street.	1880
Dinwiddie, Robert (P.) (F.),	113 Water Street.	1846
Dittenhoefer, A. J.,	P. O. Box 4836.	1878
Dix, Morgan, Rev. Dr.,	27 W. 25th Street.	1877
Dodge, Wm. E.,	262 Madison Avenue.	1867
Doremus, Chas. A., Ph.D.,	52 Union Place.	1876
Doremus, R. O., Prof., M.D. (F.),	52 Union Place.	1867
Douglass, Andrew E.,	9 E. 54th Street.	1881
Drummond, Isaac W.,	101 Horatio Street.	1877
Drummond, James F.,	436 W. 22d Street.	1872
DuBois, Eugene,	23 Park Row.	1876
Dudley, Henry (F.),	301 E. 17th Street.	1884
Dudley, P. H.,	Grand Central Depot.	1884
Eames, C. J., M.D.,	110 Broadway.	1868
Edsall, Burroughs,	Spuyten Duyvil, N. Y.	1884
Egleston, Thos., Prof. (P.) (F.),	35 W. Washington Square.	1861
Ellinger, Morris,	303 Mulberry Street.	1879
Elliot, S. Lowell,	538 E. 86th Street.	1884
Elliott, Arthur H. (F.),	School of Mines.	1881
Elseffer, William L.,	18 Broadway.	1885
Fairchild, Prof. H. Leroy (F.),	102 E. 52d Street.	1879
Fargo, James C.,	56 Park Avenue.	1878
Field, C. Depeyster (P.),	21 E. 26th Street.	1869
Fink, Albert,	346 Broadway.	1879
Fischer, Chas. S., Jr., M.D.,	110 W. 128th Street.	1881
Fish, Hamilton, Hon. (O.),	251 E. 17th Street.	1864
Friedrich, S. S., M.D.,	131 E. 52d Street.	1884
Gallaher, Mrs. Julia A.,	51 W. 52d Street.	1885
Gallatin, Albert R. (F.),	10 E. 17th Street.	1840

		ELECTED.
Glass, John,	209 W. 21st Street.	1882
Gouley, J. W. S., M.D.,	311 Madison Avenue.	1867
Gratacap, L. P.,	Am. Mus. Nat. Hist.	1884
Green, Andrew H., Hon.,	214 Broadway.	1865
Gregory, Geo.,	113 Sixth Avenue.	1882
Grinnell, George B.,	36 Broad Street.	1871
Guernsey, Egbert, M.D.,	18 W. 23d Street.	1867
Gunning, Thomas B.,	34 E. 21st Street.	1878
Gurnee, Walter S.,	35 Nassau Street.	1876
Habirshaw, W. M. (F.),	Brooklyn, N. Y.	1868
Haddon, Alexander, M.D. (F.),	155 E. 51st Street.	1878
Hale, Albert W.,	1 Broadway.	1869
Hamilton, Thomas S.,	132 Madison Avenue.	1878
Hamilton, S. M., Rev. Dr.,	62 W. 11th Street.	1881
Hartt, James C.,	21 Cortlandt Street.	1878
Hascall, Mrs. Virginia K.,	71 Broadway.	1881
Hassler, Charles W.,	7 Wall Street.	1876
Haswell, Charles H.,	29 Broadway.	1876
Hawkins, Dexter A.,	Trinity Building.	1878
Heineman, Henry N., M.D.,	49 W. 57th Street.	1880
Hermann, Mrs. Henry (P.),	59 W. 56th Street.	1881
Hewitt, Abram S., Hon. (F.),	9 Lexington Avenue.	1868
Hidden, William E. (F.),	Newark, N. J.	1875
Hildenbrand, William, C. E.,	222 W. 24th Street.	1877
Hildreth, D. M.,	52 Broadway.	1876
Hinton, John H., M.D. (F.),	41 West 32d Street.	1865
Hitchcock, Miss F. R. M.,	176 Madison Avenue.	1881
Hitchcock, Hiram,	5th Avenue Hotel.	1881
Hoe, Henry,	91 John Street.	1878
Holder, Chas. F. (F.),	Am. Mus. Nat. Hist.	1881
Holder, J. B., M.D. (F.),	Am. Mus. Nat. Hist.	1872
Holland, Thomas,	75 Fifth Avenue.	1878
Hone, J. P. (O.),	Custom House.	1836
Hoyt, Alfred M.,	1 Broadway.	1878
Hoyt, Henry (O.),	16 W. 23d Street.	1833
Hubbard, O. P., Prof., M.D. (F.),	65 W. 19th Street.	1874
Hubbard, Walter C.,	27 W. 9th Street.	1876

		ELECTED.
Humphreys, F. L., Rev.,	22 W. 39th Street.	1880
Hyde, E. Francis,	146 Madison Avenue.	1881
Ingersoll, William H.,	Portland, Conn.	1876
Ireland, John B.,	170 Broadway.	1876
Jackson, Joseph H.,	206 Franklin Street.	1867
Jacobi, Abraham, M.D. (F.),	110 W. 34th Street.	1867
James, D. Willis,	40 E. 39th Street.	1876
Jay, John, Hon. (O.),	191 Second Avenue.	1836
Jay, John C., M.D. (O.),	17 W. 46th Street.	1878
Johnson, Lawrence, M.D. (F.),	323 W. 27th Street.	1880
Judson, Adoniram B., M.D.,	117 E. 17th Street.	1876
Julien, Alexis A., Ph.D. (F.),	School of Mines.	1867
Kelly, William,	9 W. 16th Street.	1876
Kemp, J. F.,	School of Mines.	1885
Ketcham, Mrs. A. C.,	Coleman House.	1884
Kimber, Arthur C., Rev.,	105 E. Houston Street.	1878
King, Clarence, Prof.,	18 Wall Street.	1878
Kirchoff, Chas.,	Cor. Reade and Church Sts.	1882
Krotel, G. F., Rev. Dr.,	49 W. 21st Street.	1877
Kunz, George F. (F.),	Hoboken, N. J.	1876
Lamborn, R. H., M.D.,	47 William Street.	1884
Larremore, R. L., Hon.,	32 E. 60th Street.	1877
Laudy, Louis H., Ph.D. (F.),	School of Mines.	1881
Lawrence, George N. (P.) (F.),	45 E. 21st Street.	1845
Lawton, Walter E.,	12 Cliff Street.	1879
Lecomte, Joseph,	216 Front Street.	1878
Lee, J. Lawrence, M.D.,	21 W. 17th Street.	1868
Leeds, Albert R., Prof. (P.) (F.),	Stevens Inst., Hoboken, N. J.	1872
Levison, W. Goold (F.),	314 Livingston St., B'klyn.	1872
Lewis, Charlton T.,	30 W. 18th Street.	1876
Lewis, W. H., Jr.,	63 W. 19th Street.	1885
Liautard, A., M.D.,	141 W. 54th Street.	1869
Lichtenstein, Paul,	29 William Street.	1876
Livingston, Robert J. (P.),	10 E. 48th Street.	1864
Loewenthal, Herman, M.D.,	239 E. 30th Street.	1877

		ELECTED.
Lord, Benj., M.D.,	34 W. 28th Street.	1885
Lord, Franklin B.,	120 Broadway.	1879
Low, Seth, Hon.,	31 Burling Slip.	1876
Mackie, Simon F. (F.),	Salt Lake City, Utah.	1869
Maclay, W. W.,	709 Madison Avenue.	1877
Marble, Manton,	532 Fifth Avenue.	1878
Marquand, Henry G.,	21 W. 20th Street.	1876
Martin, Daniel S., Prof. (F.),	236 W. 4th Street.	1868
Martin, Edward W.,	47 W. 55th Street.	1882
Mayer, A. M., Prof. (F.),	Stevens Institute, Hoboken.	1872
Maynard, Geo. W., Prof.,	53 Broadway.	1881
McCarty, Edwin R.,	Hotel Brunswick, 5th Ave.	1875
McDonald, John,	11 Pine Street.	1882
McNulty, George W.,	139 Henry Street, B'klyn.	1873
Mead, W. H.,	65 Wall Street.	1882
Mitchell, Edward,	P. O. box 3712.	1876
Moldehnke, E. F., Rev. Dr.,	124 E. 46th Street.	1878
Moore, Gideon E., Ph.D. (F.),	69 Liberty Street.	1876
Morse, J. H.,	43 W. 39th Street.	1881
Mott, Alexander B., M.D.,	62 Madison Avenue.	1867
Mott, Henry A., Jr., Ph.D.,	30 W. 59th Street.	1874
Mulchahey, James, Rev.,	65 Church Street.	1878
Munsell, C. E.,	128 Worth Street.	1885
Neftel, J. W. K., C.E.,	327 W. 42d Street.	1881
Neftel, William B., M.D.,	16 E. 48th Street.	1876
Newberry, John S., Prof., M.D.	(P.) (F.), School of Mines.	1852
Newton, H. J.,	128 W. 43d Street.	1871
Nott, F. J., M.D.,	522 Madison Avenue.	1878
Oothout, E. Austin,	79 Clinton Place.	1882
Otis, Fessenden N., M.D. (F.),	108 W. 34th Street.	1867
Ottendorfer, Oswald, M.D.,	7 E. 17th Street.	1878
Parmly, D. D.,	P. O. box 888.	1879
Parsons, Wm. Barclay, Jr.,	505 Fifth Avenue.	1881
Peabody, Chas. A., Hon.,	60 West 21st Street.	1879
Pearsall, R. F.,	18 Bond Street.	1885

		ELECTED.
Pellew, Chas. E.,	9 E. 35th Street.	1883
Perley, Joseph L.,	23 Dey Street.	1878
Phelps, William W.,	2 Wall Street.	1878
Pitkin, Lucius,	432 Madison Avenue.	1884
Plimpton, Geo. A.,	743 Broadway.	1885
Poggenburg, Justus F.,	153 Broadway.	1885
Potter, Henry C., Rt. Rev. Dr.,	804 Broadway.	1877
Potter, Howard,	61 Wall Street.	1867
Prime, Frederick (O.),	26 Broad Street.	1832
Prime, F. E. (P.),	147 W. 14th Street.	1864
Prime, Temple (P.) (F.),	147 W. 14th Street.	1852
Pyne, Percy R.,	52 Wall Street.	1878
Randolph, John F. (F.),	35 Broadway.	1879
Rees, John K., Prof. (F.),	Columbia College.	1882
Reinhart, Benj. F.,	52 E. 23d Street.	1880
Rice, Charles,	Bellevue Hospital.	1876
Ricketts, Pierre de P., Ph.D. (F.),	School of Mines.	1871
Ripley, John H., M.D.,	605 Lexington Avenue.	1884
Rogers, F. M.,	431 Eighth Avenue.	1877
Rousseau, David,	310 Mott Avenue.	1882
Rudkin, Wm. H. (F.),	74 William Street.	1882
Russell, Wm. H.,	21 W. 10th Street.	1880
Rutherford, Lewis M.,	175 Second Avenue.	1864
Rutter, Thos.,	849 Fifth Avenue.	1880
Salter, Richard P.,	16 Wall Street.	1876
Satterlee, F. Leroy, M.D.,	21 W. 19th Street.	1864
Satterlee, Livingston (O.),	171 Broadway.	1859
Schack, Frederick,	116 E. 61st Street.	1876
Schermerhorn, F. A. (F.),	61 University Place.	1867
Schnetter, J., M.D.,	13 E. 41st Street.	1866
Schoeney, L., M.D. (F.),	670 Lexington Avenue.	1875
Schultz, Carl H.,	76 Union Place.	1878
Schuyler, Philip,	18 Washington Square.	1876
Seeley, Charles A., Prof. (F.),	714 Lexington Avenue.	1867
Serrell, Lemuel W.,	140 Nassau Street.	1876
Shearer, G. L., Rev.,	150 Nassau Street.	1879

		ELECTED.
Shriver, Walter,	333 E. 56th Street.	1878
Sieberg, W. H. J.,	158 E. 124th Street.	1877
Sloan, Samuel (P.),	26 Exchange Place.	1876
Sloane, T. O'Conor, Ph.D.,	119 Pearl Street.	1875
Smith, Mrs. E. A. (F.),	203 Pacific Ave., J. C., N. J.	1878
Smith, J. Tuttle, Rev.,	9 W. 56th Street.	1878
Smith, J. Ward,	Newark, N. J.	1883
Smith, S. Hanbury, M.D.,	309 Broadway.	1876
Snow, E. L.,	115 Broadway.	1882
Spencer, J. Selden, Rev.,	Tarrytown, N. Y.	1880
Stengel, Frederick, Prof.,	416 E. 57th Street.	1876
Stevens, Geo. F.,	33 W. 33d Street.	1882
Stevens, W. Le Conte, Prof.,	Brooklyn, N. Y.	1882
Stevenson, J. J., Prof.,	University of New York.	1880
Steward, D. Jackson (F.) (P.),	150 Fifth Avenue.	1858
Strong, Charles E.,	68 Wall Street.	1878
Stuyvesant, Rutherford,	246 E. 15th Street.	1868
Talbot, Robt. B., M.D.,	102 W. 54th Street.	1884
Talbott, E. H.,	115 Broadway.	1885
Taylor, Charles Fayette, M.D.,	100 W. 53d Street.	1876
Taylor, Henry L., M.D.,	100 W. 53d Street.	1877
Terry, Jas.,	Am. Mus. Nat. Hist.	1883
Thurber, George, M.D. (F.),	751 Broadway.	1867
Todd, A. J.,	261 Broadway.	1878
Tousey, Sinclair,	14 E. 46th Street.	1878
Townshend, John,	Bennett Building.	1882
Tows, C. D.,	P. O. Box 3779.	1878
Trotter, Alfred W.,	112 E. 127th Street.	1875
Trowbridge, W. P., Prof. (F.),	School of Mines.	1878
Valentine, Lawson,	11 E. 17th Street.	1877
Valentini, Philip, Ph.D.,	157 Ninth Avenue.	1882
Van Beuren, Fred. T.,	21 W. 14th Street.	1880
Van Brunt, Cornelius (F.),	319 E. 57th Street.	1876
Van Nostrand, H. D. (P.),	145 Chambers Street.	1850
Van Schaick, Jenkins,	55 S. Washington Square.	1877
Van Slyck, Geo. W.,	120 Broadway.	1878

		ELECTED.
Vaux, Calvert (F.),	Bible House.	1867
Viele, Egbert L., Gen. (F.),	Riverside Ave. and 88th St.	1873
Voorhis, J. H.,	Bethune and Greenwich Sts.	1878
Wall, John L. (F.),	Sixth Avenue & 21st Street.	1879
Waller, Elwyn, Ph.D. (F.),	School of Mines.	1871
Ward, Miss Mary G.,	957 Sixth Avenue.	1881
Ward, Wm.,	52 Broadway.	1880
Warner, James D.,	199 Baltic Street, Brooklyn.	1878
Warner, Alex.,	720 Lexington Avenue.	1882
Weisse, Fanueil D., M.D. (F.),	51 W. 22d Street.	1875
Weld, Mrs. Amy T.,	119 E. 23d Street.	1878
Welch, Uriah,		1879
Wenman, Jas. F.,	146 Pearl Street.	1878
Weston, Edward W.,	339 Wash. St., Newark, N. J.	1877
Weston, Henry (P.),	120 Broadway.	1865
White, Jas. H.,	14 W. 39th Street.	1881
White, Charles T.,	286 Lexington Avenue.	1874
White, Philip A.,	102 Gold Street.	1878
Whitehouse, F. Cope,	Brevoort House.	1884
Whitfield, R. P., Prof. (F.),	Am. Mus. Nat. Hist.	1879
Wiechmann, F. G. (F.),	School of Mines.	1882
Wiener, Joseph, M.D.,	102 E. 61st Street.	1876
Wilber, George M.,	43 Lafayette Place.	1873
Wood, Isaac F.,	Rahway, N. J.	1878
Wurtz, Henry, Prof. (F.),	332 Second Avenue.	1869
Yates, Joseph,	Mott Haven, N. Y.	1879
Youmans, Wm. J., M.D.,	3 Bond Street.	1877

HONORARY MEMBERS.

(RESTRICTED TO FIFTY.)

[Members known to be deceased have an asterisk prefixed to their names.]

*Agassiz, Prof. Louis, Cambridge, Mass.,	1837
Åkerman, Prof. R., Stockholm, Sweden,	1876
*Arnott, G. A. Walker, Arlay, Scotland,	1837
Baird, Prof. Spencer F., Washington, D. C.,	1864
Bentham, G., London, England,	1864
*Bleeker, Prof. P., Netherlands,	1864
Brandt, Prof. J. F., Russia,	1864
Bunsen, Prof. Robert, Heidelberg, Baden,	1876
Candolle, Prof. Alph. de, Geneva, Switzerland,	1852
Carpenter, Prof. W. B., London, England,	1876
Chevreul, Michel Eugéne, Paris, France,	1883
Croll, Prof. James, Edinburgh, Scotland,	1876
Dana, Prof. James D., New Haven, Ct.,	1842
*Darwin, Charles, London, England,	1879
Dawkins, Prof. W. Boyd, Manchester, England,	1876
Dawson, Sir William, Montreal, Canada,	1876
De la Rue, Warren, 73 Portland Place, London, England,	1879
Descloizeaux, Prof. A., Paris, France,	1876
Deshayes, Prof. G. P., Paris, France,	1852
*Deville, Prof. H. St. Clair, Paris, France,	1876
*Dumas, Prof. J. B., Paris, France,	1876
*Egerton, Sir Philip, London, England,	1876
*Ehrenberg, Prof. C. G., Berlin, Prussia,	1864

Fizeau, H. L., Paris, France, 1879
Frankland, Prof. E., London, England, 1879

Geikie, Prof. Archibald, London, England, 1876
Geinitz, Prof. Hans Bruno, Dresden, Saxony, 1876
Gray, Prof. Asa, Cambridge, Mass., 1852
Gruner, Prof. M. L., Paris, France, 1876
*Guyot, Prof. Arnold, Princeton, N. J., 1877

Hall, Prof. James, Albany, N. Y., 1852
Hartlaub, Dr. Gustav, Bremen, Germany, 1864
Hauer, Prof. Franz von, Vienna, Austria, 1864
*Heer, Prof. Oswald, Zurich, Switzerland, 1876
Helmholtz, Prof. H., Berlin, Prussia, 1876
*Henry, Prof. Joseph, Washington, D. C., 1876
Hofmann, Prof. A. W., Berlin, Prussia, 1876
*Holbrook, Prof. John E., Charleston, S. C., 1852
Hooker, Sir Joseph D., London, England, 1879
Huxley, Prof. Th. H., London, England, 1876

Joule, James P., Manchester, England, 1879

Kenngott, Prof. Adolph, Zurich, Switzerland, 1864
Kirchhoff, Prof. Gustavus, Berlin, Prussia, 1879
Kokscharow, Prof. Nicholas von, St. Petersburg, Russia, 1879

Lange, Prof. Victor von, Vienna, Austria, 1876
Lockyer, J. Norman, London, England, 1880
*Lyell, Sir Charles, London, England, 1836

*Martius, Prof. C. F. P. von, Munich, Bavaria, 1841
*Maxwell, Prof. Clerk, Cambridge, England, 1876
*Milne-Edwards, Prof. Henri, Paris, France, 1852
*Murchison, Sir R. I., London, England, 1836

Owen, Prof. Richard, British Museum, London, England, 1879

*Poggendorff, Prof. J. C., Berlin, Prussia, 1876

Quatrefages, Prof. J. L. A., Paris, France, 1879

Rawlinson, Sir Henry Cresswicke, London, England,	1882
Richter, Prof. Th., Freiberg, Saxony,	1876
*Sars, M., Sweden,	1864
*Secchi, Angelo (†S. J.), Rome, Italy,	1876
Siebold, C. T. E., Munich, Bavaria,	1864
Thomson, Sir William, London, England,	1876
Torell, Prof. Otto, Stockholm, Sweden,	1876
Tunner, Prof. P. Ritter von, Leoben, Austria,	1876
*Verneuil, Edward de, Paris, France,	1846
Verreaux, Julius P., Paris, France,	1866
*Wöhler, Prof. Friedrich, Göttingen, Prussia,	1876
Wurtz, Prof. Adolph, Paris, France,	1876
Young, Prof. Charles A., Princeton, N. J.,	1878

CORRESPONDING MEMBERS.

[Members known to be deceased have an asterisk prefixed to their names.]

Abbe, Prof. Cleveland, Washington, D. C.	
Abbott, Dr. Chas. C., Trenton, N. J.,	1883
d'Achiardi, Prof. Antonio, University of Pisa, Italy,	1883
Adams, Rev. H. M., Gaboon, Africa,	1854
Agassiz, Alexander, Cambridge, Mass.,	1866
*Allen, J. A., M.D., Middlebury, Vt.,	1825
*Andrews, Prof. E. B., Marietta, Ohio,	1868
Angas, Geo. French, London, England,	1864
*Anthony, J. G., Cambridge, Mass.,	1852
Appleton, Prof. J. H., Providence, R. I.,	1876
Archbald, Andrew, Paris, France,	1852
Austen, Prof. Peter T., New Brunswick, N. J.,	1878
Ayres, W. O., New Haven, Conn.,	1864
Balch, George T., Saratoga, N. Y.,	1876
Barclay, Robert, England,	1830
Bard, John, Tours, France,	1836
Batchelder, John M., Cambridge, Mass.,	1854
Bayle, Prof. E., School of Mines, Paris, France,	1868
Beadle, E. L., M.D., Poughkeepsie, N. Y.,	1835
Bechler, Lieut. W. H., Newport, R. I.,	1880
Bell, J. Graham, Boston, Mass.,	1878
Bell, James H., Sandusky, Ohio,	1836
Bennet, Rev. Cephas, Tavoy, Birmah,	1847
Berthoud, Edw. L., Golden City, Col.,	1867

Bertrand, Prof. Émile, Rue de Tournon, Paris, France,	1883
*Bigsby, John J., M.D., London, England,	1824
*Billings, E., Montreal, Canada,	1862
Binney, W. G., Burlington, N. J.,	1857
Bishop, Nath. H., Lake George, N. Y.,	1869
Bodley, Prof. Rachel L., Philadelphia, Pa.,	1876
*Boeck, Dr. Wilhelm, Christiania, Norway,	1870
Boissier, E., Geneva, Switzerland,	1852
Bolles, Rev. E. C., Salem, Mass.,	1865
Bombicci, Prof. Luigi, University of Bologna, Italy,	1883
*Bradley, Dr. L., Jersey City, N. J.,	1871
*Brainerd, Prof. J., Washington, D. C.,	1852
Brandegee, Townsend S., Cañon City, Col.,	1874
Branner, Prof. John C., Indiana University, Bloomington, Ind.,	1884
Brewer, Thomas M., Boston, Mass.,	1857
Brewster, Wm., Cambridge, Mass.,	1874
*Brinckerhoff, I., M.D., U.S.N.,	1828
*Brinckerhoff, P. R., Sing Sing, N. Y.,	1839
Brockett, L. P., M.D., Hartford, Conn.,	1847
Brown, Rev. Samuel R., S.T.D., Yokohama, Japan,	1859
Brunet, Dr., Bahia, Brazil,	1867
Brush, Prof. Geo. J., New Haven, Conn.,	1876
Buck, C. Elton, Wilmington, Del.,	1866
*Buckland, Rev. R. J. W., Rochester, N. Y.,	1860
Caldwell, Prof. Geo. C., Ithaca, N. Y.,	1876
Carmichael, Prof. H., Brunswick, Me.,	1876
*Carpenter, P. P., Montreal, Canada,	1864
*Cassin, John, Philadelphia, Pa.,	1847
Castelnau, Count, Paris, France,	1839
Chandler, Prof. W. H., Bethlehem, Pa.,	1876
Chapman, A. W., M.D., Apalachicola, Florida,	1836
Chapman, Prof. E. J., Toronto, Canada,	1877
*Cheesman, Prof. Louis M., Hartford, Conn.,	1884
Chester, Prof. A. H., Clinton, N. Y.,	1877
*Chitty, Edward, Jamaica, W. I.,	1851
Christy, David, Baltimore, Md.,	1852
Clark, Thomas, Bristol, England,	1827
Clarke, Prof. F. W., Washington, D. C.,	1876

Clay, Joseph A., Philadelphia, Pa., 1857
*Coates, Reynell, M.D., Philadelphia, Pa., 1837
Collett, Prof. John, Indianapolis, Ind., 1880
Comstock, Prof. Theo. B., Cleveland, Ohio, 1877
*Conrad, Timothy A., Philadelphia, Pa., 1837
Cook, Prof. G. H., New Brunswick, N. J., 1874
Cooke, Prof. Josiah P., Jr., Cambridge, Mass., 1876
Cooke, Dr. M. C., London, England, 1868
*Cooke, Robert L., Bloomfield, N. J., 1848
Cooper, Dr. James G., Hayward, Cal., 1855
Cope, Prof. Edward D., Philadelphia, Pa., 1876
Cornwall, Prof. H. B., Princeton, N. J., 1876
Cory, Charles B., Boston, Mass., 1880
*Couthouy, J. P., Boston, Mass., 1837
Cox, Kenyon, Anaheim, Cal., 1880
Crawford, Jos. A., Davenport, Iowa, 1877
Credner, Prof. Hermann, Leipsic, Saxony, 1866
Crosse, H., Paris, France, 1864

Dale, T. Nelson, Toronto, Canada, 1879
Dall, William H., Washington, D. C., 1870
Dana, Prof. Edw. S., New Haven, Conn., 1885
Deane, Ruthven, Cambridge, Mass., 1874
*Delafield, Richard, U.S.A., 1851
*De La Sagra, Raymon, Havana, Cuba, 1835
Denning, W. H., Fishkill, N. Y., 1832
*Desor, Edward, Neufchatel, Switzerland, 1847
*Diehl, J. S., New Oxford, Pa., 1867
Divine, Dr. S. R., Lake Sheldrake, N. Y., 1867
Doubleday, Edward, Epping, England, 1838
Douglass, Prof. Silas H., Ann Arbor, Mich., 1876
Dow, John M., Panama, 1869
Drown, Prof. Thomas M., Boston, Mass. 1876
Dubois, Henry A., M.D., New Haven, Conn., 1836
Duns, Prof. John, Edinburgh, Scotland, 1868

Eaton, Prof. Daniel C., New Haven, Conn., 1860
Edwards, Dr. Arthur M., Newark, N. J., 1873
Elliot, Daniel G., New York City, 1860

Elliot, Henry W., Washington, D. C.,	1876
Elliott, Prof. John B., Sewanee, Tenn.,	1880
Engelhardt, Francis E., Syracuse, N. Y.,	1869
*Engelmann, George, M.D., St. Louis, Mo.,	1846
Ernst, Dr. Adolfo, Caracas, Venezuela, S. A.,	1878
Fairbank, Rev. W., East Indies,	1853
Fay, H. F., Columbus, Ohio,	1858
Fisher, Geo. Jackson, M.D., Sing Sing, N. Y.,	1845
Fitch, Alexander, Carlisle, N. Y.,	1845
Fittica, Prof. F., University of Marburg, Germany,	1879
Foreman, Dr. E., Washington, D. C.,	1874
Ford, Prof. Darius R., Elmira, N. Y.,	1874
Ford, Silas W., Schodack Landing, N. Y.,	1873
*Foster, J. W., Zanesville, Ohio,	1846
Fresenius, Prof. C. R., Wiesbaden, Germany,	1879
Fritz-Gaertner, Dr. R., Tegucigalpa, Honduras,	1878
*Gabb, Prof. W. M., Philadelphia, Pa.,	1861
Gadolin, Gen. Alex., St. Petersburg, Russia,	1868
*Gale, Dr. L. D., Washington, D. C.,	1826
Gaussoin, E., Baltimore, Md.,	1867
*Gibbes, Prof. Lewis R., Charleston, S. C.,	1847
*Gibbs, George, Washington, D. C.,	1858
Gibbs, Prof. W., Cambridge, Mass.,	1840
Gilbert, G. K., Washington, D. C.,	1870
Gill, Dr. Theodore, Washington, D. C.,	1858
Gilman, Pres. D. C., Baltimore, Md.,	1876
Girard, Charles, Paris, France,	1852
*Giraud, Jacob P., Poughkeepsie, N. Y.,	1840
Goessman, Prof. C. A., Amherst, Mass.,	1865
Goode, Prof. G. Brown, Washington, D. C.,	1876
Gordon, Dr. Antonio de, Havana, Cuba,	1883
*Graham, Thomas, Edinburgh, Scotland,	1829
Grattarola, Prof. Giuseppe, Florence, Italy,	1883
Gravenhorst, J. H. Waters, Bonaire, W. I.,	1882
Green, S. F., Jaffna, Ceylon,	1867
Greenleaf, R. C., Boston, Mass.,	1868
Gregg, Dr. W. H., Elmira, N. Y.,	1865

Gregorio, Marchese Antonio di, Palermo, Sicily, 1883
Grierson, T. M. D., Dumfriesshire, Scotland, 1865
Grote, Prof. Aug. R., Buffalo, N. Y., 1876
Groth, Prof. Paul, University of Strasburg, Germany, 1877
*Guillaudeau, Emile, New Jersey, 1846
Guppy, R. J. L., Trinidad, W. I., 1869

Hagen, Dr. Herman A., Cambridge, Mass., 1874
Hague, James D., San Francisco, Cal., 1874
*Haldeman, Prof. S. S., Chickies, Pa., 1846
*Hallock, Edward J., New York City, 1877
Hamlin, C. E., Waterville, Maine, 1865
Hancock, D., Demerara, W. I., 1824
Hanley, Sylvanus, London, England, 1864
Harden, M. B., Lexington, Va., 1866
Hartman, W. D., M.D., West Chester, Pa., 1852
*Hartt, Prof. C. Fred., Rio Janeiro, Brazil, 1876
Hawkins, B. Waterhouse, London, England, 1868
Hayden, Prof. F. V., Washington, D. C., 1862
Hayes, S. Dana, Boston, Mass., 1876
Henry, Charlton F., U.S.A., 1853
Henwood, W. Jory, Cornwall, England, 1842
Hepburn, J. M., M.D., Japan, 1859
Hesse-Wartegg, Count Ernst von, New York, 1882
Hexamer, Dr. F. M., Newcastle, N. Y., 1857
Hickock, W. C., Vermont, 1848
Hill, Prof. Henry B., Cambridge, Mass., 1876
Himes, Prof. Charles F., Carlisle, Pa., 1876
Hitchcock, Prof. Charles H., Hanover, N. H., 1867
*Holmes, Dr. A. F., Montreal, Canada, 1825
*Hopkins, W., Auburn, N. Y., 1846
Horsford, Prof. E. N., Cambridge, Mass., 1876
Horton, Letas R., Goshen, Orange County, N. Y., 1864
*Hough, Franklin B., M.D., Lowville, N. Y., 1852
*How, Prof. Henry, Windsor, Nova Scotia, 1867
Howard, Thos. T., Jr., Perth Amboy, N. J., 1877
*Hubbard, Dr. E. W., Tottenville, N. Y., 1867
Hunt, Dr. T. Sterry, Montreal, Canada, 1867
Hyatt, Prof. Alpheus, Cambridge, Mass., 1876

Hyatt, Prof. James, Stanfordville, N. Y.,	1876
Iles, Malvern W., Denver, Col.,	1875
Irving, Prof. Roland D., Madison, Wis.,	1874
*Jackson, C. T., M.D., Boston, Mass.,	1834
James, Major O. C., Rio Janeiro, Brazil,	1867
Jamieson, Rev. J. M., Sabatha, India,	1847
Jannetaz, Prof. A., College Sorbonne, Paris, France,	1883
*Jewett, Col. E., Santa Barbara, Cal.,	1867
Johnson, Prof. Saml. W., New Haven, Conn.,	1876
*Johnston, Prof. John, Middletown, Conn.,	1838
Jordan, Pres. David S., Bloomington, Ind.,	1876
Joy, Prof. Charles A., Stockbridge, Mass.,	1878
Judd, Orange, Middletown, Conn.,	1876
Kendrick, Prof. H. L., U.S.M.A., West Point, N. Y.,	1876
*Kerr, Prof. W. C., Raleigh, N. C.,	1869
*King, Alfred T., M.D., Greensburg, Pa.,	1852
King, C. R., M.D., Philadelphia, Pa.,	1838
*King, Henry, M.D., St. Louis, Mo.,	1846
King, Prof. William, Glenoir, Galway, Ireland,	1884
Kinney, Prof. J. R., Honolulu, Sandwich Islands,	1867
*Kirtland, Prof. Jared P., Cleveland, Ohio,	1839
Knowlton, W. J., Boston, Mass.,	1880
Koenig, Prof. Geo A., Philadelphia, Pa.,	1876
Koschkull, H. von, Tiflis, Caucasus,	1868
Krebs, H. J., Copenhagen, Denmark,	1867
Kurtz, J. D., U.S.A.,	1865
Lacerda, Antonio de, Bahia, Brazil,	1867
Land, Wm. J., Atlanta, Ga.,	1877
Langley, Prof. J. W., Ann Arbor, Mich.,	1876
*Lapham, I. W., Milwaukee, Wis.,	1853
Lattimore, Prof. S. A., Rochester, N. Y.,	1876
Lauderdale, J. V., M.D., U.S.A.,	1867
Lea, Isaac, Philadelphia, Pa.,	1829
Lea, M. Carey, Philadelphia, Pa.,	1876
*Le Conte, John L., M.D., Philadelphia, Pa.,	1845
Le Conte, Prof. John, Berkeley, Cal.,	1876

Le Conte, Prof. Joseph, Berkeley, Cal.,	1876
*Lee, Charles A., M.D., Peekskill, N. Y.,	1839
Leidy, Joseph, M.D., Philadelphia, Pa.,	1848
Le Jolis, Dr. Auguste, Cherbourg, France,	1876
Le Mercier, Dr. F. G., Paris, France,	1869
*Lewis, James, M.D., Mohawk, N. Y.,	1864
Lintner, Prof. J. A., Albany, N. Y.,	1872
Lockwood, Rev. S., Freehold, N. J.,	1865
Lord, Henry B., Ithaca, N. Y.,	1868
Lowe, Edward J., Nottingham, England,	1857
Lupton, Prof. N. T., Nashville, Tenn.,	1876
Macfarlane, Dr. James, Syracuse, N. Y.,	1874
Macloskie, Prof. George, Princeton, N. J.,	1876
Mallet, Prof. John W., University of Virginia, Va.,	1876
Marcy, Prof. Oliver, N. W. University, Evanston, Ill.,	1871
Marsh, Prof. O. C., New Haven, Conn.,	1867
*Marshall, Henry, M.D., Kortright, N. Y.,	1835
Mason, Rev. Francis, Tavoy, Burmah,	1844
Matthew, Prof. George F., St. John, N. B.,	1867
Maynard, C. J., Ipswich, Mass.,	1874
McChesney, Prof. J. H., Chicago, Ill.,	1863
McCormick, Richard H., Arizona,	1869
McMurtrie, W. C., M.D., Washington, D. C.,	1876
Mead, Theodore L., New York City,	1874
*Meek, F. B., Washington, D. C.,	1862
Meigs, J. A., Philadelphia, Pa.,	1874
Merrick, Prof. J. M., Boston, Mass.,	1876
Merriam, C. Hart, Locust Grove, Lewis County, N. Y.,	1874
Metcalfe, William, London, England,	1842
Michie, Prof. P. S., West Point, N. Y.,	1885
Minot, Dr. Charles S., Boston, Mass.,	1878
Mixter, Prof. Wm. G., New Haven, Conn.,	1876
Moore, Whitby E., Para, Brazil,	1844
Morch, Otto, Copenhagen, Denmark,	1864
*Morris, Rev. John G., Baltimore, Md.,	1864
Morris, W. W., U.S.A.,	1851
Morse, Prof. Edward S., Salem, Mass.,	1864
Mortimer, Capt. John H., New York,	1875

Nason, Prof. Henry B., Troy, N. Y.,	1876
Nevius, Rev. Reuben D., Baker City, Oregon,	1867
Newcomb, Wesley, M.D., Ithaca, N. Y.,	1853
Newton, Alfred, Cambridge, England,	1866
Nichols, Prof. W. Ripley, Boston, Mass.,	1876
Nicholls, Dr. H. A. Alford, Dominica, W. I.,	1882
Nicolis, Sig. Cav. Enrico, Verona, Italy,	1884
Niles, Prof. Wm. H., Boston, Mass.,	1881
Nolan, Dr. E. J., Philadelphia, Pa.,	1880
Nordenskjold, Prof. N. A. E., Stockholm, Sweden,	1868
Ober, Frederick A., Beverly, Mass.,	1879
*Olmstead, Charles H., Hartford, Conn.,	1844
*Olmstead, Rev. Lemuel, Washington, D. C.,	1846
Oothout, Henry, Stamford, Conn.,	1865
Ordway, Prof. John M., Boston, Mass.,	1876
Orton, Prof. Edward, Columbus, Ohio,	1871
*Orton, Prof. James, Vassar College, Poughkeepsie, N. Y.,	1870
Ostensacken, Baron R., St. Petersburg, Russia,	1857
Packard, Prof. A. S., Jr., Providence, R. I.,	1866
Packard, R. L., Washington, D. C.,	1877
Paine, Prof. John A., Tarrytown, N. Y.,	1877
Palmer, F. Temple, Versailles, France,	1836
*Parker, C. H., Camden, N. J.,	1865
Parrot, Rev. Dr. J. W., Addison, Steuben County, N. Y.,	1869
*Pease, W. H., Honolulu, Sandwich Islands,	1841
Pecchioli, V., Pisa, Italy,	1846
Peck, T. M., Grand Rapids, Mich.,	1853
Peckham, Prof. S. F., Akron, Ohio,	1876
Perkins, Prof. Maurice F., Schenectady, N. Y.,	1876
*Petit, S. de la Saussaye, Paris, France,	1853
Pfeiffer, Louis, M.D., Cassel, Germany,	1853
Phené, Dr. J. S., London, England,	1882
*Pickering, Charles, M.D., Philadelphia, Pa.,	1828
Pickering, Prof. Ed. C., Cambridge, Mass.,	1876
Piddington, Henry, Calcutta, India,	1846
Pisani, F., 8 Rue Furstenburg, Paris, France,	1883

*Plum, Ovid, M.D., Salisbury, Conn.,	1874
Poey, Prof. Andreas, Paris, France,	1869
Poey, Prof. Felipe, Havana, Cuba,	1851
Post, Rev. R. P., Honolulu, Sandwich Islands,	1867
Potter, Prof. W. B., Washington University, St. Louis, Mo.,	1871
Prescott, Prof. Albert B., Ann Arbor, Mich.,	1876
Prime, Prof. Frederick, Jr., Easton, Pa.,	1877
*Pumpelly, Geo. J., Owego, N. Y.,	1857
Pumpelly, Prof. Raphael, Newport, R. I.,	1868
Purdie, H. A., Boston, Mass.,	1874
Putnam, Prof. F. W., Salem, Mass.,	1860
Pynchon, Prof. Th. R., Hartford, Conn.,	1876
Quesneville, M. le Dr., Paris, France,	1879
Ramsey, J. G., M.D., Tennessee,	1860
*Randall, Henry S., Cortlandville, N. Y.,	1846
Randall, F. A., Warren, Pa.,	1876
Rau, Dr. Charles, Washington, D. C.,	1877
Rawson, Sir Rawson W., London, England,	1867
Read, M. C., Hudson, Ohio,	1876
Redfield, John H., Philadelphia, Pa.,	1836
Remsen, Prof. Ira, Baltimore, Md.,	1876
Ridgway, Robert, Washington, D. C.,	1874
Robertson, J., Atticus, N. Y.,	1864
Robertson, Rev. J. J., Saugerties, N. Y.,	1817
Roemer, Charles F., Berlin, Prussia,	1845
Roemer, Edward, M.D., Cassel, Germany,	1864
*Roepper, Prof. C. W., Bethlehem, Pa.,	1876
Rogers, Dr. Henry R., Dunkirk, N. Y.,	1882
Rogers, Prof. R. E., Philadelphia, Pa.,	1876
*Root, Prof. Oren, Clinton, N. Y.,	1874
Rosa, W. V. V., M.D., Watertown, N. Y.,	1866
Russell, Israel C., Washington, D. C.,	1876
Sadtler, Prof. Samuel, Philadelphia, Pa.,	1876
Salvadori, T., M.D., Turin, Italy,	1866
Saussure, H. de, Geneva, Switzerland,	1856

Schaeffer, Prof. C. A., Ithaca, N. Y.,	1876
Schweitzer, Dr. Paul, University of Mo., Columbia, Mo.,	1867
Sclater, P. L., London, England,	1856
Scudder, Prof. Samuel H., Cambridge, Mass.,	1876
*Seymour, Rev. E., Bloomfield, N. J.,	1854
Sherwood, Andrew, Mansfield, Pa.,	1876
*Showalter, E. R., Union Town, Ala.,	1866
*Shuttleworth, Robert J., Berne, Switzerland,	1852
*Silliman, Prof. Benjamin, New Haven, Conn.,	1838
Sinclair, William, West Hoboken, N. J.,	1847
Skinner, Ezekiel, M.D., Liberia,	1837
*Sloat, L. W., California,	1838
Slosson, Charles,	1885
Smith, Charles E., Philadelphia, Pa.,	1866
Smith, J. Bryant, Kingston, Jamaica, W. I.,	1852
*Smith, Prof. J. L., Louisville, Ky.,	1854
Smith, Sanderson, Staten Island, N. Y.,	1854
Smith, T. L., M.D., U.S.N.,	1849
Sorby, Henry C., Sheffield, England,	1858
Spang, Norman, Etna, Alleghany County, Pa.,	1876
*St. John, Prof. Samuel, New York,	1838
Stearns, Robert E. C., Berkeley, Cal.,	1876
Stevens, Dr. Richard P., Brooklyn, L. I.,	1875
*Stewart, Charles, U.S.N.,	1825
Stillman, Charles H., M.D., Plainfield, N. J.,	1840
Stillman, J. B., M.D., Texas,	1855
*Stimpson, William, M.D., Chicago, Ill.,	1864
*Stodder, Charles, Boston, Mass.,	1868
Stoebner, Prof. F. W., Westfield, Mass.,	1882
Storer, Prof. F. H., Jamaica Plains, Mass.,	1876
Stout, A. A., M.D., U.S.N.,	1847
Stretch, Richard H., San Francisco, Cal.,	1865
Stuart, A. P. S., Lincoln, Neb.,	1876
*Swift, Robert, Philadelphia, Pa.,	1852
Taber, Augustus, Westchester County, N. Y.,	1854
Tajore, The Maharajah Sowindho Mokun, Calcutta, Hindostan,	1885
Taylor, Alexander S., California,	1860
Thomson, James, Paris, France,	1845

Thurston, Prof. Robert H., Ithaca, N. Y.,	1876
Thwing, Rev. E. P., Brooklyn, N. Y.,	1885
Torrey, H. Gray, Stirling, N. J.,	1866
Trowbridge, Prof. John, Cambridge, Mass.,	1877
*Trudeau, J., M.D., New Orleans, La.,	1846
Tryon, A. W., Philadelphia, Pa.,	73
Tryon, G. W., Jr., Philadelphia, Pa.,	1864
*Turnbull, W. P., Philadelphia, Pa.,	1865
Tuttle, Prof. D. K., Baltimore, Md.,	1876
*Vancleve, John W., Dayton, Ohio,	1852
Van Henrick, Henry, Antwerp, Belgium,	1871
*Vaux, William S., Philadelphia, Pa.,	1853
*Verplanck, Gulian C., Fishkill, N. Y.,	1817
Verrill, Prof. A. E., New Haven, Conn.,	1867
Villa, Antonio, Milan, Italy,	1846
Villa, J. B., Milan, Italy,	1846
Vogdes, Lieut. Anthony W., Governor's Island, N. Y.,	1883
Volhard, Prof. Jakob, University of Munich, Germany,	1879
Vollum, Dr. Edw. P., Jefferson Barracks, Mo.,	1880
Voss, Lothair, Berliburg, Prussia,	1869
Wailes, B. L. C., Washington, D. C.,	1854
Waldo, Leonard, New Haven, Conn.,	1876
Walling, Henry F., Boston, Mass.,	1869
Ward, James W., Buffalo, N. Y.,	1876
Warren, Rev. Joseph, Allahabad, India,	1848
Warring, Prof. Charles B., Poughkeepsie, N. Y.,	1876
Weissbach, Prof. A., Bergakademie, Freiberg, Saxony,	1883
Wheatland, Henry, M.D., Salem, Mass.,	1858
Wheaton, Dr. J. M., Columbus, Ohio,	1875
White, Rev. G. W., Marietta, Ohio,	1854
White, Prof. I. C., Morgantown, W. Va.,	1874
Whittlesey, Charles, Cleveland, Ohio,	1854
Winchell, Prof. Alexander, Ann Arbor, Mich.,	1860
Winchell, Prof. N. H., Minneapolis, Minn.,	1878
Wissman, J. F., San Francisco, Cal.,	1869
*Wood, Rev. Frank A., Beirut, Syria,	1870
Wood, Horatio C., M.D., Philadelphia, Pa.,	1866

Woodward, Henry, London, England,	1868
*Woodward, J. J., M.D., Washington, D. C.,	1871
Wormley, Dr. Theodore G., Philadelphia, Pa.,	1874
Worthen, Prof. A. H., Springfield, Ill.,	1867
Wright, Prof. A. A., Oberlin, Ohio,	1874
Wright, Prof. A. W., New Haven, Conn.,	1876
*Wyman, Prof. Jeffries, M.D., Cambridge, Mass.,	1865
Wynne, James, M.D., Central America,	1857
Yarrow, Dr. H. C., Philadelphia, Pa.,	1876

SOCIETIES AND PERSONS

TO WHOM THE

SCIENTIFIC PUBLICATIONS OF THE ACADEMY

ARE PRESENTED.

[The undermentioned Societies and Persons contribute their publications to the Library of the *New York Academy of Sciences*, formerly called the Lyceum of Natural History.]

Great Britain and Ireland.

The Belfast Naturalists' Field Club, Belfast.
The Belfast Natural History and Philosophical Society, Belfast.
The Dublin Society of Natural History, Dublin.
The Royal Dublin Society, Dublin.
The Royal Geological Society of Ireland, Dublin.
The Dumfriesshire and Galloway Scientific, Natural History, and Antiquarian Society, Dumfries.
The Edinburgh Botanical Society, Edinburgh.
The Edinburgh Geological Society, Edinburgh.
The Royal Cornwall Polytechnic Society, Falmouth.
The Philosophical Society of Glasgow, Glasgow.
The Hertfordshire Natural History Society and Field Club, Hertford.
The Literary and Philosophical Society, Liverpool.
Annals and Magazine of Natural History, London.
The British Association for the Advancement of Science, London.
The British Museum, London.
Cosmos, London.
The Entomologist, London.
The Entomological Society of London, London.

The Geological Society, London.
The Linnæan Society, London.
The Museum of Practical Geology, London.
The Pathological Society, London.
The Royal Horticultural Society, London.
The Royal Microscopical Society, London.
The Royal Society of London, London.
The Society of Arts, London.
The Zoological Society of London, London.
Manchester Literary and Philosophical Society, Manchester.
The Tynesdale Naturalists' Field Club, Newcastle.

France.

La Société Académique de Maine et Loire, Angers.
La Société des Sciences Historiques et Naturelles de l'Yonne, Auxerre.
Commission Metéorologique de la Gironde, Bordeaux.
La Société Linnéenne de Bordeaux, Bordeaux.
La Société des Sciences Physiques et Naturelles de Bordeaux, Bordeaux.
L'Académie Nationale des Sciences, Arts, et Belles-Lettres de Caen, Caen.
La Société Linnéenne de Normandie, Caen.
La Société des Sciences Naturelles de Cherbourg, Cherbourg.
L'Académie Nationale des Sciences, Arts, et Belles-Letters, Dijon.
Union Géographique du Nord de la France, Douai.
L'Académie des Sciences, Belles-Letters, et Arts de Lyon, Lyons.
La Société Linnéenne de Lyon, Lyons.
La Société Nationale d'Agriculture, d'Histoire Naturelle, et d'Arts Utiles de Lyon, Lyons.
La Société d'Histoire Naturelle du Département de la Moselle, Metz.
L'Académie des Sciences et Lettres de Montpellier, Montpellier.
Bulletin de la Société Chimique de Paris, Paris.
Comptes Rendus, Quai des Augustins 55, Paris.
L'École Polytechnique, Paris.
Institut Ethnographique, Paris.
L'Institut de France, Paris.

Journal de Micrographie, Paris.
Le Muséum d'Histoire Naturelle, Paris.
Le Naturaliste, Paris.
Revue et Magasin de Zoologie, Paris.
La Société Américaine de France, Paris.
La Société Entomologique de France, Paris.
La Société d'Ethnographie, Paris.
La Société Géologique de France, Paris.
La Société de Législation Comparée, Paris.
La Société de Thérapeutique, Paris.
La Société Zoologique de France, Paris.

Austro-Hungary.

Der Naturforschende Verein in Brünn, Brünn.
The Hungarian Academy of Sciences, Pesth.
Die Königliche Böhmische Gesellschaft der Wissenschaften in Prag, Prague.
Die Kaiserliche Akademie der Wissenschaften, Vienna.
Die Kaiserlich-Königliche Geographische Gesellschaft in Wien, Vienna.
Die Kaiserlich-Königliche Zoologisch-botanische Gesellschaft in Wien, Vienna.
Die Kaiserlich-Königliche Geologische Reichsanstalt, Vienna.
Der Naturwissenschaftliche Verein an der Universität, Vienna.

Germany.

Die Naturforschende Gesellschaft des Osterlandes zu Altenburg, Altenburg.
Der Naturhistorische Verein zu Augsburg, Augsburg.
Die Naturforschende Gesellschaft in Bamberg, Bamberg.
Die Deutsche Geologische Gesellschaft, Berlin.
Der Entomologische Verein in Berlin, Berlin.
Garten-Zeitung, Berlin.
Die Königliche Preussische Akademie der Wissenschaften zu Berlin, Berlin.
Mathematische und Naturwissenschaftliche Berichte aus Ungarn, Berlin.

Der Verein zur Beförderung des Gartenbaues in den Königlich Preussischen Staaten, Berlin.
Der Naturhistorische Verein der Preussischen Rheinlande und Westfalens, Bonn.
Der Botanische Verein, Brandenburg.
Der Naturwissenschaftliche Verein zu Bremen, Bremen.
Die Deutsche Ornithologische Gesellschaft, Brunswick.
Malakozoologische Blätter, Cassel.
Der Verein für Hessische Geschichte und Landeskunde in Kassel, Cassel.
Die Naturwissenschaftliche Gesellschaft, Chemnitz.
Die Technische Staatslehranstalten zu Chemnitz, Chemnitz.
Die Naturforschende Gesellschaft in Danzig, Dansic.
Der Verein für Erdkunde und verwandte Wissenschaften, Darmstadt.
Die Naturwissenschaftliche Gesellschaft Isis in Dresden, Dresden.
Die Naturforschende Gesellschaft, Emden.
Die Senkenbergische Naturforschende Gesellschaft, Frankfurt am Main.
Die Zoologische Gesellschaft in Frankfurt am Main, Frankfurt a. M.
Die Thurgauische Naturforschende Gesellschaft, Frauenfeld.
Die Naturforschende Gesellschaft zu Freiburg i. Baden, Freiburg.
Die Ober-hessische Gesellschaft für Natur- und Heilkunde, Giessen.
Die Naturforschende Gesellschaft zu Görlitz, Görlitz.
Die Königliche Gesellschaft der Wissenschaften zu Göttingen, Göttingen.
Die Geographische Gesellschaft, Greifswald.
Der Verein der Freunde der Naturgeschichte in Mecklenburg, Güstrow.
Die Kaiserliche Leopoldino-Carolinische Deutsche Akademie der Naturforscher, Halle a. S.
Die Naturforschende Gesellschaft zu Halle, Halle a. S.
Der Naturwissenschaftliche Verein für Sachsen und Thüringen, Halle a. S.
Naturhistorisches Museum zu Hamburg, Hamburg.
Der Naturwissenschaftliche Verein in Hamburg, Hamburg.
Die Gesellschaft für Mikroskopie zu Hannover, Hanover.
Die Naturhistorische Gesellschaft zu Hannover, Hanover.
Der Naturwissenschaftliche Verein für Schleswig-Holstein, Kiel.

Die Königliche physikalisch-ökonomische Gesellschaft zu Königsberg i. Pr., Königsberg.
Die Fürstliche Jablonowski'sche Gesellschaft der Wissenschaften, Leipsic.
Die Königlich-Sächsische Gesellschaft der Wissenschaften zu Leipzig, Leipsic.
Der Naturwissenschaftliche Verein für Fürstenthum, Lüneburg, Lüneburg.
Der Verein der Freunde der Naturgeschichte in Mecklenburg, Mecklenburg.
Die Königliche Bayerische Akademie der Wissenschaften zu München, Munich.
Der Königlich Bibliothek, Munich.
Der Westfälischen Provinzial-Verein für Wissenschaft und Kunst, Münster.
Die Naturhistorische Gesellschaft zu Nürnberg, Nuremberg.
Der Offenbacher Verein für Naturkunde, Offenbach a. M.
Der Naturwissenschaftliche Verein zu Osnabrück, Osnabrück.
Der Naturwissenchaftliche Verein in Regensburg, Regensburg.
Der Entomologische Verein, Stettin.
Der Verein für Vaterländische Naturkunde in Württemberg, Stuttgart.
Der Nassauische Verein für Naturkunde, Wiesbaden.
Die Physich-medic. Gesellschaft zu Würzburg, Würzburg.

Russia.

Die Gelehrte Estnische Gesellschaft zu Dorpat, Dorpat.
Societas Scientiarum Fennica, Helsingfors.
La Société Impériale des Naturalistes de Moscou, Moscow.
Der Naturforscher-Verein, Riga.
L'Académie Impériale des Sciences de St. Pétersbourg, St. Petersburg.
Acta Horti Petropolitani, St. Petersburg.
La Bibliothèque Impériale Publique, St. Petersburg.
Le Comité Géologique, à l'Institut des Mines, St. Petersburg.
Die Kaiserliche Mineralogische Gesellschaft, St. Petersburg.
Societas Entomologica Rossica, St. Petersburg.
La Société Physico-Chimique Russe à l'Université de St. Pétersbourg, St. Petersburg.

SWEDEN.

Entomologisk Tidskrift, Stockholm.
Institut Royal Géologique de la Suède, Stockholm.
Kongliga Svenska Vetenskaps-Akademien, Stockholm.
Sveriges Geologiska Undersökning, Stockholm.
Kongliga Vetenskaps Societeten, Upsala.

NORWAY.

Bergens Museum, Bergen.
Kongelige Norske Frederiks Universitets, Christiania.
Den Norske Gradmalings Komission, Christiania.
Den Norske Nordhaus-Expedition, Christiania.
Videnskabs-Selskabet, Christiania.
Det Kongelige Norske Videnskabers Selskabs, Drontheim.

DENMARK.

L'Académie Royale de Copenhague, Copenhagen.
Det Kongelige Danske Videnskabernes Selskabs i. Kjobenhavn, Copenhagen.

BELGIUM.

La Société Géologique de Belgique, Liège.
La Société Royale des Sciences de Liège, Liège.
L'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique à Bruxelles, Brussels.
Le Musée Royal d'Histoire Naturelle de Belgique, Brussels.
La Société Belge de Microscopie, Brussels.
La Société Entomologique de Belgique, Brussels.
La Société Royale Malacologique de Belgique, Brussels.

NETHERLANDS.

De Koninklÿke Akademie van Wetenschappen, Amsterdam.
De Koninklÿke Zoologisch Genootschap "Natura Artis Magistra," Amsterdam.
The Royal Library, the Hague.
Musée Teyler, Harlem.
La Société Hollandaise des Sciences à Haarlem, Harlen
The University of Leyden, Leyden.

L'Institut Royal Grand-Ducal de Luxembourg, Luxemburg.
La Société Provinciale des Arts et Sciences établie à Utrecht, Utrecht.

SWITZERLAND.

Die Naturforschende Gesellschaft, Basel.
Die Naturforschende Gesellschaft in Bern, Berne.
La Société Helvétique des Naturalistes, Freiburg.
La Société Fribourgeoise des Sciences Naturelles, Fribourg.
La Société de Physique et d'Histoire Naturelle de Genève, Geneva.
L'Institut National Genevois, Geneva.
La Société Vaudoise des Sciences Naturelles, Lausanne.
Die Schweizerische Naturforschende Gesellschaft in Luzern, Luzerne.
La Société des Sciences Naturelles de Neuchatel, Neuchatel.
Die St. Gallischen Naturwissenschaftliche Gesellschaft, St. Gallen.
Die Schweizerischen Naturforschende Gesellschaft in Zürich, Zurich.

SPAIN

Real Academia de Ciencias, Madrid.

PORTUGAL.

Academia Real das Sciencias de Lisboa, Lisbon.
Jornal de Sciencias, Coimbra.
Secção dos Trabalhos Geologicos de Portugal, Lisbon.

ITALY.

Accademia delle Scienze dell' Istituto di Bologna, Bologna.
Istituto Regio Lombardo di Scienze, Lettere, ed Arti, Milan.
Reale Accademia delle Scienze e Belle Lettere, Naples.
Reale Accademia di Scienze, Lettere, e Belle Arti di Palermo, Palermo.
Reale Istituto Lombardo di Scienze e Lettere, Pisa.
La Società Toscana di Scienze Naturali, Pisa.
Reale Accademia dei Lincei, Rome.
Reale Comitato Geologico d'Italia, Rome.
Osservatorio della Reggia Universitá di Torino, Turin.
Reale Accademia delle Scienze di Torino, Turin.
Reale Istituto Veneto di Scienze, Lettere, ed Arti, Venice.

East Indies.

Het Bataviaasch Genootschap van Kunsten en Wetenschappen, Batavia, Java.

Australia.

The Royal Society of South Australia, Adelaide.
The Royal Society of Queensland, Brisbane, Queensland.
Australian Museum, Sydney, New South Wales.
The Linnean Society of New South Wales, Sydney, New South Wales.
Royal Geological Society, Sydney, New South Wales.
The Royal Society of New South Wales, Sydney, New South Wales.

Japan.

The Science Department, University of Tokio, Tokio.

The West Indies.

Professor Felipe Poey, Havana, Cuba.

Mexico.

El Museo Nacional de México, Mexico.

South America.

La Academia Nacional de Ciencias en Córdoba, Buenos Aires, República Argentina.
Museo Publico de Buenos Ayres, Buenos Ayres, República Argentina.
H. M. The Emperor of Brazil, Rio Janeiro, Brazil.
Museu Nacional do Rio do Janeiro, Rio Janeiro, Brazil.

Dominion of Canada.

Le Naturaliste Canadien, Cap Rouge, Quebec.
The Nova Scotia Institute of Natural Science, Halifax, N. S.
The Botanical Society of Canada, Kingston, Ont.
Queen's College and University, Kingston, Ont.
The Canadian Entomologist, London, Ont.
The Natural Historical Society of Montreal, Montreal.

The Canadian Record of Science, Montreal.
McGill College and University, Montreal.
The Royal Society of Canada, Montreal.
Geological and Natural History Survey of Canada, Ottawa.
Ottawa Field Naturalists' Club, Ottawa.
The Quebec Literary and Historical Society, Quebec.
The Canadian Institute of Toronto, Toronto, Ont.
The Entomological Society of Ontario, Toronto, Ont.

UNITED STATES.

The Albany Institute, Albany, N. Y.
The New York State Agricultural Society, Albany, N. Y.
The New York State Library, Albany, N. Y.
The New York State Museum of Natural History, Albany, N. Y.
Amherst College, Amherst, Mass.
The University of Michigan, Ann Arbor, Mich.
The Biological Laboratory, Johns Hopkins University, Baltimore, Md.
Johns Hopkins University, Baltimore, Md.
The Peabody Institute, Baltimore, Md.
St. Mary's College, Baltimore, Md.
University of California, Berkeley, Cal.
The Boston Society of Natural History, Boston, Mass.
Ornithologist and Oologist, Boston, Mass.
The Brooklyn Library, Brooklyn, N. Y.
The Long Island Historical Society, Brooklyn, N. Y.
The Brookville Society of Natural History, Brookville, Ind.
Bowdoin College, Brunswick, Me.
The Buffalo Historical Society, Buffalo, N. Y.
The Buffalo Society of Natural Sciences, Buffalo, N. Y.
The American Academy of Arts and Sciences, Cambridge, Mass.
The Astronomical Observatory at Harvard College, Cambridge, Mass.
Harvard University, Cambridge, Mass.
The Museum of Comparative Zoology at Harvard College, Cambridge, Mass.
The Peabody Museum of American Archæology and Ethnology, Cambridge, Mass.

The American Antiquarian and Oriental Journal, Chicago, Ill.
The American Society of Microscopists, Chicago, Ill.
The Chicago Academy of Sciences, Chicago, Ill.
The Cincinnati Society of Natural History, 108 Broadway, Cincinnati, Ohio.
The Ohio Mechanics' Institute, Cincinnati, Ohio.
Hamilton College, Clinton, N. Y.
Ohio State University, Columbus, Ohio.
The Academy of Natural Sciences, Davenport, Iowa.
Des Moines Academy of Science, Des Moines, Iowa.
The American Institute of Mining Engineers, Dr. T. Drown, Easton, Pa.
St. John's College, Fordham, N. Y.
Georgetown College, Georgetown, D. C.
Dartmouth College, Hanover, N. H.
Trinity College, Hartford, Conn.
The Library of Cornell University, Ithaca, N. Y.
The Kansas City Review of Science and Industry, Kansas City, Mo.
The Virginia Military Institute, Lexington, Va.
Washington College, Lexington, Va.
University of Wisconsin, Madison, Wis.
Journal of Mycology, Manhattan, Kan.
The Museum of the Wesleyan University, Middletown, Conn.
The Natural History Society of Wisconsin, Milwaukee, Wis.
The Public Museum, Milwaukee, Wis.
The Geological and Natural History Survey of Minnesota, Minneapolis, Minn.
The Delaware College, Newark, Del.
Geological Survey of New Jersey, New Brunswick, N. J.
Rutgers College, New Brunswick, N. J.
The Connecticut Academy of Arts and Sciences, New Haven, Conn.
Yale College, New Haven, Conn.
The University of Louisiana, New Orleans, La.
The American Chemical Society, N. Y. University, New York.
The American Geographical Society, 11 W. 29th St., New York.
The American Metrological Society, New York.
The American Museum of Natural History, New York.
The Astor Library, New York.

Columbia College, New York.
The College of the City of New York, New York.
Die Aufgeklärten Mosaischen Archi-Geschichte, New York.
The Lenox Library, New York.
The Linnean Society of New York, New York.
The Mercantile Library Association, New York.
The New York Historical Society, 70 Second Ave., New York.
The New York Microscopical Society, 64 Madison Ave., New York.
The School of Mines Quarterly, New York.
State Charities Aid Association, New York.
St. Francis Xavier College, New York.
The Torrey Botanical Club, 9 Waverley Place, New York.
The University of New York, New York.
Illinois State Laboratory of Natural History, Peoria, Ill.
The Portland Natural History Society, Portland, Oregon.
The Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.
The American Naturalist, Philadelphia, Pa.
The American Philosophical Society, Philadelphia, Pa.
The Conchological Section of the Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.
The Zoological Society of Philadelphia, Philadelphia, Pa.
United States Hay Fever Association, Portland, Me.
Vassar Brothers' Institute, Poughkeepsie, N. Y.
The College of New Jersey, Princeton, N. J.
The E. M. Museum of Geology and Archæology, Princeton, N. J.
The Elisha Mitchell Scientific Society, Raleigh, N. C.
The University of Rochester, Rochester, N. Y.
York Institute, Saco, Me.
The American Association for the Advancement of Science, Salem, Mass.
The Essex Institute, Salem, Mass.
The Peabody Academy of Sciences, Salem, Mass.
The California Academy of Sciences, San Francisco, Cal.
The California Farmer and Journal of Useful Sciences, San Francisco, Cal.
Union College, Schenectady, N. Y.
The Academy of Sciences, St. Louis, Mo.
The Library of Syracuse, Syracuse, N. Y.

University of Syracuse, Syracuse, N. Y.
The Natural Science Association of Staten Island, Tompkinsville, N. Y.
The Kansas Academy of Science, Topeka, Kan.
The American Monthly Microscopical Journal, Washington, D. C.
The American Antiquarian Society, Washington, D. C.
The Anthropological Society, Washington, D. C.
Bureau of Ethnology, Washington, D. C.
Congressional Library, Washington, D. C.
The Smithsonian Institution, Washington, D. C.
United States Bureau of Education, Department of the Interior, Washington, D. C.
United States Coast and Geodetic Survey, Washington, D. C.
United States Commission of Fish and Fisheries, Washington, D. C.
The United States Entomological Commission, Department of Agriculture, Washington, D. C.
United States Geological Survey, Washington, D. C.
National Academy of Sciences, Washington, D. C.
The United States National Museum, Washington, D. C.
United States Signal Office, War Department, Washington, D. C.
The United States Military Academy, West Point, N. Y.
The Young Mineralogist and Antiquarian, Wheaton, Ill.
Williams College, Williamstown, Mass.
Rutgers Scientific School, Woodbury, N. J.

ADDENDA.

De Koninklijke Natuurkundige Vereeniging in Nederlandsch-Indië, Batavia, Java.

ERRATA.

Page 62, second line from bottom : for *Elephantum dentalium*, read *Dentalium elephantinum*.
Page 124, sixth line from top : insert * before the name of Prof. M. L. Gruner, deceased.
Page 125, fifth line from top : insert * before the name of Prof. C. T. E. Siebold, deceased.
Page 125, twelfth line from top : insert * before the name of Prof. A. Wurtz, deceased.

CHARTER,

CONSTITUTION,

AND BY-LAWS,

OF THE

NEW YORK ACADEMY OF SCIENCES,

(LATE LYCEUM OF NATURAL HISTORY.)

AN ACT

TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY

IN THE CITY OF NEW YORK.

Passed April 20, 1818.

1. WHEREAS the members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State—therefore,

Be it enacted by the People of the State of New York, represented in Senate and Assembly, That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D. Jurco V. Knevels, James Clements, and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are constituted a body corporate and politic, by the name of LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever ; and may have a common seal, with power to alter the same from time to time ; and shall be capable of purchasing, taking, holding, and enjoying, to them and their successors, any real estate in fee simple or otherwise, and any goods, chattels, and personal estate, and of selling, leasing, or otherwise disposing of the said real or personal estate, or any part thereof, at their will and pleasure : *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars : *Provided*, however, that the funds of the said corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this Act, and those only.

2. *And be it further enacted*, That the said Society shall, from time to time, forever hereafter, have power to make, constitute, ordain, and establish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State, or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and Five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted*, That Samuel L. Mitchill shall be the President; Casper W. Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper, Recording Secretary; Benjamin P. Kissam, Treasurer; and John Torrey, William Cumberland, D. Jurco V. Knevels, James Clements, and James Pierce, Curators; severally to be the first officers of the said corporation, who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted*, That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,
Dep. Sec'ry.

ALBANY, *April* 29, 1818.

ORDER OF

THE SUPREME COURT OF THE STATE OF NEW YORK

TO CHANGE THE NAME

OF

THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK

TO

THE NEW YORK ACADEMY OF SCIENCES.

WHEREAS, in pursuance of the vote and proceedings of this Corporation to change the Corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden and Hubbard, acting as the Attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz.:

At a Special Term of the Supreme Court of the State of New York held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present—HON. GEORGE C. BARRETT, *Justice.*

In the matter of the Application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of The New York Academy of Sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and

Chief Officer of said Corporation, to authorize it to assume the Corporate name of The New York Academy of Sciences, duly setting forth the grounds of the said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit, *The Albany Evening Journal*, and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York in which County said Corporation has its business office, to wit, in the *Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Brownne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the Managers of said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name, as prayed in said petition: Now, on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is:

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the Corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876.

A copy. WM. WALSH, *Clerk.*

Resolution of the ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, the order hath been published as therein required and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the Corporate name thereof, from and after the adoption of the vote and resolution herein above referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

CONSTITUTION.

ARTICLE I.

This Society shall be styled The New York Academy of Sciences.

ARTICLE II.

It shall consist of four classes of members, namely : resident members, corresponding members, honorary members, and fellows. Resident members shall be such as live in or near the City of New York ; corresponding members, such as reside at a distance from said city ; and honorary members, such as may be judged worthy, from their attainments in science, to be admitted into the Academy. The number of honorary members shall not exceed fifty. Fellows shall be chosen from among the resident members, in virtue of scientific attainments or services.

ARTICLE III.

All fellows and members shall be elected by ballot. The names of candidates shall be proposed in writing, at least two meetings previous to being balloted for. The affirmative votes of three-fourths of the fellows and members present shall be necessary to elect a candidate ; honorary or corresponding members, however, may be elected without previous notice, provided that the ballot on such election is unanimous.

ARTICLE IV.

None but fellows or resident members shall be entitled to vote in the Academy.

ARTICLE V.

No fellow or member who shall be in arrears for one year, shall be entitled to vote, or be eligible to any office in the Academy.

ARTICLE VI.

The officers* of the Academy shall consist of a president, a first and a second vice-president, a corresponding secretary, a recording secretary, a treasurer, five curators, and a librarian, who shall be chosen annually on the fourth Monday of February.† The president, vice-presidents, and secretaries, shall be fellows. There shall also be elected at the same time, a finance committee of three.

ARTICLE VII.

There shall be elected at the annual meeting six members, at least three of whom shall be fellows, who together with the president, the vice-presidents, the two secretaries, and the treasurer, shall constitute a council, by whom all business, to be brought before the Academy, shall ordinarily be prepared. Vacancies occurring in the offices or in the council of the Academy in the interval between the annual elections, may be filled for the unexpired term by special election at any regular business meeting, provided notice of such election shall have been given at a previous regular business meeting.

ARTICLE VIII.

The election of officers and of the council shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

ARTICLE IX.

Five members at an ordinary meeting shall form a quorum, and ten at a special or business meeting, a majority of whom, in either case, shall be fellows.

* See Section 3 of the Charter.

† See sixth line of Section 3 of the Charter.

ARTICLE X.

By-laws, for the further regulation of the society, may from time to time be made.*

ARTICLE XI.

† No alteration shall be made in this Constitution, unless by a vote to that effect of three-fourths of the fellows and three-fourths of the resident members entitled to vote under Article V.

* See Section 2 of the Charter.

† This clause must be taken in connection with Section 5 of the Charter, which requires a previous request in writing of one-third of all the resident members, which must be considered in this case as including fellows, as that class of members was not in existence at the time the Charter was granted, submitted one month previous to any vote being taken.

BY-LAWS.

Chapter I.—*Of Members and Fellows.*

1. No person shall be considered a resident member, until he shall have signed the Constitution and paid his initiation fee; and unless the candidate shall comply with these conditions within six months from the date of his election, such election shall be void. No member in arrears shall be eligible as a fellow.

2. A resident member or fellow removing permanently from the city, may, on giving notice thereof, and on payment of his arrears, become a corresponding member; and a corresponding member who removes to the city, with an intention of making it his permanent residence, may become a resident member, on complying with the provisions of the first section of this chapter.

3. No person not engaged in the pursuit of some branch of science shall be elected a corresponding member.

Chapter II.—*Of Original Subscriptions.*

1. Every holder (whether original subscriber, transferee, or legatee) of a receipt for the sum of one hundred dollars, paid into the treasury of the New York Lyceum of Natural History towards the liquidation of the debt incurred by the erecting of the building formerly the property of the Lyceum, in Broadway, in this city, shall be entitled for himself and his family to free admission to the Museum of the Academy, and to such public lectures as may be delivered on its behalf, which the members have a right to attend. He shall be entitled to the use of the books of the library; and shall have the privilege of introducing strangers to the Museum and library, in accordance with the regulations of the Academy.

Chapter III.—*Of Patrons.*

1. Any person may become a Patron of the Academy of Sciences by contributing, at one time, one hundred dollars toward the fund for the general purposes of the Society.

2. A Patron shall, during his life, be entitled for himself and his immediate family, to the same privileges as an original subscriber.

Chapter IV.—*Of Officers.*

1. The President, or, in his absence, one of the Vice-Presidents, or, in their absence, a Chairman *pro tempore*, shall preside at all meetings of the Academy, and shall have a casting vote. He shall preserve order, and shall decide all parliamentary questions, subject to an appeal to the Society. He shall appoint all committees authorized by the Academy, unless otherwise specially ordered.

2. The Corresponding Secretary shall be charged with the correspondence of the Academy. It shall be his duty to be present at all its meetings, to read all communications made to him in his official capacity; to keep a book in which shall be recorded the correspondence of the Academy, and the names of all corresponding members; to lay the same on the table at all regular meetings thereof; to notify corresponding and honorary members of their election; and to report to the Academy on the fourth Monday of February, annually, the state of its correspondence.

3. The Recording Secretary shall be present at all meetings of the Academy, and keep a record of the proceedings thereof. He shall take charge of all papers and documents belonging to the Society; shall keep a corrected list of members and fellows; shall notify all resident members and fellows of their election, and committees of their appointment; and shall give notice to the Treasurer and to the Council of all matters requiring their action.

4. The Treasurer shall have charge of all moneys belonging to the Academy, and, under its orders, of their investment, and shall give good and satisfactory security to the Society for the faithful discharge of the trust, in a sum not less than five thousand dollars. He shall collect initiation fees and annual dues from all members and fellows, all subscriptions made in behalf of the Academy, and any incomes that may accrue from property belonging to the institution; shall report at the business meeting in January the names of members in arrears; shall give due notice to the Society of the expiration of all policies of insurance that may be effected on its property; and pay all debts against the Society which shall have been audited by the Committee of Finance, or the discharge of which shall have been ordered by the Academy at a regular business meeting. He shall furnish the Committee of Finance, on due application, with such information of the state of the funds as they may require; and shall report to the Academy, at each business meeting, the condition of its finances, and on the fourth Monday of February, the receipts and expenditures of the entire year.

5. The Curators shall be separately charged with the safe-keeping and arrangement of the several collections, and with the keys

of the cabinets. Each Curator shall have his particular department allotted to him when elected. All regulations made by the Curators shall be reported to the Council, and approved of by the Academy, before such regulations shall come into operation.

6. The Curator having charge of any division of the collection, shall alone be authorized to select duplicate specimens from such division for the purpose of exchange or donation ; but no exchange or donation shall be made, except such as is authorized by a vote of the Society.

7. The increase and improvement of the collections being the inducement to exchange, it shall be the duty of the Curators to report to the Society all such opportunities to exchange as would favor this object.

CHAPTER V.—*Of the Council.*

1. The President, Vice-Presidents, and Secretaries of the Academy, shall hold the same offices in the Council. In the absence of any of them, officers *pro tempore* may be appointed.

2. The Council shall meet at least once a month, within ten days preceding the regular business meeting of the Academy. Minutes shall be kept of its proceedings, which may be called for at any business meeting, upon a vote of the Academy. Matters of a strictly personal nature, however, need not be entered on the minutes of the Council.

3. Five members of the Council, a majority of whom shall be fellows, shall constitute a quorum ; but the Council may appoint an Executive Committee, or business may be transacted at a regularly called meeting of the Council at which less than a quorum is present, subject to the written approval of a majority of the Council, subsequently given to the Secretary, and recorded by him with the minutes.

4. The Council shall prepare all business referred to it by the Academy, and may present any other business at its discretion. It shall frame its own rules and regulations, and determine the time and place of its meetings.

5. The Council shall organize within itself a Committee on Nominations, a Committee on Publication, and a Committee on the Library, to whom, in the intervals of the meetings of the Council, all matters pertaining to these several subjects shall be referred. Their action shall always be subject to the revision of the Council. The names of the persons composing these committees shall be kept publicly posted in the rooms of the Academy.

6. All business prepared by the Council shall be presented to the Academy by the Recording Secretary, or, in his absence, by some other officer of the Council. But the Council may decline to present business at any meeting at which a majority of those present shall not be fellows.

Chapter VI.—*Of Committees.*

1. The Committee of Finance shall audit all accounts against the Academy, and shall have the duties and powers of a Committee of Ways and Means. They shall report on financial questions referred to them, whenever called upon to do so by the Academy or the Council.

2. Committees for Special Purposes may be appointed when required.

Chapter VII.—*Of Sections.*

1. The Academy shall organize itself into sections, as follows:
   I. Biology.
   II. Chemistry and Technology.
   III. Geology and Mineralogy.
   IV. Physics, Astronomy, and Mathematics.

2. These sections shall be organized with at least a Chairman and a Secretary, and shall be considered responsible for the scientific papers to be presented on the first, second, third and fourth Mondays of each month, respectively. When a fifth Monday occurs, it may be devoted to general or special scientific discussions, at the discretion of the Academy or Council. The Academy or the Council may, for sufficient reasons, change or suspend this order.*

Chapter VIII.—*Of Initiation Fees, Annual Dues, &c.*

1. Every resident member, at the time of his admission, shall pay into the treasury, as an initiation fee, the sum of five dollars. All members who become fellows shall pay into the treasury an initiation fee of five dollars. Resident members and fellows shall be subject to pay an annual fee of five dollars.†

2. Any resident member or fellow coming under the provision of Chapter II., or who becomes a Patron, shall be exempt from all future annual dues.

3. The Academy may, on account of services, exempt any member or fellow from his annual dues, provided the proposal be made at a regular business meeting, be approved by the Council, lie over until the next regular business meeting, and all the members then present agree thereto.

4. If any resident member or fellow, in arrears for his annual dues for over one year, shall neglect or refuse to liquidate the

* This method of organization has been suspended, by order of the Academy.

† Corresponding and Honorary members are exempt from initiation fees and annual dues.

same within three months after notification by the Treasurer, his name may be erased from the rolls.*

5. All contributions received under the provisions of Section 2 of this Chapter, as also those received from the Patrons, shall be invested in United States or in New York State securities, and the income derived therefrom be applied to the general purposes of the Academy.

CHAPTER IX.—*Of the Publications.*

1. The publications of the Academy shall consist of the Annals and the Proceedings,† and such other documents as shall be ordered by the Academy.

2. The publications shall be issued under the supervision of the Committee of Publication, and shall be furnished to members, fellows, and subscribers at such rates as may be determined by the Academy.

3. No member or fellow shall publish any part of the proceedings of the Academy, nor any paper read before it, without the consent of the Council, or by a resolution of the Academy.

CHAPTER X.—*Of the Publication Fund.*

1. Contributions may be received towards establishing a Publication Fund; all such contributions shall be invested in United States or in New York State securities, and the income thereof be applied toward defraying the expense of the scientific publications of the Academy.

2. Contributors to this fund in the sum of one hundred dollars, or more, at one time, shall be entitled to one copy of all the scientific publications of the Academy appearing subsequently to the date of the payment of their contribution.

CHAPTER XI.—*Of the Museum.*‡

1. All donations shall have the names of the donors affixed thereto.

2. All members shall have access to the Museum, subject to the regulations of the Academy.

3. All deposited specimens shall be labelled with the name of

* See Section 2 of the Charter.

† This name was changed to *Transactions*, by Resolution of the Academy, December 5, 1881.

‡ This chapter has been suspended, on account of the destruction of the Museum by fire.

the depositor, and while they remain as such, shall be exclusively under the control of the Academy, and subject to the same uses and regulations as the specimens belonging to it.

4. No person, making a deposit of specimens, shall be allowed to remove them without giving a receipt for the same to the Curator in charge.

5. No specimen contained in the Museum shall be loaned, unless by special permission of the Academy.

6. The Curators shall arrange, in systematic order, all the specimens belonging to the Museum, and keep a catalogue of the same; and shall report, on the fourth Monday in February in each year, the state of the property confided to their charge.

Chapter XII.—*Of the Library.*

1. The library shall be under the control of the Librarian and the Library Committee.

2. No book shall be purchased, or other expense incurred for the library, except by a recommendation to that effect signed by a majority of the Library Committee, and ratified by the Council.

3. The Library Committee shall designate such books as ought not to be removed * from the rooms of the Academy, which shall be marked on the catalogue, and shall not be taken out without special permission from the Academy.

4. The Librarian shall be furnished with a book, in which he shall keep a regular account of all books borrowed and returned, by inserting the name of the borrower and the book borrowed, the time when taken out and when returned. In the absence of the Librarian, one of the Library Committee shall keep this record.

5. A volume, not returned within one month, shall incur a fine of fifty cents, and twenty-five cents for each week thereafter.

6. Any injury done to works shall be estimated by the Committee, and the borrower fined accordingly.

7. The Librarian shall report to the Treasurer, from time to time, the fines imposed.

8. No member or fellow shall take out more than two volumes at one time, without special permission from the Council.

9. On the first Monday in June, all books shall be called in; and the Library Committee shall examine the library, and compare it with the catalogue. They shall note all missing books, and report the same, at the next meeting, to the Academy.

Chapter XIII.—*Of Meetings.*

1. The ordinary meetings shall be held on Monday evening in each week.

* By the present rule, no book can be so removed without special permission from the Council.

2. The President, or either of the Vice-Presidents, with any five members or fellows, may call a Special Meeting.

3. Special Meetings shall be called by a notice sent to each resident member and fellow, stating the time at which such meeting is to be held, and the object for which it is called.

4. The meeting held on the fourth Monday in February shall be considered a special business meeting.

5. Ordinary meetings shall be held in such place as shall be determined by the Academy or Council. When meetings are not held in the rooms of the Academy it shall be the duty of the Recording Secretary to notify all the fellows and members of the time and place of meeting. All business meetings shall be held in the rooms of the Academy.

6. Visitors at the meetings shall be introduced by one or more members, and their names shall be announced by the President, and entered on the minutes.

Chapter XIV.—*Of Business.*

1. All business other than such as relates immediately to the cultivation of science, shall be transacted at the first meeting of each month only,—except when the Council shall report it as urgent, in which case it may be transacted at any meeting, provided at least a week's notice shall have been given to all members and fellows.

2. The following shall be considered the regular order of business at the ordinary meetings :—

1. The minutes of the preceding ordinary meeting read, and the sense of the members taken thereon.
2. The names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Examination of specimens exhibited.
6. Report of Committees not of a business character.
7. Presentation and discussion of papers previously announced.
8. Any other scientific business.
9. Rough minutes read.
10. Adjournment.

3. The following shall be considered the order of business at the regular business meetings :—

1. The minutes of the preceding business meeting read, and the sense of the members taken thereon.
2. The names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Report of the Council.

6. Reports of Officers.
7. Reports of Committees.
8. Deferred business.
9. New business.
10. Elections.
11. Scientific business.
12. Rough minutes read.
13. Adjournment.

Chapter XV.—*Of Elections.*

1. The annual elections shall be conducted as follows:

Nominations may be sent in writing to the Recording Secretary, with the names of the proposers, at any time not less than thirty days before the Annual Meeting; and the Council shall prepare, from the names so proposed, a list which shall constitute the regular ticket. This list shall be furnished to every resident member and fellow at least two weeks before the Annual Election, and be publicly posted during that time in the rooms of the Academy. But any resident member or fellow shall be at liberty to alter this list, or to prepare another.

The ballots shall be received and examined by at least two tellers, appointed by the presiding officer at the Annual Meeting. A list of the persons who have received the greatest number of votes of those present, certified by the tellers, shall then be presented by them to the presiding officer, who shall thereupon declare the said persons elected to their several offices, and shall present the list to the Recording Secretary, who shall enter it on the minutes and file it: the ballots shall be destroyed as soon as the certified list is handed to the presiding officer.

2. Elections for members and fellows shall be held on the first meeting of each month only. Resident members shall be elected as follows: the candidates shall be proposed publicly, in writing, at any meeting, by a fellow or member; and the nominations, together with the name of the person making them, shall be referred to the Council; the report of the Council shall be openly read at the next regular business meeting, upon which the Academy will proceed to a ballot.* Names of candidates for honorary membership shall be presented by the Council.

3. Fellows shall be elected as follows: candidates shall be recommended to the Council in writing, with the reasons for such recommendation, signed by the proposer; then, if the Council see fit, it shall publicly nominate them at a regular business meeting, and the names of such nominees shall be entered on the minutes, and then be posted in some conspicuous place during all meetings

* See Article 3 of the Constitution.

held in the rooms of the Academy, at least until the next regular business meeting. They shall be balloted for in the same manner as resident members.

CHAPTER XVI.—*Of General Provisions.*

1. No expenditure shall be incurred on behalf of the Academy, or disbursement made, unless authorized by a vote of a majority of the members and fellows present at a business meeting.

2. No alteration shall be made in these By-Laws, unless such alteration be submitted publicly in writing, at a regular business meeting, be entered on the minutes with the name of the member or fellow proposing the same, and be adopted by two-thirds of the members and two-thirds of the fellows present at a subsequent regular business meeting.