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ERRATA.

In part of edition, p. 118, 8 l. from foot, for "46·173," read "461·73. P. 143, 3 l. from foot, for "au," read "an."

Page 220, l. 8 from top, for "rifles," read "riffles."—Same page, l. 17 from bottom, for "rifles," read "riffles."

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Sir William Jackson Hooker.*

SIR WILLIAM JACKSON HOOKER died at Kew, after a short illness, on the 12th of August last, in the eighty-first year of his age.

Seldom, if ever before, has the death of a botanist been so widely felt as a personal sorrow,—so extended were his relations, and so strongly did he attach to himself all who knew him. By the cultivators of botany in our own country, at least, this statement will not be thought exaggerated. Although few of our botanists ever had the privilege of personally knowing him, there are none who are not much indebted to him, either directly or indirectly. It is fitting, therefore, that some record of his life and tribute to his memory should appear upon the pages of the American Journal of Science.

The incidents of his life are soon told. He was born on the 6th of July, 1785, at Norwich, England, where his father,—who survived to even a greater age than his distinguished and only son,—was at that period confidential clerk in a large business establishment. He was descended from the same family with "the judicious Hooker," author of the "Ecclesiastical Polity." The name William Jackson was that of our botanist's cousin and godfather, who died young, and was soon followed by both his parents; in consequence of which their estate of Sea-salter, near Canterbury, came to young Hooker while yet a lad at the Norwich High School. He could therefore indulge the taste which he early developed for natural history, at this time mainly for ornithology. But the chance discovery of that rare and curious Moss, *Buxbaumia aphylla*, which he took to his eminent townsman, Sir James Edward Smith, directed his attention to Botany, and fixed the bent of his long and active life. He now made extensive botanical tours through the wildest parts of Scotland, the Hebrides and the Orkneys, which his lithe and athletic frame and great activity fitted him keenly to enjoy. Coming up to London he made the acquaintance of Sir Joseph Banks and of the botanists he had drawn around him, Dryander, Solander, and Robert Brown.

In 1809 he went to Iceland, to explore that then little-known island. The exploration was most successful; but the ship in which he embarked with all his collections, notes, and drawings, was fired and destroyed and everything was lost, he himself narrowly escaping with his life. Hooker's earliest work, the Journal of a Tour in Iceland, in two octavo volumes, published at Yarmouth in 1811, and republished at London two years afterwards, gives an interesting account of his explorations and adventures, along with the history of a singular attempt at the time to revolutionize the island,—with which the disaster to the vessel he returned in was in some way connected, we forget how. Not disheartened by these losses, he now turned from a polar to an equatorial region, and made extensive preparations for going to Ceylon, with Sir Robert Brownrigg, then appointed Governor. But the disturbances which broke out in that island, more serious than those which attended the close of his Iceland tour, again frustrated his endeavors.

The strong disposition for travel and distant exploration, frustrated in his own case, came to fruit abundantly in the next generation, in the world-wide explorations of his son. He himself made no more distant journey than to Switzerland, Italy, and France, in 1814, becoming personally acquainted with the principal botanists of the day, and laying the foundations of his wide correspondence and great botanical collections. In 1815 he married the eldest daughter of the late Dawson Turner, of Yarmouth, and established his residence at Halesworth, in Suffolk. The next year, in 1816, besides publishing some of the *Musci* and *Hepaticæ* of Humboldt and Bonpland's collection, he brought to completion his first great botanical work, the British Jungermanniæ, with colored figures of each species, and microscopical analyses, in 84 plates, all from his own ready pencil,—a work which took rank as a model both for description and illustration. In 1828 he brought out, in conjunction with Dr. Taylor, the well-known Muscologia Britannica, the second edition of which, issued in 1827, is only recently superseded. The Musci Exotici, with 176 admirable plates, appeared, the first volume in 1818, the second in 1820. These were his principal works upon Mosses and the like,—an excellent subject for the training of a botanist, and one in which Hooker, with quick eye, skilled hand, and intuitive judgment, was not only to excel but to lay the foundation of high excellence in general descriptive botany.

When arranging for a prolonged visit to Ceylon, it appears that he sold his landed property, and that his investment of the proceeds was unfortunate; so that the demands of an increasing family and of his enlarging collections, for which he always lavishly provided, made it needful for him to seek some remunerative scientific employment. Botanical instruction in Great Britain was then, more than now, nearly restricted to medical classes; the botanical chairs in the universities therefore mainly belonged to the medical faculty, and were filled by members of the profession. But, through the influence of Sir Joseph Banks, as is understood, the Regius Professorship of Botany in the University of Glasgow was offered to Hooker, and was accepted by him. He removed to Glasgow in the year 1820, and assumed the duties of this position. Here, for twenty years—the most productive years of his life—he was not only the most active and conspicuous working botanist of his country and time, but one of the best and most zealous of teachers. The fixed salary was then only fifty pounds; and the class-fees at first scarcely exceeded that sum. But his lecture-room was soon thronged with ardent and attached pupils, and the emoluments rose to a considerable sum, enabling him to build up his unrivalled herbarium, to patronize explorers and collectors in almost every accessible region, and to carry on his numerous expensive publications, very few of which could be at all remunerative.

The first production of these busy years was the Flora Scotica, brought out in 1821. The next year but one brought the first of the three volumes of the Exotic Flora, containing figures and descriptions of new, rare, or otherwise interesting exotic plants, admirably delineated, chiefly from those cultivated in the Glasgow and Edinburgh Botanic Gardens. Here first is manifested the interest in the flora of our own country, which has since identified the name of Hooker with North American botany,—a considerable number of our choicest plants, especially of the Orchis family, having been here illustrated by his pencil.

The Icones Filicum (in which he was associated with Dr. Greville,) in two large folio volumes, with 240 plates, begun in 1829 and finished in 1831, was his introduction to the great family of Ferns, to which he in later years devoted his chief attention.

In 1830 began, with the Botanical Miscellany, that series of periodical publications, which, continued for almost thirty years, stimulated the activity and facilitated the intercourse of botanists in no ordinary degree. The Miscellany, in royal octavo, with many plates, closed with its third volume, in 1833. The Journal of Botany, a continuation of the Miscellany in a cheaper other botanist who could have come into competition with him in this respect.[2] The office, moreover, was no pecuniary prize; the salary being only three hundred pounds a year (less, we believe, than the retiring pension of his unscientific superannuated predecessor), "with two hundred pounds to enable him to rent such a house as should accommodate his herbarium and library, by this time of immense extent, and essential, we need not say, to the working of the establishment, whether in a scientific or economic point of view." The salary, if we mistake not, has since been increased in some moderate proportion to the enlarged responsibilities and cares of the vast concern; but, up to his death, so important an auxiliary as his unrivalled herbarium, and the greatest scientific attraction of the institution, was left to be supported (excepting some incidental aid) out of the Director's own private means.

Such record as need here be made of Sir William Hooker as Director of Kew Gardens can be best and most briefly given mainly in the words of a writer in the Gardener's Chronicle (for Sept. 2), to whose ripe judgment and experience we may defer.

"Sir William entered upon his duties in command of unusual resources for the development of the gardens, such as had never been combined in any other person. Single in purpose and straight-forward in action, enthusiastic in manner, and at the same time prepared to advance by degrees, he at once won the confidence of that branch of the government under which he worked..... To those in office above him, he imparted much of the zeal and interest he himself felt, which was proved by constant visits to the gardens, resulting in invariable approval of what he was doing, and promises of aid for the future. Another means at his disposal, and which he at once brought to

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[2] We refer of course to Dr. Lindley; and now while revising the proof of this article, the sad intelligence reaches us that he also is no more; that this eminent botanist and remarkable man died, of apoplexy, on the first of November, at the age of sixty-six.

It is well known that Dr. Lindley's health became seriously impaired a year or two ago, and that his scientific pursuits had to be given up, with slight hope that they could ever be renewed. We were under the impression, however,—perhaps an erroneous one,—that he was the author of the well-written biographical notice of Sir William Hooker which appeared in the Gardeners' Chronicle, and from which the citations in our article were taken; and on this we had founded a hope that his vigor was returning, and that his usefulness might still be prolonged. A sketch of his life and scientific labors may hereafter be given. But we may now properly and freely speak, as we had wished to do in this article, of the paramount influence which the two eminent botanists, now taken from us, have exerted upon the condition of the science they cultivated in their own country. From forty years ago down to recent times, although neither was the most profound botanist of his age, both were unrivalled for the example they set and the active interest they took in diffusing a knowledge of Botany in Great Britain, and promoting its study generally, for which they deserve the large and lasting gratitude of their countrymen. One other name will suggest itself as worthy to be associated with theirs in this regard; but we trust the day is very distant in which that may be added to an obituary record.

bear on the work in hand, was his extensive foreign and colonial correspondence, including especially that with a large number of students whom he had imbued with a love of botany, and who were scattered over the most remote countries of the globe, and several of whom, indeed, remained in more or less active correspondence with the Gardens up to the day of his death. His views were further greatly facilitated by his friendly intercourse with the Foreign and Colonial offices, the Admirality, and the East India Company, to all of whom he had been the means of rendering services, by the recommendation of former pupils to posts in their employment, and by publishing the botanical results of the expeditions they sent out......

"At the time of Sir William's taking office, the Gardens consisted of eleven acres, with a most imperfect and generally dilapidated series of ten hot houses and conservatories. Most of these have since been gradually pulled down; and, with the exception of the great orangery (now used as a museum for woods) and the large architectural house near the garden gates, which had just previously been removed from Buckingham Palace, not one now remains. They have been replaced by twenty-five structures (in most cases of much larger dimensions) exclusive of the Palm-stove and the hitherto unfinished great conservatory in the pleasure grounds.

"To describe the various improvements which have resulted in the present establishment,—including, as it does, a botanic garden of 75 acres, a pleasure-ground or arboretum of 270 acres, three museums, stored with many thousand specimens of vegetable products, and a magnificent library and herbarium, the finest in Europe, placed in the late King of Hanover's house on one side of Kew Green and adjoining the gardens, — would rather be to give a history of the gardens than the life of their Director."....

"It might be supposed that the twenty-four years of Sir William's life spent at Kew in the above public improvements, added to the daily correspondence and superintendence of the Gardens, would have left little time and energy for scientific pursuits. Such, however, was far from being the case. By keeping up the active habits of his early life, he was enabled to get through a greater amount of scientific work than any other botanist of his age."

From this period his contributions to systematic botany, if we except the journals and illustrated works (continued until lately, and some of them to the last), were mainly restricted to his old favorites the Ferns. Some years before he removed to Kew, he found the veteran Francis Bauer, then an octogenarian, or near it, employed in drawing under the microscope admirable and faithful illustrations of the fructification of Ferns. He arranged immediately for their publication, drew up the letterpress, and so brought out, between 1838 and 1842, the well-known work entitled "Genera Filicum, or Illustrations of the Ferns and other allied Genera." His large quarto, "Filices Exoticæ, in Colored Figures and Descriptions of Exotic Ferns, chiefly of such as are cultivated in the Royal Gardens of Kew," (100 plates) appeared in 1859;—the drawings of these, as of nearly all his illustrated works for the last thirty years, by Walter Fitch, his indefatigable coadjutor, whom he had trained in Scotland, and who soon became "the most distinguished botanical artist in Europe." "A second Century of Ferns" (imp. 8vo,) was published in 1860 and 1861, the First Century being the tenth and closing volume of the Icones Plantarum.

But the principal systematic work of these later years was his "Species Filicum, being Descriptions of the known Ferns, ... accompanied with numerous figures," in 5 volumes, 8vo. The first volume of this work appeared in 1846, the last only a year and a half ago.

The crowd of new Ferns and new knowledge which had accumulated in the interval of seventeen or eighteen years, demanded large revision and augmentation of the earlier volumes to bring them up to the level of the later ones. Moreover, a compendious work on this favorite class of plants was much needed. Both objects might be well accomplished by a synopsis of known Ferns in a single volume, to be for our day what Swartz's Synopsis Filicum was just sixty years ago. To this Sir William Hooker, upon the verge of fourscore, undauntedly turned, as soon as the last sheets of the Species Filicum passed from his hands, devoting to it the time that remained after attending to his administrative duties. Upon it he steadily labored, with unabated zeal and with powers almost unimpaired, conscientiously diligent and constitutionally buoyant to the last. He had made no small progress in the work, and had carried the sheets of the initial number through the press, when an attack of diptheria, then epidemic at Kew, suddenly closed his long, honored, and most useful life.

Our survey of what Sir Wm. Hooker did for science would be incomplete indeed, if it were confined to his published works —numerous and important as they are—and to the wise and efficient administration through which, in the short space of twenty-four years, a Queen's flower and kitchen garden and pleasure-grounds have been transformed into an imperial botanical establishment of unrivalled interest and value. Account should be taken of the spirit in which he worked, of the researches and explorations he promoted, of the aid and encouragement he extended to his fellow-laborers, especially to young and rising botanists, and of the means and appliances he gathered for their use no less than for his own.

The single-mindedness with which he gave himself to his scientific work, and the conscientiousness with which he lived *for* science while he lived *by* it, were above all praise. Eminently fitted to shine in society, remarkably good-looking, and of the most pleasing address, frank, cordial, and withal of a very genial disposition, he never dissipated his time and energies in the rounds of fashionable life, but ever avoided the social prominence and worldly distinctions which some sedulously seek. So that,—however it may or ought to be regarded in a country where court honors and government rewards have a factitious importance,—we count it a high compliment to his sense and modesty that no such distinctions were ever conferred upon him, in recognition of all that he accomplished at Kew.

Nor was there in him,—while standing in a position like that occupied by Banks and Smith in his early days,—the least manifestation of a tendency to overshadow the science with his own importance, or of indifference to its general advancement. Far from monopolizing even the choicest botanical materials which large expenditure of time and toil and money brought into his hands, he delighted in setting other botanists to work upon whatever portion they wished to elaborate; not only imparting freely, even to comparatively young and untried men of promise the multitude of specimens he could distribute, and giving to all comers full access to his whole herbarium, but sending portions of it to distant investigators, so long as this could be done without too great detriment or inconvenience. He not only watched for opportunities of attaching botanists to government expeditions and voyages, and secured the publication of their results, but also largely assisted many private collectors,—whose fullest sets are among the treasures of far the richest herbarium ever accumulated in one man's life-time, if not the amplest anywhere in existence.

One of the later and not least important services which Sir William Hooker has rendered to botany is the inauguration, through his recommendation and influence, of a plan for the publication, under government patronage, of the Floras of the the different British colonies and possessions, scattered over every part of the world. Some of these (that of Hongkong and that of the British West Indies) are already completed; others (like that of Australia, and the Cape Flora of Harvey and Sonder, adopted into the series,) are in course of publication; and still others are ready to be commenced.

The free and cordial way in which Hooker worked in conjunction with others is partly seen in the various names which are associated with his in authorship. This came in part from the wide range of subjects over which his survey extended,—a range which must have contributed much to the breadth of his views and the sureness of his judgment. Invaluable as such extent of study is, in the present state and prospects of our science we can hardly expect to see again a botanist so widely and so well acquainted both with cryptogamic and phanerogamic botany, or one capable of doing so much for the advancement and illustration of both.

Our narrative of Sir William Hooker's scientific career and our estimate of his influence has, we trust, clearly, though incidentally, informed our readers what manner of man he was. To the wide circle of botanists, in which he has long filled so conspicuous a place, to his surviving American friends and correspondents, some of whom have known him long and well,—and "none knew him but to love him, nor named him but to praise,"—it is superfluous to say that Sir William Hooker was one of the most admirable of men, a model Christian Gentleman.

There could really be no question as to the succession to the charge of the great botanical establishment at Kew. But we may add, for the information of many of our readers, that the directorship vacated by Sir William's death has been filled by the appointment of his only surviving son, Dr. Joseph Dalton Hooker, whose well-established scientific fame and ability, no less than his lineage, may assure the continued equally successful administration of this most interesting and important trust.

A. G.

ART. II.—*On a Boulder, and Glacial Scratches, at Englewood, N. J.;* by Rev. W. B. DWIGHT.

THE summit-level of the trap ridge known as the Palisades, in Bergen Co., N. J., presents in many places an appearance suggestive of glacial erosion; but on account of the ease with which the trap disintegrates, whether exposed to the air, or to a covering of moist earth, it has heretofore been difficult to find a surface where the polishing and grooving are sufficiently plain to warrant a decisive conclusion. Such a locality has however been recently observed.

A large boulder, called "Sampson's Rock," at Englewood, N. J., has long been an object of interest among the residents of the place for its isolation and bold and striking appearance, but it was not known to possess any special scientific interest, until the year 1860; in that year, in company with my brother, I visited the place, and we soon discovered that this imposing boulder preserves beneath its concave base a record of the great movement which placed it there.

The locality is situated on the top of the Palisades, about 100 rods from the brow of the precipice that faces the Hudson river, and about 450 feet above the level of the river. It is on the premises of Francis Howland, Esq., fifty rods to the rear of the residence of Mr. Wm. B. Dana; and as its proprietor is a man of much public spirit, we may feel assured that it will be carefully preserved. The monument with its inscriptions has a vastly greater antiquity than those of Assyria or Egypt.

The boulder rests upon the trap rock. It consists of coarse red sandstone, and is from the triassico-jurassic formation which the trap-dike of the Palisades intersects. This sandstone is the surface rock for a large extent of country to the west and north. In the latter direction it extends thirty miles to Stony Point, and this is therefore about the extreme distance which, judging from the present limits of the formation, can be assigned for the passage of the boulder.

The general level of the sandstone in the vicinity is from one to two hundred feet below the summit of the trap, and none of the sandstone is in position within a mile and a half of the locality.

The boulder averages ten feet long by seven broad, and is nine feet in greatest height. The weight computed from careful measurement is about thirty-two tons. It is nearly a square block below but terminates in a low pyramid above. Its under surface is quite concave and it rests upon three points; it has thus shielded the record of erosion beneath.

The area covered by the block is undulating in surface, and throughout is smoothed and strongly marked with parallel groovings and scratches. The course of the scratches is mainly S. 34° E. (true); a few run 5° to 10° more to the east.

The area thus protected slopes gradually away on the north and east; but to the west and south it descends perpendicularly 34 to 42 inches down to the general level; and this appears to give a measure of the loss which the rock has experienced since the glacial period, either by slow superficial disintegration, or by a cleavage into vertical columns and a subsequent falling away of the masses.

The courses of the scratches correspond nearly to courses observed by Ramsay upon the Catskill mountain, S. 22° E., as also to observations of Mather on New York island bearing S. 25°, 35°, and 45° E. We are thus led clearly to the conclusion that this boulder was located, and these groovings scored, by the great Hudson-valley glacier which has left so many other records of its passage. In this instance, an interesting page of the natural history of New Jersey, has been preserved by this natural cover from the disintegrating elements and from the equally decomposing action of moist soil.

Englewood, N. J., Oct. 26, 1865.

ART. III.—*On a Subsidence of land at Coxsackie, N. Y.;* by Rev. W. B. DWIGHT.

LANDSLIDES upon a small scale are quite frequent in the soft or semi-consolidated Post-tertiary clays of the Hudson river and its tributaries. In the great majority of cases, however, they do not, either in extent, or in any of the attendant phenomena, depart from the simple, typical, slide-movement.

An occurrence of this kind having come under my observation in 1863, (and in a subsequent visit to the locality in 1864,) which is of remarkable extent, and which combines, besides many other interesting features, the double effect of depression and of elevation, I think it desirable to put an account of it upon record.

The locality is upon the farm of Mr. Casper Flansburgh, four miles north of the village of Coxsackie, N. Y., and two miles west of the Hudson river.[1] The Post-tertiary terrace has here a width of about three miles, having its extreme western limit at the base of a bold ridge of Helderberg limestones, from which line its surface continues quite level and unbroken toward the east, till, at the distance of one mile from the hills, it reaches the ravine which is the scene of this movement. Here a creek has excavated a ravine or valley of a considerable size, cutting through the terrace, which stands at the same level on both sides of the valley. The banks thus formed are by no means steep, but gradual declivities; the terrace level was about 75 feet above the bed of the creek previous to the disturbance. The general course of the creek and valley at this point is N. 45° E; but a little below, and just at the termination of the slide, the course is north; the stream was eight feet wide, and six feet deep.

The terrace consists superficially of light-colored clay soil, mixed with sand and stones. Underneath this there is a thick stratum of light gray clay, quite firmly consolidated into well-defined horizontal laminæ of rock, very soft and porous, very fine, and free from grit, but containing a considerable amount of lime. These consolidated laminæ do not appear except where there has been a recent excavation, as exposure soon destroys their structure; about fifty feet of these layers could be made out at the fracture of the slide; how much greater their depth, I was not able to ascertain. Below these light-colored layers is a deposit of blue clay, everywhere quite distinct from the other, as stated by the New York State Reports: "these clays are almost uniformly associated; the blue lying below the other; the line

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[1] I acknowledge, with pleasure, my indebtedness to Mr. Casper Flansburgh, the owner of the property upon which the subsidence took place, for his cordial assistance, and to Mr. H. A. Whitbeck of Coxsackie, for much useful information founded upon his own intelligent observations, and also for valuable sketches of the locality.

of junction is very distinctly marked." (N. Y. State Geol. Rep. 1st Dist., p. 128.) This blue clay is also of very fine quality, and valuable for pottery: it contains more lime than the other, effervescing freely with acids. There is no appearance in this blue clay of consolidation into compact laminæ, but there is evidence that it is brought into a semi-liquid condition by the presence of water much more easily and thoroughly than the gray clay above. In the normal condition of the valley, the blue clay was not visible, being covered, even at the lowest points, by its lighter-colored associate.

The terrace-level is cleared and tilled; the whole of the slope of the valley or ravine is, however, timbered with forest trees.

On the morning of March 16th, 1861, Mr. Flansburgh, on visiting this part of his farm, to his utter amazement found his geography of the locality entirely at fault; a precipice, and a yawning gulf took the place of his wooded hill-slope; his sloping ground was nearly level, and his level sloping; a grove of fine trees stood waist-deep in a new pond of water, while the bed of his creek stood aloft high and dry; his trees were pointing in every imaginable direction, looking as if they had passed a hard night.

The movement took place between 5 P. M., of the 15th, and 9 A. M., of the 16th. There is no evidence that it attracted the attention of any one at the time, which is not very strange, as the nearest house is a half a mile distant. From the appearances at the time of visiting the locality, I was not able to form any judgment concerning the amount of local erosion on the edge of the bank at the creek, but am informed that there was a perceptible, though not extensive, undermining. There was no frost in the ground, but it was covered with one foot of very dense snow, which was coated with a heavy crust.

The mass of earth consisting of the slope of the west bank and a part of the summit level, broke off sharply and perpendicularly across the top of the bank about 30 or 40 feet back from the brow; the line of fracture then curved to the east on both sides until it touched the creek, after enclosing a semi-circular tract of about 6½ acres. The flexure seems to have been determined by small ravines running toward the creek at right angles to its course.

The fragment, which was in fact an enormous wedge of earth, 75 feet thick at the back, being now free, was at once subjected to two different forces; for it was immediately separated into two parts by a chasm opening lengthwise and stretching from end to end, (N. and S.), at the distance from the upper edge, of about one-third of the whole width of the detached mass. The portion west of this line, consisting of the brow of the hill, and the higher part of the slope, at once sunk, partially throughout its whole extent, but most deeply at its western edge, which rested at a depth of 40 feet below its former position at the terrace level; it probably moved also a few feet to the eastward.

The other fragment also sunk considerably at its thicker end, thus bringing its surface nearer to a level; but it had also a decided sliding movement toward the creek, for the distance of from a foot or two at the southern, to 42 feet at the northern end. This measurement was obtained by ascertaining the variation of a line of stakes, trees and other landmarks, from the original line which was known.

The effect of this double movement upon the ground at the creek was extraordinary; the whole bed of the stream, together with a portion of its borders, was lifted bodily, and left at the top of a long and nearly continuous mound. This mound is from 75 to 150 feet wide at the base, and in most places 30 feet high, thus becoming the highest ground on the eastern section of the slide.

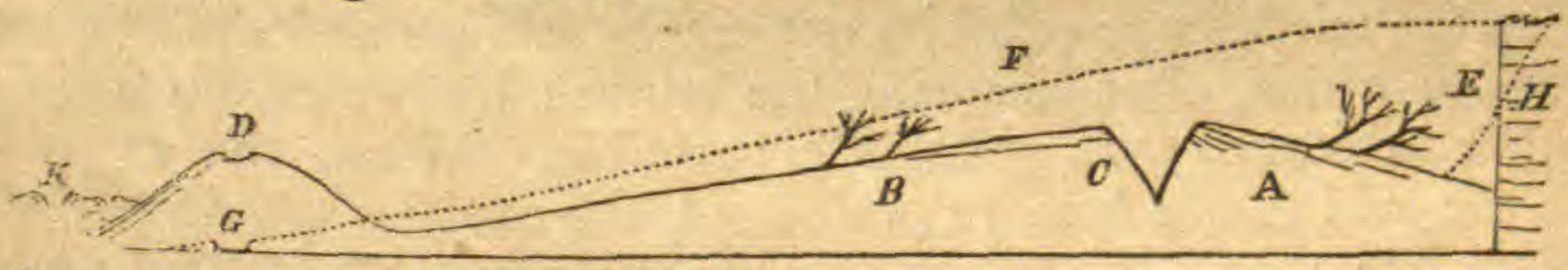
At the same time heavy masses of the underlying blue clay were forced up at the outer (eastern) edge of the mound, and, pouring over the adjacent clay of lighter color, now lies in beds in reverse of its geological position, forming a striking feature of the scene. The water-course being thus blocked up, a large pond was formed to the south, submerging a grove of trees in fifteen or twenty feet of water. Another pond was formed along the western side of the mound, and smaller ones in various positions. The creek has since formed a new channel east of the mound at a much higher level than before.

The surface of the mound is much fissured; its trees are tilted, and in many places uprooted from beneath; on the main slope, west of the mound is a tract of about 2½ acres of quite unbroken ground, the only sign of change being the uniform slant of the trees; but at the northern and southern extremities, especially at the northern—there are numerous intersecting fissures, varying from one to ten feet in width, and the same in depth; making the surface to resemble the irregular fragments of a floe of ice left by the tide upon a sloping shore. The positions of the trees are correspondingly irregular. In one instance a fissure one foot in width, opened directly under the roots of a tall maple, splitting its trunk to the height of fifteen feet; one margin of the fissure then slipped past the other nine or ten feet, carrying with it its half of the trunk, twisting the tree and holding it in a sufficiently awkward position.

In forming a correct conclusion as to the nature and direction of the forces which produced this movement, it must be noticed, that the *blue clay* underneath was capable of assuming a condition approaching fluidity, and its appearance as found both in the front and rear of the area of subsidence, proves it to have been in this condition; on the other hand, the lighter-colored clay above, though softened by water so as to be quite flexible, and capable of parting in any one line of great pressure, yet possessed, in its consolidation into distinct laminæ, and in its being interpenetrated by the roots of trees and underbrush, elements of tenacity,—which enabled it to act as an organized mass, which quality was entirely wanting in the under-clay.

There was then a tongue of land of considerable tenacity, a few feet thick at the lower end, and seventy-five at the upper, resting upon a very mobile and smooth clay: the erosion of a shallow channel at the creek, afforded a passage for the *exit* of this clay; and the great and principal force which caused the fracture, was in my judgment, one acting in a *perpendicular* direction, as shown from the fact, 1st, that the fracture is a sharp, perpendicular well defined line, and not the ragged, irregular sloping line usually seen where the soil has been simply drawn down a declivity; 2nd, that immediately after the fracture, the thickest and heaviest portion *did sink* and forced the blue clay before it, outward, and upward, at the lower levels; its own lateral motion being very small.

The following section will further illustrate the action:



Cross section from N. W. to S. E. A, western fragment. B, eastern do. C, chasm. D, new mound, with the bed of the creek at its summit, (30 feet.) E, perpendicular line of fracture. F, former outline of the bank. G, former position of the creek. H, present appearance of the line of fracture. K, masses of blue clay forced up from below, and containing the present bed of the creek.

The eastern fragment, in addition to sinking considerably, slid forty-two feet toward the creek; impelled however in this lateral direction it would seem, not by the principal force, but by a secondary and incidental one, for it did not overwhelm the hollow of the creek, nor did it effect a single *fold* over toward the east, but allowed its lower edge, with the bed of the stream, to be raised by the clay, extended by the subsiding portions, into a mound of equal slope on both sides.

The whole movement appears therefore to be best explained upon the supposition of a body *floating* upon a semi-liquid, and seeking to right itself from a position of very unstable equilibrium; it resembles in many respects the interesting subsidence which occurred at Tivoli on the Hudson in April, 1862.

Although many changes have since taken place in its superficial appearance, much yet remains that is characteristic and wonderful—enough to repay amply the trouble of a visit.

Englewood, N. J., Nov. 11th, 1865.

ART. IV.—*On the Crystalline Nature of Glass;* by CHARLES M. WETHERILL, Ph.D., M.D.[1]

THE usual explanation given for the different appearance of etchings by hydrofluoric acid in the gaseous and in the liquid state, is that by employing gas, the products of decomposition of the glass remain in the corroded cavities communicating a ground-glass appearance. This does not obtain by the use of the liquid acid, since in this case the said products are removed from the cavities.

An examination of this subject by the aid of the microscope at once showed that the ordinary explanation is erroneous. Ground glass is seen, under the microscope, to be covered with irregular cavities of uniform size, which act by the dispersion of light to produce the characteristic appearance of glass in this condition.

When glass is exposed to the vapor of hydrofluoric acid, the corrodent is deposited in the condition of minute globules, each of which attacks the surface to which it is attached. Articles of glass placed near the apparatus in which the gas is generated are thus coated with a delicate film of the vapor, and are etched, so that the microscope exhibits extremely minute and shallow cavities in which, after cleansing the surface by water, no trace of other substance than glass is perceptible. When the exposure to the acid fumes is more prolonged, the cavities are deeper and more irregular. A still greater irregularity is effected by a more lengthened action of the corrosive vapor; the acid acts more intensely upon the spots first attacked, and the holes are extended with ragged margins and deepened by the action.

On the other hand, when the glass is immersed in *liquid* hydrofluoric acid, or if a drop of the same be suffered to fall upon the plate, the whole surface is corroded with a certain degree of uniformity. There are no minute points of action as in the case of the deposition of spherules of the acid vapor.

Hydrofluoric acid gas, so called, is thus shown to be a *vapor*, constituted of minute drops, like cloud. It would be interesting to test the effect upon glass of the perfectly anhydrous gas obtained lately. From these considerations, hydrofluoric gas appears to possess in an eminent degree the cloud-forming property of antozone. An appreciable quantity of this substance exists in the Woelsendorf fluor spar, and it may be questioned whether all specimens of this mineral do not contain traces of antozone.

In observing the specimens etched by the liquid acid, the crystalline nature of glass was discovered and witnessed in every

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[1] The observations of which an account is here given were made in the laboratory of the Smithsonian Institute, Washington.

case. By an examination of the literature of the subject it was ascertained that Leydolt (Wiener Acad. Bericht, viii, 261) had made this interesting and important discovery. I have been inclined to publish my results because Leydolt's observations do not appear to have received the attention which they merit; because my manner of applying the acid is different; and because crystals were observed of form differing from those described in Leydolt's paper.

In addition to these reasons, his discovery may appear to need a certain confirmation, since Daubrée has asserted (Comptes Rend., xlv, 792) that the crystalline phenomena are due not to the glass, but to the deposition of crystals of fluosilicid of potassium, &c., which retard the corrosive action by protecting the glass under them. In the following experiments with as prolonged a microscopic observation as the object-glass could be trusted to the corrosive fumes, the result of the reaction of a drop of the acid upon the glass appeared to be amorphous. In an experiment in which a watch glass was exposed, with the convex surface downward, as a cover to a platinum crucible containing hydrofluoric acid, a lapse of twelve hours effected a deep corrosion. This was most extensive at the lowest point of the glass where a large drop of liquid was adhering. The solid products of the reaction had settled to the inferior portion of the drop, and some of them had fallen with previous drops into the crucible. A microscopic examination of the glass demonstrated the presence of etched crystals, which could not, under the circumstances, have resulted from a protecting effect of crystals of fluosilicid.

Frankenheim (Jr. pr. Ch., liv, 430) maintains that solid bodies generated from a liquid are always crystalline, although the crystals may be too minute to be perceptible by our present instruments. His arguments, in the cases of glass, resins and the like, are *a priori*, being based upon the analogies proceeding from a study of the general properties of matter. They render the crystalline character of glass very probable.

This chemist places the glasses, resins, and fats in the same category in their relations to crystallization. In the transition of these bodies to liquids by an elevation of temperature, they pass through conditions of softness and semi-fluidity before melting. This softening does not depend upon a malleability, as in the case of metals. Glass, for example, remains perfectly brittle to a certain temperature, and when fusion begins to take place the angles are rounded by the cohesion of the liquid portions and the adhesion of these to the parts not yet melted. At a higher temperature, the liquid portion constitutes the mass of the body, but in it are suspended innumerable solid particles, which communicate to it a sticky or gelatinous character.

When melted glass cools, its least fusible compounds separate at first, and when the refrigeration is gradual a distinct crystallization takes place. By a rapid cooling the crystals must be more numerous and much smaller. If they cannot be detected in such glass by the eye or by aid of the microscope, the reason may be in their extreme tenuity, so that the light behaves to them as to the natural roughness of the polished surface. The author observes that silica is often separated in so fine a condition that it passes through the small pores of the filter. He finds no reason in the phenomena of this class of bodies for an actual amorphism; but assumes that they are composed of *crystals*, which, although really small, are large in relation to the atomic molecules of the bodies.

He concludes (op. cit., p. 476) that "amorphous bodies, in the ordinary sense of the expression, are unknown among solids, for solidity depends upon crystallization."

Gaudin, in his *brochure* (*Reforme de la Chemie Minerale et Organique*, Paris, 1863), endeavors to show what crystalline forms are probable for all bodies, deducing his results from the number of atoms in their chemical formulæ and the simplest manner in which they may be arranged. Chemists are divided as to the reliance to be placed upon Gaudin's views; but if they are tenable, or if in any degree founded upon reasonable grounds, the crystalline condition of all solid bodies would seem to be a necessary consequence.

Pelouze (Comptes Rendus, xl, 1321), in an investigation of the devitrefication of glass, as in the so-called porcelain of Réaumur, exposed a tablet of plate glass to incipient fusion upon the sole of a glass furnace for a period of 24–48 hours, and then suffered it to cool slowly. The result was a porcelain-like substance consisting of numerous opaque acicular crystals which were arranged in parallel series, the individuals being perpendicular to the surface of the plate. It was found that the crystallization proceeded from the surface to the interior of the tablet, and that when the process was arrested there was a distinct line of demarcation between the crystalline and vitreous portions. In rare instances the fibrous structure was wanting, and the crystallization was of such nature that the fractured glass presented the appearance of fine white marble. Occasionally the crystals were replaced by an enamel-like material. In repeated experiments of this character Pelouze found that the glass experienced no change of weight during the devitrefication, and the altered glass was restored to its transparency by a simple fusion. The process might be repeated several times without any alteration of weight. Devitrefied window glass, and more especially bottle glass when in large masses in the melting pots, sometimes exhibited yellowish-green *needles*, which were occasionally *small* and *short*, but often exceeded a centimeter in length, being closely adherent one to another and *interwoven in all directions*. The vacant spaces between the crystals recalled the crystallization of sulphur.

The crystallization of the glass was assisted by the addition of infusible or difficultly fusible substances to it when in the pasty condition. This is shown by the following experiment performed upon portions of material weighing one hundred kilograms.

Two melting pots were half filled with the same kind of glass, which was at first melted and then suffered to cool until it had assumed a pasty or tenacious consistence. To one crucible a small quantity of vitreous matter was added, and both pots were suffered to cool. That to which nothing had been added contained a transparent glassy mass, while the material in the other crucible was nearly opaque from crystal aggregations. One per cent of sand added to the pasty glass produced the same effect; and when quartz was employed the mineral retained its transparency, remaining mingled with the devitrefied mass.

Pelouze found that mirror, plate, lead, bottle, and Bohemian glasses were all susceptible of devitrefication, although with different degrees of readiness, the tri-silicate of soda being the most ready. A glass of silica, boracic acid, potassa and zinc yielded mere traces of crystallization; but the combination of silica and boracic acid with potassa and lime could not be devitrefied by an exposure of ninety-six hours to a temperature at which softening took place.

This chemist infers that the change experienced by glass during this process is a physical, and not a chemical one. He states, as the result of many analyses performed by himself, that the crystals do not differ in composition from the vitreous mass in which they are embedded.

Dumas (op. cit.) takes exceptions to some of Pelouze's inferences, having found a difference in the constitution of the glassy and crystallized portions of the mass. Thus, in respect to silica; for the vitreous portion 64·7 per cent, and in the crystals 68·2.

Leblanc found in the two kinds respectively: for mirror glass 66 2 and 69·3; for bottle glass 57·9 and 62·95. In the bottle glass Leblanc found that the transparent portions contained 1·57 per cent of protoxyd of iron, although only indistinct traces of this base were detected in the opaque part.

Dumas therefore holds that the products obtained by Pelouze are "analogous to *mixtures of the fatty acids*, which by fusion form a homogeneous liquid, which by cooling gives a fibrous solid, in which although the eye can perceive nothing heterogeneous, each acid has separated in its own crystal form."

Terreil (Comptes Rendus, xlv, 693) observed in the melting pots of a glass furnace which had cooled very slowly, a perfectly crystalline mass which contained cavities with small transparent crystals. These had a composition similar to that of a transparent bottle glass prepared from the same materials in the same proportions. Thus:

	Glass crystals.	Bottle glass.
Silica,	55·85	56·84
Lime,	24·14	21·15
Magnesia,	7·63	6·37
Alumina,	2·22	3·64
Peroxyd iron,	1·06	2·59
Soda,	8·47	8·69
Potassa,	0·63	0·40
Manganese,	traces	traces
	100·00	99·68
Spec. gravity,	2·824	2·724

For the composition of a partially devitrefied glass which was formed in the same furnace, under different circumstances, he found:

	Vitreous part.	Devitrefied part.
Silica,	62·40	63·67
Lime,	18·14	18·65
Magnesia,	4·47	6·12
Alumina,	7·21	4·98
Peroxyd iron,	2·66	0·71
Alkalies,	5·12	5·87
Manganese,	traces	traces
	100·00	100·00
Spec. gravity,	2·610	2·857

Leydolt (Wien. Acad. Bericht, viii, 261) introduces his experiments upon glass etching by observations of himself and others upon specimens of glass and slag in which crystals are visible without the aid of hydrofluoric acid.

Thus Prechtl melted a considerable quantity of feldspar with one and a half cwt. of glass and cooled the mass in water. In the inside of the lump, where the refrigeration had been more gradual, were found numerous crystals of feldspar, with well defined angles and edges, one of the crystals having the volume of a cubic inch.

Among the specimens of glass with perceptible crystals illustrated by Leydolt are the following:

1. Green flint glass, perfectly transparent, containing opaque grains, which are resolved by the microscope into well defined octahedra of one-half a line in diameter.

2. A glass flux, of emerald color, containing many groups of four-sided prisms, of white tinge and pearly luster.

3. A large mass of blackish green glass, with prismatic crystals singly and in aggregations, also fibrous crystals in globular tufts. The color of the crystals is dirty yellow, passing into green; their luster pearly. They had a rhomboidal section, and were a line in length by one-eighth of a line in thickness.

4. A bluish green English glass, containing tufts of needles uniting to globules of one and a half lines in diameter.

5. A glass flux, of red and green color, containing a large quantity of small four-sided prisms, solitary, and in tufts. The prisms were transparent, and of the same color as the glass, so that they could only be distinguished by the different degree of their refraction and that of the matrix.

6. A vitreous iron slag, of bottle-green color, containing perfect cubes of whitish tinge and pearly luster; also feathery crystals.

7. Another specimen of iron ore slag, similar to the last; but in which the cubes are larger, of nearly the color of the glass, and more equally diffused through the mass.

In a similar slag the cubes were of olive-green color, and in another specimen the cubes were sparse and accompanied by feathery crystals. To these may be added the observations of Splitgerber (Pogg. Ann., lxxvi, 566), that in a lead glass slag presented to Faraday by H. Rose, he found large and well defined six-sided tablets. In a glass prepared with 100 silica, 40 soda, and 10 carbonate of lime, which were perfectly fused and suffered to cool slowly for six hours, he discovered fine acicular crystals grouped star-wise, like flakes of snow. These floated in quantity in the melted liquid, and disappeared when the temperature of the crucible was raised again.

Leydolt's experiments of etching were performed by placing slips of glass in a mixture of fluor spar and oil of vitriol; by exposing glass plates to an atmosphere of hydrofluoric acid vapor; or finally by employing a very dilute solution of this acid contained in leaden vessels.

The following are his results:

1. A thick tablet of fine colorless mirror plate glass, after exposure to the vapor, was covered with colorless rhomboidal crystals. They projected from the plate, were perceptible to the touch, and plainly visible to the naked eye, from the contrast between their lustrous surfaces and the rough etched background.

He obtained similar forms by fluor spar and oil of vitriol, and also by the use of the dilute acid. He infers that they are not quartz, which does not dissolve in hydrofluoric acid, but that they are of similar nature to that of their matrix.

2. A flint glass of bluish color, passing into violet, transparent, and apparently homogeneous, yielded crystals by careful etching. Ordinary window glass gave similar crystals which were of the form of rectangular tablets.

3. A pure transparent English glass (a salt cellar), various vessels of French and Bohemian ware, very thick glass stoppers, glass of various colors, such as white bluish or green, and differently tinted glass fluxes and plates, all yielded similar crystals.

4. Some of the dilute residue of the reaction of sulphuric acid upon fluor spar having been left in a beaker glass, etched the same, with beautiful tufts of fibrous crystals, giving the appearance of some specimens of agate.

Leydolt infers from his experiments that all glass consists of an amorphous mass containing a variable proportion of crystals, and consequently; that not only density and composition, but also the more or less uniform distribution of the crystals, and their nature have a marked influence upon the character and optical behavior of the glass.

He deems the following questions to be of importance.

1. Upon what circumstances depends the formation of the crystals in relation to quantity?
2. What influence have the crystals upon optic phenomena?
3. May not their presence have an influence upon the doubly refracting character which glass acquires by heating and sudden cooling; or by pressure?
4. What substances may be dissolved in melted glass and separated therefrom by slow cooling?

Daubrée (C. R., xlv, 792) obtained various crystals by exposing glass for weeks to the action of water and steam in sealed iron vessels, at a temperature of 400° C. The glass was converted into a white, swollen, kaolin-like substance, composed almost entirely of crystalline particles. He found many crystals of quartz, and also acicular forms of nearly the same composition as Wollastonite (53 p. c. silica, 46 lime; with traces of magnesia). The quantity of water equalled half the weight of the glass, and the action of the water was the same as that of the steam.

Daubrée does not believe that the crystals preëxisted in the glass; but were formed by the action of the water. Although this is probable, it may be questioned whether some of the crystals were not ready formed in the glass.

My own experiments were performed by dropping strong liquid hydrofluoric acid upon plates of glass, using one or successive drops, according to the degree of etching desired. By this means the energy of the acid is expended upon one particular spot of the glass, and by taking more or less of the solvent, or by employing it of greater or less strength, the reaction is completely under control.

The acid was generated in the usual manner in a leaden retort with a condensing tube of the same metal, cooled with a mixture of salt and ice; the liquid acid was received in a platinum crucible, also refrigerated.

The following are the results of the experiments:

When the vapor escaping from the crucible was condensed upon plates of glass, a "ground glass" etching, with in some instances distinct traces of crystallization, resulted.

The following is the action of the liquid acid upon different kinds of glass.

1. Greenish window glass, free from lead. One drop of the acid acted energetically, coating the glass with a white sediment. When washed, the spot was found to be deeply etched, and presented a roughened although transparent appearance. Under the microscope, with oblique, transmitted light, the surface was found to be covered with a web of acicular crystals, crossing at all angles, and presenting exactly the appearance of sublimed caffeine. The average length of the needles was 0·08 of a millimeter; their thickness somewhat less than 0·006 mm.

It was difficult at first to determine whether the crystals were elevated, or depressed below the surface of the plate, in which case they would have represented casts of crystals dissolved out by the acid; but by careful management of the light, studying the shadows and comparing them with caffeine crystals, they were judged to be in relief. Polarized light had no effect upon them. Beside these crystals, there were observed scattered over the field of view a few irregular etchings, in intaglio, which seemed to be casts of crystalline scales dissolved out by the hydrofluoric acid.

2. A piece of the same plate of glass was treated with successive drops of the acid upon the same spot, waiting to add a drop until the reaction of the former one had ceased.

A deep etching was the result, and the extensively corroded surface presented here and there a ground glass appearance. Acicular crystals were apparent, although not as well defined as in the former example.

Nos. 3, 4 and 5 were slips of the same glass etched by vapor. Of these No. 3 was very slightly corroded; upon No. 4 and still more upon No. 5, the action was of greater duration. In these examples the evidence of acicular crystallization was apparent, as a shading upon the ground glass surface. Toward the edges of the etched spot the needles were as distinct as in example No. 1. Here a few well defined prisms with oblique extremities and one or two very small rhombic tablets were observed.

No. 6. Mirror plate glass. This specimen was corroded by a drop of the acid with greater uniformity than the window glass, although the etching was not so deep. It required careful management of the light to detect the crystals which were observed here and there in the form of scales or tablets, apparently broken and very small. A few acicular crystals were also detected.

No. 7. Plate glass (microscope slide). This specimen, when etched, presented the same appearance as No. 6. Very small acicular crystals distributed sparsely over the field of view could be seen.

No. 8. Three specimens of thin glass covers for microscopic objects. The etching of these was very uniform. Numerous and extremely minute needle-shaped crystals, requiring a high power for their definition, were observed.

No. 9. Green bottle glass (two specimens). In these the crystallization was different from that of the former examples. In some places the etching was granular, as if small and short crystals had been removed by the acid. In other places blade-shaped crystals were apparent; these had a tendency to unite in star-like groups, as in snow. Upon one portion of the plate a few small squares and triangles (insoluble in water) were seen.

No. 10. Two specimens of Bohemian glass combustion-tube etched upon the inside. These yielded a granular, very regular etching, and presented a very delicate ground glass appearance, which was resolved by the microscope into small crystalline tablets or scales, apparently fragments of crystals.

No. 11. Bohemian beaker glass; two specimens, of which one was attacked upon the outside, and the other upon the inner surface of the vessel. Small acicular crystals, resembling those of No. 1, but better defined, and a few squares, triangles and trapezoids were detected.

No. 12. Lead glass tubing; two specimens, etched upon the inside. The action of the solvent was energetic. The etching was granular, with numerous short and minute needles, requiring a high power of the microscope for their definition.

No. 13. A portion of a soda glass flask etched upon the inside. This was corroded very readily and yielded plenty of needles resembling in appearance those of No. 1.

No. 14. Lead glass; inside surface of a matrass. The action of the hydrofluoric acid upon this specimen was energetic. The crystals presented the appearance of confused broken tablets, with here and there a needle-shaped crystal.

The acid employed in the experiments gave no etching when dropped upon the different surfaces of a clear transparent quartz crystal.

No. 15. After having completed the preceding series of observations the object-glass of the microscope was protected from the action of the hydrofluoric acid by cementing upon it a plate of thin glass with Canada balsam. A large number of experiments were then made with slips cut from the same piece of window glass, similar to No. 1, with the object of ascertaining by the microscope whether the residue of the reaction was crystalline, and whether, if so, it could have any influence upon the etching to give an *appearance* of crystals having in reality no existence.

The acid employed was strong enough to hiss when water was added, and emitted copious fumes. Dropped upon the glass it spread, forming a thin circular cake or film of solid substance having a granular appearance.

By a close inspection small prisms or needles were visible here and there in this residue. They were not as numerous as the etched crystals perceptible when the glass was cleansed, and it was not certain that they were not shadows of the glass crystals. In some cases larger prisms could be seen near the edge of the disc; these might be removed by the needle point; but under them was found no corresponding etched appearance of a crystal.

In one instance the slip of glass was coated with wax for the purpose of confining the acid to a small disc where the glass was laid bare. This gave beautiful crystals, similar to the other specimens. When the plate was covered with a thin film of oil the crystalline etching resulted as in the former instances. When the acid was constantly stirred upon the plate with the platinum spoon employed for dropping it, the crystalline etching resulted as before.

No. 16. At length an etching was found which served as an *experimentum crucis* to the question of the protecting action of the residue. In this case the acid was slightly diluted, but still fumed in the air. The glass, after having been acted upon, contained circular white patches of a ground glass appearance. By the microscope these were resolved into groups of star-shaped crystals which, in some cases, were indistinct from corrosion; in others they were plainly crystals. Their appearance was exactly similar to that of the snow-flake, viz., stars composed of needles which were combined with smaller needles forming feathery rays. In two places long needles of one-eighth of an inch in length were visible. Beside these, the acicular web of the former specimens covered the glass. These starry crystals were undoubtedly in *intaglio.* The depression could be distinctly felt with a needle when observing under the microscope, and fine powder of vermilion filled the rays. When first viewed, before the glass was cleansed perfectly, the corroded remains of the crystals could be removed from the depressions with a needle point.

Now while we can conceive that a crystal formed by the action of an acid, might adhere so closely to the glass as to retard the corrosive effect of the acid under it, it is impossible to see how such a crystal could eat away the glass beneath it and thus sink itself under the surface.

In some of the other specimens these starry groups were perceived; but in no case as distinctly as in this one. There happened here to be groups of crystals which were large and very favorably disposed for the etching process. The result of this series of experiments seemed to throw some doubt upon the "elevated" character of the acicular web of crystals; at least as much doubt as may arise from the difficulty of judging the question from the shadows. The former conclusion was reached by a comparison of the shadows with those of a web of crystals of sublimed caffeine which were known to be in relief. If in intaglio, their depression is too slight to be able to form a judgment by rubbing the etching with vermilion powder. But as the stars are known to be depressions, it may be that the scattered needles are of the same character.

In some examples, two rays of a star-shaped crystal were seen giving the form of a V, which in other cases was transformed into a triangle by an additional needle happening to lie at its base. The △-shaped crystals described upon a former page may be formed in this manner, although they were not so determined.

It results that the window glass examined contains crystals already formed, of which some are more soluble in hydrofluoric acid than their matrix, and perhaps others less soluble in the same reagent.

All of the specimens of glass submitted to the action of hydrofluoric acid yielded crystalline forms. Those of the window glass are similar in appearance to the crystals obtained by Pelouze by the slow cooling of the same kind of glass after it had been maintained for several hours at incipient fusion. Since in the experiments of this chemist no alteration of weight was observed and the normal character of the glass was restored by simply melting, it is probable that the crystals are of the same nature in both instances. It would appear from some of my observations as if the crystals first formed during the refrigeration of the glass, were subsequently broken by the operations of pressing, rolling &c., to which the material had been subjected.

Doubtless additional interesting phenomena might be observed by a more extended study of different varieties of glass under different conditions by the use of this method.

An analogous action of certain solvents upon other supposed amorphous bodies, as the resins, &c. may demonstrate a crystalline character in them.

From a more extended study of this interesting subject, results the most important respecting the true nature of glass may be expected.

The effect of annealing may here find its true explanation.

If we were able to produce at will an interlacement of long fibrous transparent crystals, a glass of superior flexibility and strength might be obtained. It would also be interesting to ascertain what kind of crystals of different substances might be introduced into glass without destroying its valuable properties.

If such, having the crystalline character of mica or asbestus, could be added a valuable product might result.

Leydolt observed in a slag (see his No. 7) cubic crystals of nearly the same color as the glass and visible to the eye. If we could ascertain the nature of the glass crystals as well as that of the matrix (which may also be crystalline) possibly we might, by the laws of isomorphism, be able to color the crystals at will, thus producing new and beautiful effects in articles of glass-ware. In this connection Leblanc's observation of protoxyd of iron in the transparent portion and but traces of this base in the crystalline part of a specimen of glass, may be noted.

The detection of the crystalline nature of glass demonstrates that we are as yet unacquainted with the true character of this complex substance; but at the same time it indicates the path to be pursued for acquiring this desirable knowledge.

ART. V.—*Contributions from the Sheffield Laboratory of Yale College.* No. IX.—*On the assimilation of complex nitrogenous bodies by Vegetation;* by S. W. JOHNSON.

DURING the summer of 1861 the writer undertook a series of observations on the nutrition of plants, which, though a failure as regards the principal object of the investigation, led to some interesting results. Besides various inorganic matters, the nitrogenous compounds occurring in urine which may be directly applied to crops as fertilizers, viz: urea, guanine, uric acid and hippuric acid, were intended to be made the subjects of experiment.

Washed and ignited flower-pots (of clay, unglazed) were employed to contain, for each trial, a soil consisting of 700 grms. of ignited and washed granitic sand mixed with 0·25 grm. sulphate of lime, 2 grm. ashes of hay prepared in muffle and 2·75 grm. bone-ashes. This soil was placed upon 100 grms. of clean gravel to serve as drainage.

In each of several pots containing the above soil was deposited July 6th, a weighed kernel of maize. The pots were watered with equal quantities of distilled water containing a scarcely appreciable trace of ammonia. But four seeds germinated in a healthy manner, the plants developed slowly and alike until July 28th, when the addition of nitrogenous matters was begun.

To No. 1, no solid addition was made.

To No. 2, was added July 28, 0·420 grm. uric acid.

To No. 3, was added 1·790 grm. hippuric acid, at four different times, viz: July 28, 0·358 grm., Aug. 26th, 0·358 grm., Sept. 16th, 0·716 grm., Oct. 3d, 0·358 grm.

To No. 4, was added 0·4110 grms. hydrochlorate of guanine, viz: July 28th, 0·0822 grm., Aug. 26th, 0·0822 grm., Sept. 16th, 0·1644 grm., Oct. 3d, 0·0822 grm.

The nitrogenous additions contained in each case, 140 grm. of nitrogen, and were strown, as fine powder, over the surface of the soil.

It not being practicable to attend to the germination of other seeds, urea was not experimented with. This deficiency was of less account, since Cameron's paper on the direct nutritive effect of urea, read before the British Association in 1857, had demonstrated that this substance supplies the plant with nitrogen without previous decomposition in the soil and has a fertilizing effect equal to salts of ammonia.[1]

The plants continued to grow or to remain healthy, (the lower leaves withering more or less,) until they were removed from the soil Nov. 8th.

The plants exhibited striking differences in their development. No. 1, (no added nitrogen) produced in all seven slender leaves and attained a height of seven inches. At the close of the experiment, only the two newest leaves were perfectly fresh, the next was withered and dead throughout one-third of its length. The newer portions of this plant grew chiefly at the expense of the older parts. No sign of floral organs appeared.

No. 2, fed with uric acid, was the best developed plant of the series. At the conclusion of the experiment it bore ten vigorous leaves, six of which were fresh and two but partly withered. It was 14 inches high and carried two rudimentary ears (pistillate flowers), from the upper one of which hung tassels six inches long.

No. 3, supplied with hippuric acid, bore eight leaves, four of which were withered, and two rudimentary ears, one of which was tasseled. Height 12 inches.

No. 4, with hydrochlorate of guanine, had six leaves, only one withered, and two ears, one of which was tasseled. Height 12 inches.

These experiments, together with a large number of others simultaneously undertaken, failed to give satisfactory results from the unfavorable situation of the only apartment at disposition for conducting them in. The light was good but for a small part of the day, and very unequally distributed at that. For this reason, chiefly, most of the plants made but imperfect growth and therefore the laborious analyses which would have properly supplemented the observations on growth were not attempted.

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[1] This result has been recently confirmed by Hampe of Göttingen who has made maize to grow as a water-plant with its roots in a dilute solution containing sulphate of magnesia, chlorid of calcium, phosphate of potash, sesquichlorid of iron and urea. Hampe found in the well developed plants—stems and leaves as well as roots—evident quantities of urea.

In the case of the four experiments under notice, the weight of the crops (dried at 212° F.), exclusive of the fine rootlets that could not be removed from the soil, was ascertained with the subjoined results.

No. 1, (no added nitrogen,)	Weight of dried crop,	0·1935 grm.
	" " " seed,	0·1644 "
	gain,	0·0291 "
No. 2, (added 0·420 grm. uric acid,)	Weight of dried crop,	1·9470 grm.
	" " " seed,	·1725 "
	gain,	1·7745 "
No. 3, (added 1·790 grm. hippuric acid),	Weight of dried crop,	1·0149 grm.
	" " " seed,	0·1752 "
	gain,	0·8397 "
No. 4, (added 0·411 grm. hydrochlorate of guanine,)	Weight of dried crop,	0·9820 grm.
	" " " seed,	0·1698 "
	gain,	0·8122 "

We thus have proof that all the substances employed contributed nitrogen to the growing plant. This is conclusively shown by the fact that the development of pistillate organs, which are especially rich in nitrogen, occurred in the three plants fed with nitrogenous compounds, but was totally wanting in the other. The relation of matter new-organized by growth to that derived from the seed is strikingly seen from a comparison of the ratios of the weight of the seed to the increase of organized matter, the former being taken as unity.

The ratio is approximatively

for No. 1,	1 : 0·2
" " 2,	1 : 10·2
" " 3,	1 : 4·8
" " 4,	1 : 4·8

The relative gain by growth, that of No. 1, assumed as unity, is

for No. 1,	1
" " 2,	56
" " 3,	26
" " 4,	26

No examination was made of the soil to ascertain whether the uric acid, &c., had undergone decomposition with formation of ammonia before entering the plant. If urea escapes decomposition, as Cameron and Hampe have shown is true, for the most part, it is not to be anticipated that the more stable bodies employed in these trials should suffer such alteration.

It will be noticed that the gain of dry matter during growth was identical in case of the plants fed with guanine and hippuric acid, and this quantity was again, quite nearly half that manifested by the plant which was supplied with uric acid. Whether this is more than accidental is worthy of study.

From these experiments the writer concludes that the amids resulting from the disorganization of protein compounds, as well as ammonia salts and nitrates, are capable of direct passage into the plant, and there serve for the reorganization of albumen, &c.

Cameron, in the investigation alluded to, remarked that his results demonstrate that it is not necessary that urea should decompose into carbonate of ammonia in order to become available to vegetation, and the above facts warrant the generalization that all the amids existing in the urine of animals are ready for assimilation, without any further resolution by decay. So far as they are directly concerned, then, any "fermenting" of manures of which they are ingredients is useless.

Oct. 1865.

ART. VI.—*Results of observations on the Drift Phenomena of Labrador, and the Atlantic coast southward;* by A. S. PACKARD, Jr., M.D.

THE whole surface of Labrador has passed through a denudation of great extent by continental glaciers. In the southern part of the peninsula, bordering on the gulf of the St. Lawrence, the glaciers evidently moved southward down the slope from the water-shed in the interior. On the eastern or Atlantic coast, at both sides of the mouth of Hamilton Inlet, which is forty miles wide, there are glacial lunoid furrows, like those observed in Maine by Dr. DeLaski, which tend to prove by their direction that a glacier forty or fifty miles in breadth filled this great fiord, and moved in an easterly direction from the water-shed in the interior, thence debouching into the sea.

Owing to the powerful disrupting agency of the frost and ice, the rounded and denuded rocks of Labrador have as yet revealed but few glacial striæ. The distribution of the boulders is restricted to the higher levels of the plateau. To find them in any abundance, it is necessary to ascend 500 to 800 feet above the sea, at which point they occur in profusion. Below this point they have been rolled, rounded, and rearranged into ancient sea beaches. But on the smooth polished quartzites and syenites, the former of which are levelled into broad plains grooved and furrowed and afterward polished almost like glass, with shallow depressions, being glacial troughs filled with water and forming countless pools, and on the rounded syenitic hills which assume dome-like or high conical sugar-loaf forms, we see everywhere in Labrador, below a level of 2000 feet, the traces of ancient glacier action exhibited on a vast scale.

At the close of the Glacial epoch the moraine matter was reassorted into marine deposits, which in this country have been exposed to a general and sweeping denudation. Only small patches are found remaining in sheltered positions. These marine deposits consist of finely laminated clays resting upon coarser, more stony, and gravelly beds. The former were evidently estuary deposits, the latter thrown down in deeper water, where the strong Arctic current prevailed. The oldest beds are the coarser strata, which, as in Maine, occur at high-tide mark. The more recent beds occur from ten to twenty feet above the sea level.

The fossil Invertebrata, found abundantly in these beds, afford excellent material for comparison with the present marine fauna of Labrador, and throw new light on the distribution of marine life during the close of the Glacial epoch. The assemblage is thoroughly Arctic in character, but, when compared with lists of the glacial shells of the north of Europe, it is found to bear a very distinct *facies.* It is evident that on each side of the Atlantic, the same faunal distinctions obtained during this period as now. There was, however, a greater range in space of purely Arctic species, and, though the European marine fauna was much more closely allied to our own, owing to the great predominance of exclusively Arctic forms, it is yet evident that the Arctic glacial fauna was divided into a Scandinavian district, and a Labrador district, each the metropolis of a small number of species peculiar to itself and limited to its area.

The assemblages found at various points along the coast from Labrador to Maine are not the exact equivalents of the present faunæ. They differ in containing a very small percentage of extinct species, and in a different grouping of species still living.

Thus, in the Labrador beds are several species of *Fusus* (Sipho) which differ from recent Arctic forms, and also a species of *Bela;* certain forms, such as *Panopæa* and perhaps *Cyrtodaria*, which were abundant formerly, seem to be dying out at the present day. In Maine the change is still more marked. Thus, the most characteristic shell of the marine clays is *Leda truncata* (*Portlandica*), which has wholly disappeared from the seas south of the circumpolar regions, unless future deep-sea dredging reveals its presence in some of the abysses off our coast. An undescribed *Macoma* is also characteristic of the beds about Portland; and other important changes have occurred in the relative abundance of species, and the manner in which they are grouped as compared with the present assemblages in zoological districts farther north, and similar in physical surroundings to the glacial seas.

The Labrador district of the Arctic fauna, instead of being restricted as now to the eastern coast of North America from the Arctic archipelago to the banks of Newfoundland, and shading off into the Acadian district at the present line of floating ice, during the Glacial epoch extended up the St. Lawrence river, and as far as Portland, on the coast of Maine, where it shaded into a more southern assemblage.

In Maine there are two distinct horizons of life. The lowest and oldest is found at the bottom of the boulder-clay at high-tide mark along the coast. The second horizon is composed of rewashed, finely laminated, less stony clays occupying the coast from 25 feet above the sea level to a height, 50 to 100 miles inland, of nearly 300 feet. The species found in this second horizon are rather *boreal* forms than purely Arctic. In the beds about Saco and Scarboro' we find *Leda tenuisulcata* intermingled with the Arctic *L. pernula*, as it is not at present on the coast, and *Pandora trilineata* replaces the Arctic *Pandorina arenosa.* At Berwick, *Astarte castanea*, a boreal form, is introduced; while south of this, at Point Shirley, Desor and Stimpson found *Nassa trivittata*, *Buccinum plicosum*, *Astarte castanea* and *Venus mercenaria*, species which now, as an assemblage, abound most on the shores of New England south of Cape Cod, and in New York bay. Again, at Nantucket, Desor found a still warmer fauna occupying, apparently, an extension of this second horizon. *Arca transversa*, *Crepidula fornicata*, with *Buccinum plicosum* and *Nassa obsoleta* were found to abound in this locality, where the warming influence of the Gulf Stream was strongly felt, while the waters of Maine were cooled down by the Arctic or Polar current.

In the beds of this horizon at Gardiner occur the teeth of the bison, walrus, and bones of other animals, and the *Mallotus villosus;* also in the same beds at Bangor the fossil whale, and in Burlington, Vt., in the Champlain clays, which evidently belong to this horizon, the *Beluga Vermontana* of Thompson.

Thus the two glacial faunæ that have successively gained a foothold in northeastern temperate America, seemed, as regards both their land and marine animals, and also plants, (for *Potentilla tridentata* which is found only in Maine, Labrador and Greenland, is also found fossil in the Ottowa clays, according to Dr. Dawson,) to be a purely Arctic American assemblage. According to the view of Dr. Hooker,[2] the most ancient glacial flora was derived from Scandinavia. On the contrary, as far as geological evidence at present tends, the cave mammals of Europe were associated with the musk ox, reindeer, white bear, and other Arctic animals which abound in Arctic America, while no features in the Post-tertiary fossils of America seem to be European. These faunal distinctions would seem to be even more strongly marked than now in the distribution of the Vertebrata during the closing part of the Glacial epoch.

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[2] Outlines of the Distribution of Arctic plants, by J. D. Hooker, M.D. Trans. Linn. Soc. London, xxiii, part ii.

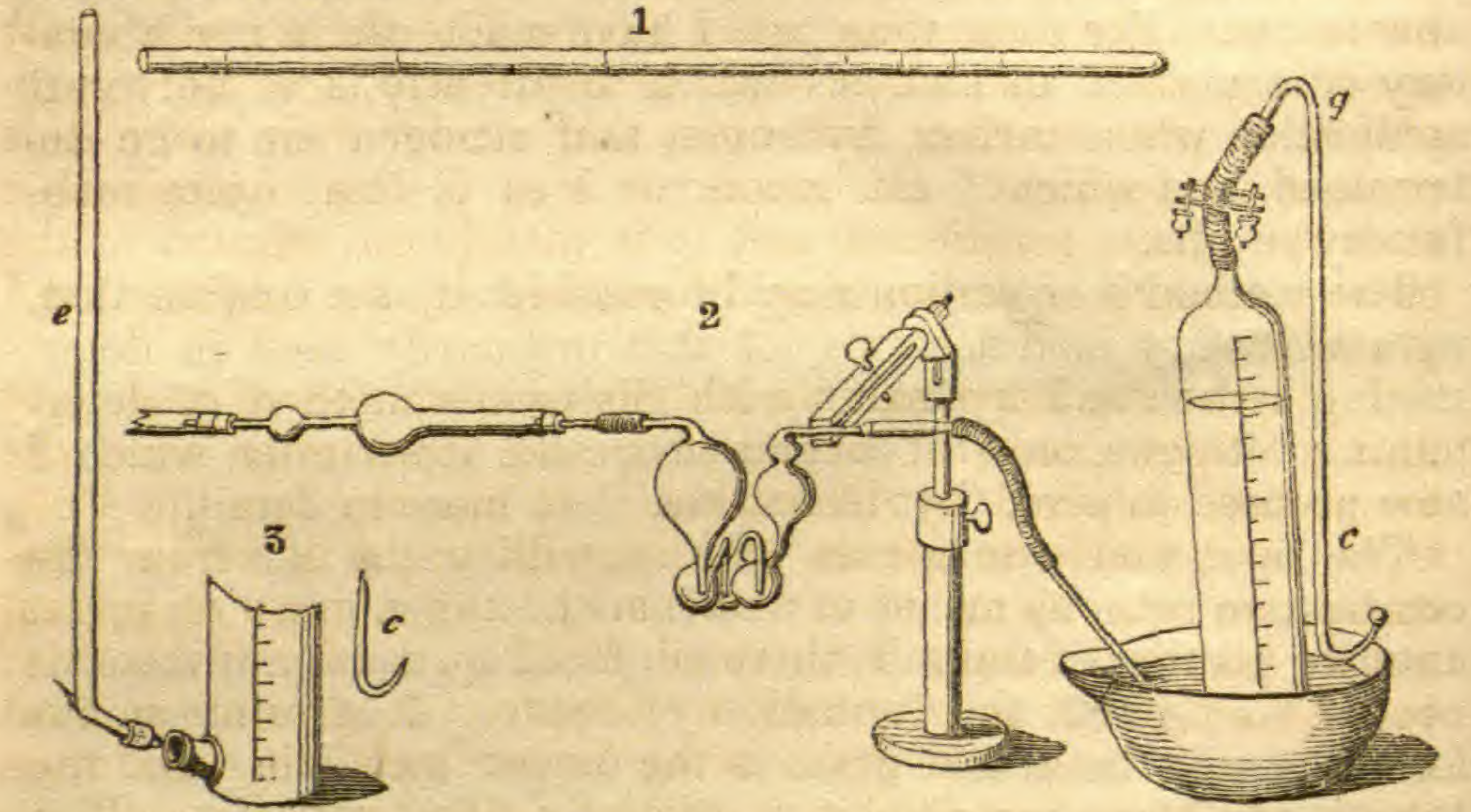
ART. VII.—*On a Process of Elementary Analysis admitting of the determination of Carbon, Hydrogen and Nitrogen at a single combustion;* by C. GILBERT WHEELER.

THE processes of ultimate organic analysis heretofore employed, when applied to substances containing carbon, hydrogen and nitrogen, contemplate the determination of the latter element by a *separate* and *distinct operation* and are therefore often embarrassing where the chemist has but a small amount of the substance to be analyzed at his disposal. A method by which these three elements might be determined at a single combustion would appear to be desirable, and, if equally accurate with other approved processes, and also admitting of a not less expeditious execution, might with advantage be employed, not only in the special class of cases referred to, but also in general, as a substitute for those now in use. For some time past I have made use in my laboratory of a method of analysis which apparently is of universal application when carbon, hydrogen and nitrogen are to be determined, and which I can recommend as yielding quite satisfactory results.

The method in question may be considered as a combination, with necessary modifications, of that ordinarily used in determining carbon and hydrogen with Simpson's method of determining nitrogen, as will be seen from the description which I now proceed to give, first in outline, then more in detail.

The operation commences with expelling the air from the combustion tube, by means of a stream of oxygen gas. As in the anterior portion of the tube there is placed a quantity of metallic copper, to prevent the formation of deutoxyd of nitrogen, the former cannot be heated without the copper oxydizing and the tube again becoming wholly or partially filled with air. This is prevented by expelling in turn the oxygen by means of a known quantity of carbonic acid gas, which effected, the combustion proper is commenced and carried on in the ordinary manner with this modification, viz: that, at the close, a current of oxygen gas is again employed for the purpose of forcing into the appropriate apparatus the residuary products of combustion, as also, when necessary to complete the oxydation of particles of the substance yet unconsumed. The water and carbonic acid resulting from the analysis are absorbed in the usual apparatus and weighed, while the nitrogen, mixed with oxygen, is conducted into a special apparatus where it is measured over mercury.

The simplest method would be to conduct the gases into a Bunsen's eudiometer, and in the same perform the necessary further determinations. However, the capacity of such a eudiometer is not sufficient in the great majority of cases, even where it has a length of 800 to 1000 millimeters. I have therefore made use of Bunsen's gasometer[1] and found the same exceedingly well adapted for the purpose. It has, however, proved desirable to make one or two trifling alterations which in practice I have found to enhance its value and usefulness. Instead of the original arrangement for regulating the escape of gas, I make use of a screw-slip as shown at *g*, fig. 2. Also the tube *c g*, which is not capillary but somewhat larger, is filled with mercury and thus remains during the combustion. The filling is conveniently effected by pouring mercury into the gasometer through the tube *e*, fig. 3, until it passes the point *g*, fig. 2, and flows out in a constant, regular stream at *e*, which is closed with a piece of soft wax. The screw-slip being closed, the gasometer is ready for use.



Both the gasometer above described and the eudiometer, in which the mixture of nitrogen and oxygen is to be analyzed, are graduated, and their cubic capacities referred to a common standard (cubic centimeter). This is necessary, as only an aliquot part of the total gas obtained is submitted to analysis, the greater portion being held in reserve in case any disaster should occur to that under investigation.

I pass now to a detailed description of the mode of procedure in performing an elementary analysis by the process under consideration.

A combustion tube 2–2½ feet in length is sealed up at one end, as shown in fig. 1. From 3 to 5 grams pure, well-dried and pulverized chlorate of potassa are introduced and thoroughly mixed with the aid of a mixing wire, with at least an equal

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[1] Bunsen, Gasom. Methoden, p. 21, fig. 16.

volume of freshly ignited oxyd of copper. It is important that the mixture be as uniform as possible in order that the supply of oxygen may be easily regulated. Then follows about two inches of oxyd of copper, and thereupon a weighed portion, from 0·2 to 0·3 gram, of *oxalate of lead* which is likewise thoroughly mixed with oxyd of copper. This salt is the substance I find the most convenient from which to obtain a known amount of carbonic acid gas.

I adopt oxalate of lead in preference to other substances that have hitherto been employed in organic analysis for evolving carbonic acid, as more completely free from the various practical objections presented by the latter, and in particular by the following, viz: carbonate of magnesia (magnesite), carbonate of manganese, carbonate of copper, bicarbonate of soda and oxalic acid. The use of these substances is impracticable, as they either fail to give the theoretical percentage of carbonic acid on being heated, partially decompose when exposed to the air in a moist condition, yield also water with carbonic acid, are too hygroscopic, or present other difficulties that render their use in this process inexpedient. Carbonate of lead is less objectionable than the above mentioned, and it is mainly on account of the greater amount of carbonic acid furnished by the oxalate that I prefer it.

I prepare the latter salt by adding to a solution of acetate of lead a slight excess of oxalic acid, and thoroughly wash the precipitate obtained by decantation. It has the formula PbO, C_2O_3, and yields on gentle ignition with oxyd of copper precisely two equivalents of carbonic acid. As a mean of several nearly identical results I obtained 29·83 p. c. of carbonic acid instead of 29·81 as required by theory. A greater amount of this salt than 0·3 gram being never used, the maximum error, therefore, possible in a carbon determination would be 0·00001643 gram.

After introducing, as previously explained, the oxalate of lead into the combustion tube, about two inches of pure oxyd of copper are added, then a mixture of the substance for analysis with oxyd of copper, and thereupon, again, several inches of the oxyd. Finally, the remaining space in the tube, which should never be less than 4 inches, and need not exceed, except in rare cases, 8 inches, is filled with metallic copper freshly reduced in a stream of hydrogen gas. I prefer for the purpose a compact roll of copper wire gauze.

After a channel has been secured in the usual manner throughout the whole length of the tube—at the posterior end it is well to have the channel larger than elsewhere—a chlorid of calcium tube and potash bulbs are placed in communication as in an ordinary combustion and the anterior end of the latter is connected by means of a thick piece of gutta percha tubing, about four inches in length, with a glass tube bent at one end so as to admit of being conveniently introduced into the tubulure of the gasometer. The gutta percha tubing taken of the length indicated renders this manipulation much easier. The gasometer having been filled with mercury in the manner previously described, is placed in a suitable vessel, and in a slightly inclined position as shown in fig. 2, directly before the potash bulbs and the tube *e* is removed, the tubulure being submerged in mercury. A small porcelain mortar is a very convenient receptacle for the gasometer.

The apparatus thus put together, and it having been ascertained by the usual method that no leakage exists, the combustion may be commenced. The chlorate of potassa is first heated, and the evolution of oxygen gas continued until its presence is ascertained at the anterior end of the apparatus by the inflaming of a taper; for which purpose, about ten minutes are required. Heat is now applied to the mixture of oxalate of lead and oxyd of copper, and the necessary carbonic acid evolved to displace the oxygen, at least as far as to the anterior portion of the combustion tube. In order to be certain that the metallic copper is surrounded by an atmosphere of carbonic acid gas, the heating of the oxalate of lead is proceeded with until an absorption, usually occurring in from five to eight minutes, is clearly perceptible in the potash bulbs. At this stage of the process it is necessary that the bent tube at the extremity of the apparatus be immersed in the mercury contained in the mortar, in order that during the absorption of the carbonic acid by the potassa there may no air again enter the apparatus. Fire is now applied to the metallic copper; then the oxyd of copper is heated, and the analysis is thenceforward performed precisely as by the ordinary method. When the point is reached where the substance under analysis is situated, the tube at the anterior end of the apparatus is introduced into the tubulure of the gasometer, care being taken that the apperture of the same is not raised above the surface of the mercury. As fast as the gasometer becomes filled with the gases, thus displacing the mercury, the latter is removed from the mortar. The height of the mercury surrounding the gasometer being thus very moderate, merely sufficient to prevent the admission of air, the internal pressure, therefore, upon the apparatus is quite inconsiderable. The combustion of the substance having been effected and the remaining oxalate of lead decomposed, the chlorate of potassa is again heated and the products of combustion completely carried forward to their respective recipients. When the oxygen reaches that portion of the tube previously containing the substance analyzed, a rather vivid but entirely harmless incandescence is observed resulting from the reoxydation of the copper reduced. The same occurs also when the metallic copper at the anterior end of the tube is reached, at which stage of the process great care is necessary, for, as the oxydation of the copper commences, there is a sudden cessation in the passage of gas through the potash bulbs and one is easily tempted to accelerate the liberation of oxygen. In this event, when the reoxydation is completed, a very sudden and altogether too rapid stream of gas passes through the apparatus and disaster results. If, on the other hand, the liberation of oxygen be not sufficiently rapid, or, in particular, if it should cease for a few moments, the oxydation of the copper would proceed at such a rate and so reduce the tension of the gases within the apparatus as to cause the mercury to ascend the tube communicating with the potash bulbs, and even to enter the latter if not timely observed and prevented by accelerating the stream of oxygen. The one extreme, as well as the other, may be avoided by so regulating the stream of gas that constant but slow oxydation of the copper takes place, and this is readily seen by the change of color that results. Care should be taken that the necessary oxygen be liberated *without interruption* and *uniformly*, which may be easily effected when the chlorate of potassa has been sufficiently pulverized and mixed with at least an equal volume of oxyd of copper.

This somewhat critical stage of the process successfully passed, the supply of oxygen is continued until a considerable quantity has entered the gasometer, which one may confidently assume as accomplished on continuing the stream of gas for about five minutes after absorption ceases to be observable in the potash bulbs. The apparatus is now disconnected and the oxygen remaining in the chlorid of calcium tube and potash bulbs is expelled by air previously freed from carbonic acid and moisture before weighing.

The height of the mercury in and surrounding the gasometer is read off, after the same has been placed in an upright position in a mercury trough with glass sides; also the height of barometer and thermometer. A portion of the gas is then transferred to the eudiometer, previously filled with mercury, in the following manner; the stopper of wax is removed from the extremity of the tube at *c* and the latter is introduced into the eudiometer. The tube *e* is then inserted in the tubulure, and mercury is poured into the same until its level in the tube is above that in the gasometer by about one or two inches. The screw-clip at *g* is then gradually opened and the gas flows out through *c* into the eudiometer. When enough has been transferred for an analysis, the screw-clip is closed, the gasometer removed and the amount of gas in the eudiometer is read off. The further analysis of the gas is performed precisely as in an ordinary air analysis.[a]

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[a] Bunsen's Gasometrischen Methoden, p. 74.

A quantity of hydrogen is introduced, the mixture exploded, and, from the thereby resulting contraction in volume, the volume of oxygen present is calculated. This deducted from the volume of the mixture of oxygen and nitrogen gives that of the latter. The relation between the volume of mixed gases introduced into the eudiometer and that originally contained in the gasometer expresses also that of the nitrogen in each apparatus, which total volume thus found is reduced to milligrams and calculated as percentage of nitrogen in the substance under analysis. Should for any cause a repetition of the gas analysis be desirable, a fresh portion is transferred from the gasometer, care being taken that, if the tube *c g* has in the interval been in communication with the air, the first portion of gas be rejected. Ordinarily, not more than one-fifth or one-tenth of the gas contained in the gasometer is taken for analysis.

I herewith submit the results of a number of analyses made for the purpose of testing the process.

1. Urea, $C_2H_4N_2O_2$.

	Theory.	Found.
$C_2 =$	20·00	19·84
$H_4 =$	6·67	7·01
$N_2 =$	46·67	46·40
$O_2 =$	26·66	26·66
	100·00	99·91

2. Nitrate of urea, $C_2H_4N_2O_2$, HO, NO_5.

	Theory.	Found.
$C_2 =$	9·756	9·455
$H_5 =$	4·065	4·342
$N_3 =$	34·146	33·980
$O_8 =$	52·032	52·032
	100·000	99·809

3. Uric acid, C_5H, N_2O_2, HO.

	Theory.	Found.
$C_5 =$	35·71	35·42
$H_2 =$	2·38	2·49
$N_2 =$	33·33	33·55
$O_3 =$	28·58	28·58
	100·00	100·04

4. Urate of ammonia, NH_4O, $C_5HN_2O_2+HO$, $C_5HN_2O_2$.

	Theory.	Found.
$C_{10} =$	32·432	32·265
$H_7 =$	3·783	4·205
$N_5 =$	37·838	37·330
$O_6 =$	25·945	25·945
	100·000	99·745

5. Hippuric acid, $C_{18}H_8NO_5$, HO.

	Theory.	Found.
$C_{18} =$	60·34	59·993
$H_9 =$	5·02	5·071
$N =$	7·82	7·949
$O_6 =$	26·82	26·820
	100·00	99·833

6. Hippurate of ammonia, NH_4O, $C_{18}H_8NO_5+HO$, $C_{18}H_8NO_5$.

	Theory.	Found.
$C_{36} =$	57·6	57·509
$H_{21} =$	5·6	6·017
$N_3 =$	11·2	10·984
$O_{12} =$	25·6	25·600
	100·0	100·110

7. Morphine, $C_{34}H_{19}NO_6$.

	Theory.	Found.
$C_{34} =$	71·57	71·742
$H_{19} =$	6·66	6·591
$N =$	4·91	5·011
$O_6 =$	16·86	16·860
	100·00	100·204

8. Narcotine, $C_{46}H_{25}NO_{14}$.

	Theory.	Found.
$C_{46} =$	64·61	64·483
$H_{25} =$	5·85	5·834
$N =$	3·31	3·101
$O_{14} =$	26·23	26·230
	100·00	99·648

9. Asparagine, $C_8H_8N_2O_6$.

	Theory.	Found.
C_8 =	36·364	36·195
H_3 =	6·060	5·985
N_2 =	21·212	21·009
O_6 =	36·364	36·364
	100·000	99·553

10. Oxalate of ammonia, NH_4O, C_2O_3+2HO.

	Theory.	Found.
C_2 =	19·35	19·123
H_6 =	6·45	6·805
N =	22·58	22·557
O_6 =	51·61	51·610
	100·00	100·095

11. Nitrate of ammonia, NH_4O, NO_5.

	Theory.	Found.
H_4 =	5·0	5·244
N_2 =	35·0	34·876
O_6 =	60·0	60·000
	100·0	100·120

12. Nitrate of potassa, KO, NO_5.

	Theory.	Found.
N =	13·833	13·956

In analyzing the latter substance, it was mixed with carbon obtained by exposing crystallized sugar to a high temperature in a close vessel.

Among the advantages this process of analysis presents may be enumerated the following:

I. The saving of material and time; a single combustion sufficing where two have formerly been found necessary. Where properly conducted two complete analyses can be performed in a day.

II. Its general applicability, which as would appear from the substance analyzed to have the very widest range and to include the most diversified combinations of nitrogen with other elements.

III. The complete oxydation, even of those substances presenting the greatest difficulty in this respect, is perfectly secured, as the combustion is completed in a stream of oxygen gas.

IV. As an additional recommendation may be considered the circumstance that where a loss of carbonic acid has occurred during the combustion, either on account of the potassa becoming too nearly saturated, or a momentarily too rapid oxydation of the substance, this loss may be ascertained, added to the carbonic acid already found, and the analysis thus made satisfactory. As this carbonic acid is to be found in the gasometer, it is simply necessary to introduce a potash ball into the eudiometer and, from the contraction resulting, calculate the amount of carbonic acid present. I have in several instances had an opportunity of proving the value of this supplementary determination, and at the same time of saving analyses otherwise worthless.

In closing, I would acknowledge, with thanks, the valuable aid rendered me during the above investigation, by my assistant, Dr. G. Seelhorst.

Nuremberg, Bavaria, Sept. 15, 1865.

ART. VIII.—*On a new Process for the determination of Sulphur in Organic Compounds, by combustion with Oxygen Gas and Peroxyd of Lead;* by C. M. WARREN.[1]

IN my former communication "On a Process of Organic Elementary Analysis by Combustion in a Stream of Oxygen Gas,"[2] I treated exclusively of the determination of carbon and hydrogen in volatile liquid hydrocarbons,—my experiments up to that time having been confined to the analysis of substances of this class. It was my intention, however, to have applied the process before this to other classes of bodies, and especially to have tested its applicability, with suitable modifications, for the analysis of organic substances containing other elements.

Other work with which I was then occupied, and to which this process was only incident, as already stated in the paper referred to, has prevented me from extending the research beyond the requirements of my other investigations.

Having recently had occasion to determine sulphur in some volatile liquid compounds, for which neither of the processes now in use seemed satisfactorily adapted, I was naturally led to make an effort to utilize my safety-tube and the stream of oxygen in this species of analysis also. But the fact that sulphur is usually, at least, but partially converted into sulphuric acid by combustion in oxygen gas seemed at first to present a difficulty not to be easily overcome. It soon occurred to me, however, that the well-known reaction between sulphurous acid and peroxyd of lead, by which the former is completely converted into sulphuric acid, might probably serve to remove this objection. Furthermore, that, by placing the peroxyd of lead within the combustion-tube in the manner which I shall presently describe, and by maintaining the peroxyd of lead at a temperature sufficient to prevent condensation of water within the combustion-tube, the carbon, hydrogen, and sulphur might all be determined from the same portion of substance. This result has been accomplished.[3]

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[1] From the Proceedings of the American Academy, March, 1865.

[2] Proceedings of the American Academy, 1864, p. 251.

[3] Carius (Annalen der Chemie und Pharmacie, 1860, cxvi, 28) has observed that when substances rich in sulphur are burnt with oxyd of copper—a tube containing peroxyd of lead being placed between the chlorid of calcium tube and the potash bulbs in the usual manner—the determination of carbon is too high. And on the other hand he found that, with substances rich in carbon, the determination of the carbon was too low. In the latter case, the peroxyd of lead was supposed to absorb and retain carbonic acid; and in the former, sulphurous acid was found to pass unabsorbed through the peroxyd of lead.

The incomplete absorption of the sulphurous acid may be reasonably accounted for on the supposition that a channel was formed, by handling or jarring, along the top of the peroxyd of lead, which indeed would be very likely to occur in using, by

Referring to my former paper above mentioned for details regarding the construction and use of the apparatus employed, I need here describe only such modifications as have been found expedient to adapt the process to this special purpose.

1.

The combustion-tube being packed with pure asbestus betweeen the points *a* and *b*, fig. 1, and the space—about two inches in length—between *b* and *c* left vacant, a plug of pure asbestus is placed at *c*, and the space between *c* and *d*, about three or four inches in length, then filled with a mixture of pure asbestus and peroxyd of lead, and finally a plug of asbestus is placed at *d*. As the sulphuric acid formed is to be absorbed by, and finally determined from, the peroxyd of lead,—in order to obviate the necessity of treating the whole of the asbestus in the tube to obtain the sulphuric acid, which would be troublesome, and at the same time preserve the asbestus packing in the posterior part of the tube in a fit condition for future use,—it is important that the asbestus plug at *c* should be packed closely enough to prevent any particles of the peroxyd of lead from passing back of this plug.

As already stated, the object of mixing asbestus with the peroxyd of lead is to prevent the formation of a channel along the top. In this manner but a short column of the mixture of asbestus and peroxyd of lead will suffice to secure complete conversion of the sulphurous acid. The combustion is conducted precisely as for the determination of carbon and hydrogen alone, except that the portion of the tube which contains the peroxyd of lead is maintained at a gentle heat, sufficient to prevent condensation of water in that part of the tube and at the cork, but avoiding a temperature which would decompose the peroxyd of lead. As usual, the water formed is absorbed in a chlorid of

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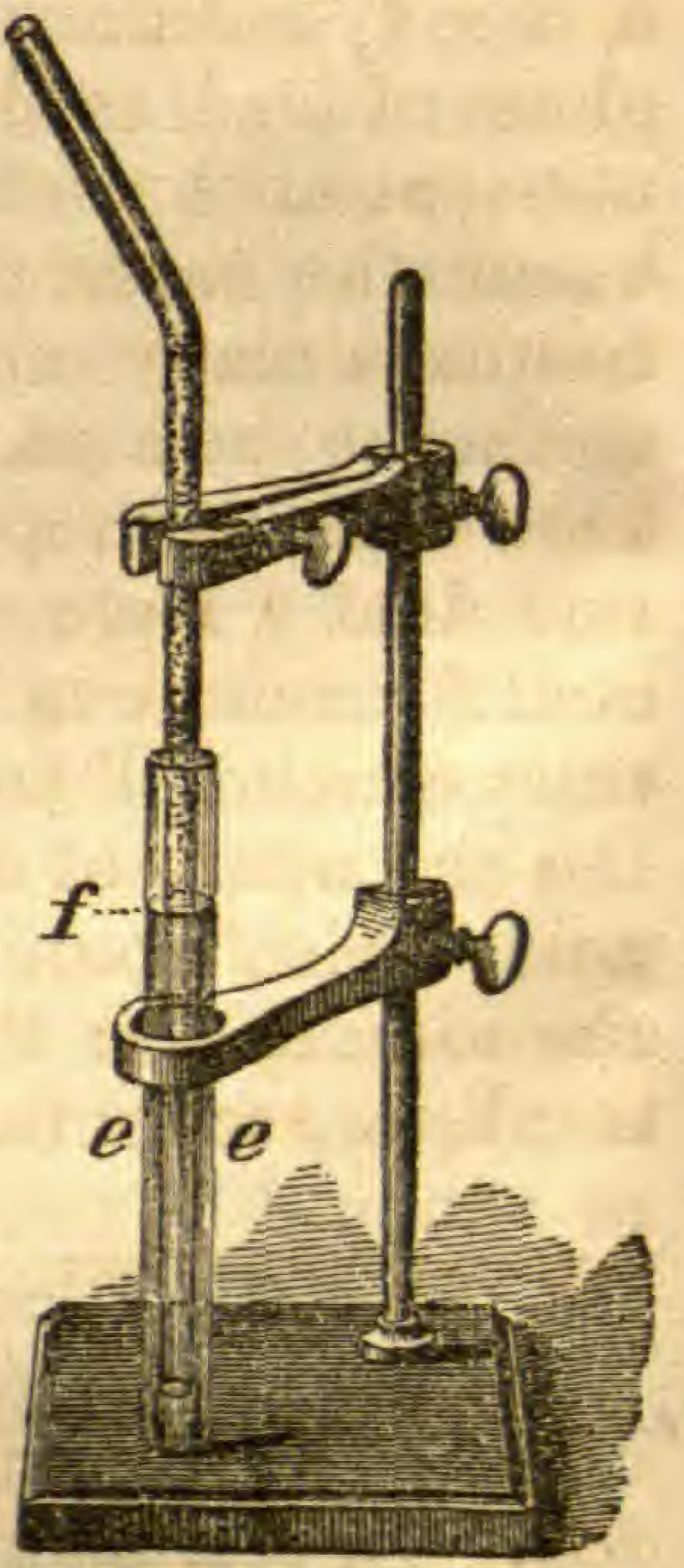
itself, so heavy a powder. Through such a channel sulphurous acid might pass, in so small proportion, without coming in contact with the peroxyd of lead. It will be seen that the liability to the formation of a channel is obviated in my process by mixing the peroxyd of lead with a large proportion of asbestus. The asbestus serves also to increase the porosity of the mass, and in this manner also to lessen the chances of escape of sulphurous acid without coming in contact with the peroxyd. I may here add that, in making the combustion with oxygen in presence of asbestus, the quantity of sulphurous acid which reaches the peroxyd of lead is by no means very large. In a preliminary experiment, in which carbonate of soda was employed instead of peroxyd of lead, (the substance burnt being bisulphid of carbon), the carbonate of soda was found to contain within about 9 per cent of the equivalent of sulphur; and a portion of the deficiency it is not unlikely may have been taken up by the impure asbestus that was employed in this instance.

Concerning the other source of error in the determination of carbon which Carius mentions, it will suffice to remark that, in my process, the peroxyd of lead is kept at so high a temperature that the absorption of carbonic acid appears to be prevented.

calcium tube, and the carbonic acid in Liebig's potash bulbs with a mulder tube attached.

After the close of the combustion, when the tube shall have sufficiently cooled it is carefully removed from the furnace, the mixture of peroxyd of lead and asbestus cautiously drawn out into a beaker glass, by means of a bent iron wire, and the tube then inverted within another tube, *e e*, closed at one end, as shown in fig. 2. The mixture of peroxyd of lead and asbestus contained in the beaker glass is now treated with a strong solution of bi-carbonate of soda, and left to stand for about twenty-four hours, with frequent shaking.[5]

2.



Solution of bi-carbonate of soda is also poured into the tube *e e* until the level of the liquid shall have reached a point, *f*, on the combustion-tube, a little above that which was occupied by the plug *c*, and this is also left to stand as the other. After the lapse of sufficient time for the reaction to be completed, the solution is filtered from the asbestus mixture, including also the solution in the tube *e e*, and not omitting to carefully rinse out the anterior portion of the combustion-tube. The asbestus mixture upon the filter is then thoroughly washed, the filtrate concentrated by evaporation, and the sulphuric acid precipitated with chlorid of barium.

The following results of analyses of bi-sulphid of carbon indicate the degree of accuracy afforded by this process.

The preparation employed was commercial bi-sulphid of carbon, which was first subjected to re-distillation.

Analysis 1. 0·1414 gram of bi-sulphid of carbon gave 0·0806 of carbonic acid, and 0·8592 of sulphate of baryta.

			Calculated.	Found.
Carbon,	C	6	15·79	15·61
Sulphur,	S_2	32	84·21	83·70
			100·00	99·31

Analysis 2. 0·274 gram of the same substance gave 0·158 of carbonic acid, and 1·6768 of sulphate of baryta.

			Calculated.	Found.
Carbon,	C	6	15·79	15·73
Sulphur,	S_2	32	84·21	84·05
			100·00	99·78

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[5] H. Rose, Chimie Analytique, new French edition, p. 662.

Analysis 3. In this analysis, in which I was prevented from determining the carbon, 0·1537 of bi-sulphid of carbon gave 0·9461 of sulphate of baryta, corresponding to 84·5 per cent of sulphur.

The mixture of asbestus and peroxyd of lead employed was of that which had already been used in the preceding analyses, and may possibly have contained a trace of undecomposed sulphate of lead, as the per-cent of sulphur found in this case is 0·3 per-cent above, while in the preceding analyses it was a fraction below the theoretical quantity. Trusting, however, that the results already obtained will be deemed sufficient to show the method to be a good one, I have not thought it advisable at this time to further repeat the analysis of this substance. I may here state that I have already applied the process in the analysis of bodies containing hydrogen, and have obtained satisfactory results which will soon be published.

The important advantage thus gained of being able to determine the different elements from the same portion of substance, considering also the simplicity of the process, can hardly fail, I think, to secure for this preference over the older methods.

ART. IX.—*Description of an Automatic Registering and Printing Barometer;* by G. W. HOUGH, A.M., Director of the Dudley Observatory.

THE science of meteorology is as yet in its infancy. Universally interesting as its phenomena have ever been, and powerfully affecting the most important relations of society, it is but recently that the subject has engaged the systematic and combined effort requisite for its development, since its laws are still regarded as the most recondite problem in Physics. The first thing to be done is of course the collection of facts, and much is now being done in England and on the continent in this direction. The chief obstacle, hitherto, has been in the imperfection of the methods of observation. The results, in order to be of value as data from which to construct a science, should present a *continuous* record of the phenomena during a considerable period of time, and taken at as many different stations as possible. By the ordinary method of personal observation, this is well nigh impracticable. It would demand at every station the services of several observers, at great expense, and their results could only at best be more or less of an approach to what is desired. To obtain this, the only alternative is to substitute some mechanical means for the labor of personal observation; in short, to make the instrument record its own changes. If this can be done in a single instance, it can be done continuously.

The only method by which this has been hitherto attempted with success has been by the application of photography. This, though a very considerable advance, and probably all that could be desired in respect of continuity and accuracy of the record, is liable perhaps to the objection that it is too complicated a process for general use. If we consider the skill requisite in the preparation of the paper, the delicacy of manipulation involved by the apparatus, and the labor of interpreting the results, as compared with the average capacity and means of the great number of observers desired and likely to volunteer or be employed for such a purpose, it would seem that a simpler process is both desirable and necessary. This it has been my intention to furnish, and with what success remains for time and experience to determine. The importance of the subject will justify me perhaps in presenting some account of the new method.

The problem to be solved, was to cause any meteorological instrument, by means of suitable mechanism, simply and effectually to record its own changes. The instrument selected for experiment was the barometer. When any delicate instrument is made to record its own changes by mechanical means, the chief difficulty is that of getting sufficient power for the mechanism attached to make a distinct and continuous record, without taking a perceptible amount of force from the instrument itself, and thereby vitiating the results. The use of electricity naturally suggested itself as the best means of overcoming this obstacle. This agency has not as yet been made economical or certain as a motor, but is chiefly valuable in controlling power obtained through some other means. By it, as may be seen in its application to clock work, and in the telegraph, the movements of one machine may be reproduced in an other with no greater expenditure of force than is requisite for electrical contact. In the cases cited, however, the motion to be reproduced is sensibly uniform and in the same direction. For the solution of our problem, a mechanism is demanded that shall repeat the changes of the original in every form, whether the motion be uniform or variable, forward or reverse.

The feasibility of this plan was discussed with my friend Mr. Thomas Simons as early as the year 1862, and some steps were then taken to apply it to the thermometer. I may here express my acknowledgments to Mr. Simons for valuable suggestions in the construction of the present machine. Various plans were considered for effecting the electrical contact with the fluctuating medium which is the basis of this method. It was at first proposed to do this at the surface of the mercury in a siphon barometer, by means of a platinum wire which should be carried continually toward the mercury surface by suitable mechanism, and on touching the surface, a galvanic current would be formed which should operate by an electro-magnet on the mechanism so as to reverse the motion of the wire and break the circuit. This would be immediately restored by the normal movement of the mechanism, and thus the point of contact would be kept oscillating *at* the surface continually. The consumption of battery power by this plan would have been considerable, and it was thought the oxydization of the mercury by the electric circuit would in time be appreciable. It was therefore concluded to make the connection outside of the barometer tube, by means of a float resting upon the mercury column. By this plan there is no demand of action from the battery until some change takes place in the barometer, and a considerable saving of battery elements is effected.

Attention was then given to determining the degree of delicacy with which changes of the mercury surface could be represented by this process. It was found by experiment that a motion of less than ·0005 of an inch was readily shown, a quantity within the limits of reading of a first class standard barometer.

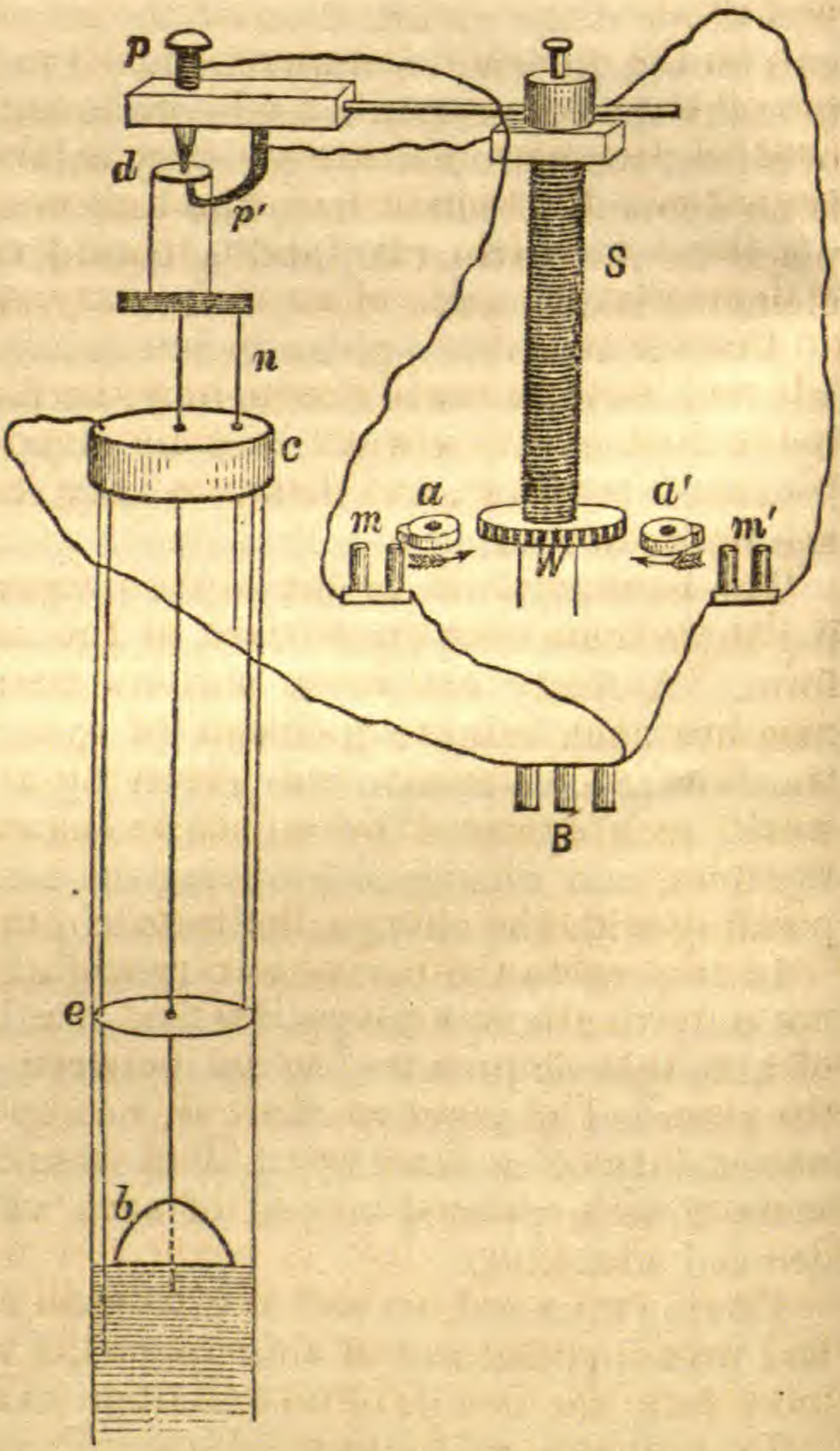
The next step was to devise the proper mechanism for repeating the motion thus transferred, and recording it in some legible form. A finely cut screw was considered as best adapted to measure such minute intervals of space. To this screw a forward or reverse motion was given by a double system of clock work, each operated by an electro-magnet in connection with the float, and raising or lowering the screw by intervals corresponding with the changes indicated in the mercury column.

In respect to the permanent record of results, it was decided not only to attempt the production of a linear diagram or curve of atmospheric pressure, as an interesting method of presenting the recorded changes to the eye, but to avoid the tedium and uncertainty of measuring up such results, by producing at the same time a printed record of such variation, to any extent deemed advisable.

Having thus endeavored to give some conception of the design and principal features of this method, I will proceed to explain more fully the details of its execution as at present arranged.

In order to make any self-recording machine of this kind practicable, we need to attend to two points. First, to reduce the consumption of electricity to the smallest possible amount consistent with certainty in the results; and secondly, to secure the greatest amount of useful work with the minimum of labor. We at once decided to adopt the "make" circuit; for so long as there is no motion, there will be no consumption of battery elements. The battery which we have adopted for recording transits is essentially that of Daniell; sulphate of copper being the exciting agent. A battery of this kind will maintain sufficient power for chronographic records for two or three months, without being cleaned; it being only necessary to add a little sulphate of copper and water from time to time, to supply the necessary waste. The only power demanded of the electro-magnets is the unlocking of the mechanism, which is driven by weight power.

1



In fig. 1, we have a sectional view of the lower leg of the siphon, showing the principle on which this method is based. It may be necessary to remark, however, that the electro-magnets and battery do not occupy these positions in reality, but are placed here for convenience of illustration.

Let B = battery.
" m, m' = electro-magnets.
" a, a' = wheels having one tooth, and revolving in the direction of the arrows.
S = screw supporting the arm, carrying two wires, p, and p' tipped with platinum.
d = platinum disk carried by the float b.

The two wires, p, p' are respectively above and below the center of the disk d.

W = wheel with 40 teeth in which is inserted the screw S.
n = a small steel wire passing through the brass cap c, to prevent the disk d from revolving.
e = an ivory disk inserted in the tube, to prevent the float b from rubbing against the sides of the tube.

Now suppose the mercury should rise in the short leg of the siphon, as represented in the figure. The float b will be raised, and cause the platinum disk d to come in contact with the point of the platinum wire p, closing the circuit through the electro-magnet m; the armature of which being attracted, unlocks the clock-work, and allows the wheel *a* to make a complete revolution. By this means the wheel W is advanced one tooth, which raises the screw S the $\frac{1}{2000}$ of an inch, and consequently carries the point *p* that distance away from the disk *d*.

As long as the mercury rises, the magnet *m* will be operated, and the platinum point *p* will be kept the $\frac{1}{2000}$ of an inch above the disk *d*.

If, on the contrary, the mercury falls in the siphon, the under side of the platinum disk *d* will be brought in contact with the point of the wire *p′*, thereby closing the circuit through the magnet *m′*; the armature of which allows the one tooth wheel *a′* to make a complete revolution, thereby causing the screw S to be depressed the $\frac{1}{2000}$ of an inch, carrying of course, the platinum point *p′* with it.

It will now be readily seen how the platinum disk *d*, carried by the float *b*, may always be maintained midway between the two points *p* and *p′*, and distant a little less than the $\frac{1}{2000}$ of an inch from each.

The barometer is of the siphon form; the inside diameter of the portions near the surface of the mercury is nearly one inch. The upper and lower portions were made from the same glass tube, the two being connected by a tube of smaller diameter. The experiments and observations, so far, indicate that there is no appreciable difference in the size of the two legs of the siphon.

The float *b* is of ivory; the form a paraboloid of revolution. The under side of this float is very slightly concave. The diameter is one-tenth of an inch less than the inside diameter of the tube, so that there is no friction between the sides of the float and glass. The platinum disk *d* is supported by a steel wire passing through a brass cap *c* fitted on the top of the tube, and an ivory disk *e* inserted at a distance of 2½ inches above the float *b*. The ivory disk is connected with the brass cap by means of two wires, so that it can readily be removed. A light steel wire *n* passes through a hole in the cap, for the purpose of preventing the disk *d* from revolving. This is made sufficiently free to prevent any friction.

The disk *d* is made of brass one-half an inch in diameter, and is covered on both sides with platinum plates.

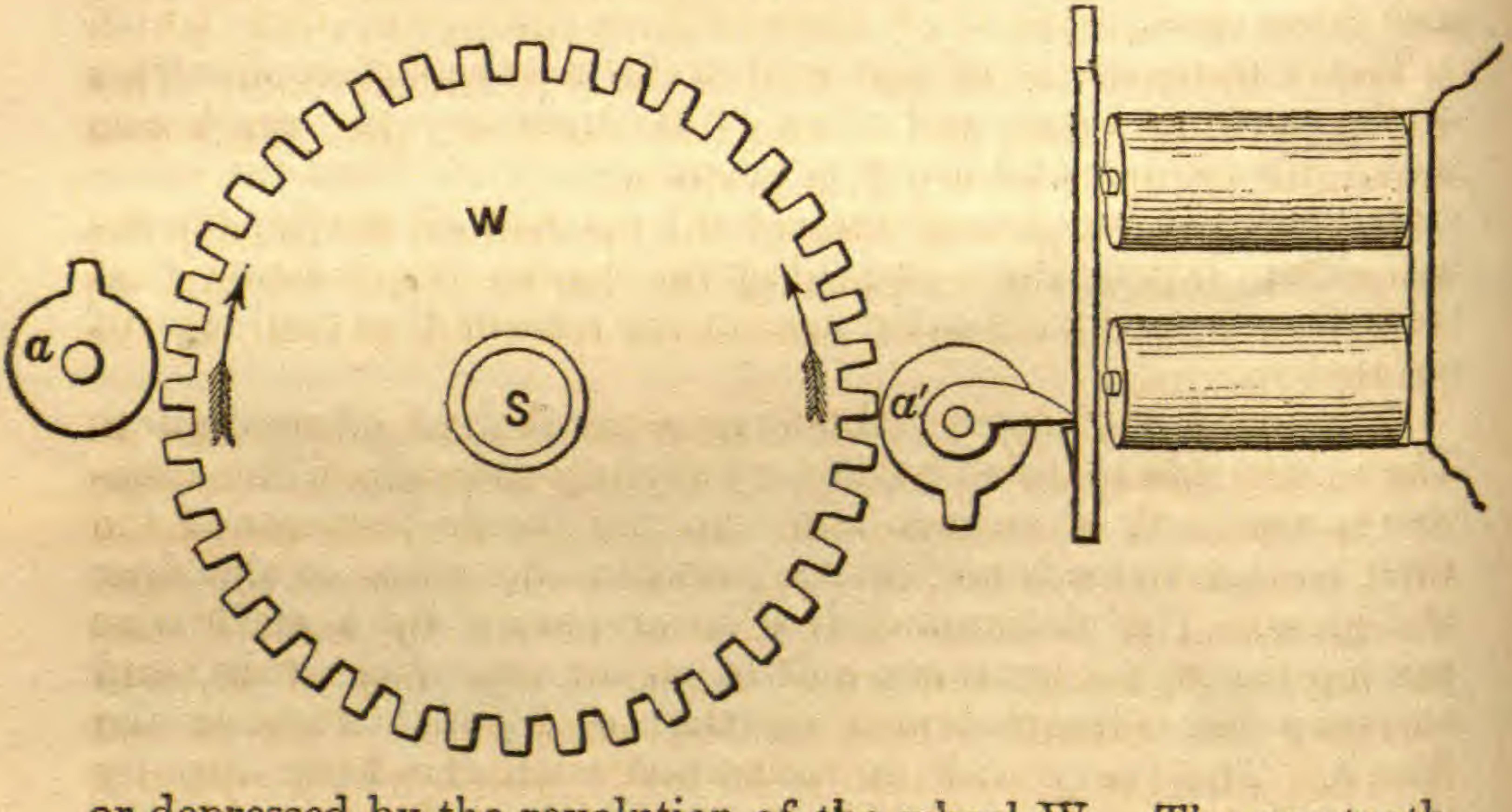
The wire *p* is attached to a fine screw, for adjusting the distance of the points *p* and *p′* from the surface of the disk *d*.

These wires *p* and *p′* are, of course, insulated by being attached to an ivory block, as shown in the figure. The wires from these points are led to the top of the screw S, where they are fastened to an ivory block, after which they are connected with the electro-magnets *m*, *m′*.

A platinum wire is inserted in the side of the barometer tube, and passes down in the mercury on the side of the float *b*. This wire is also connected with one pole of the battery.

The principle employed for giving motion to the screw S, which follows the fluctuations of the mercurial column, has been taken from the stop work long used on clocks. The barrel of a clock on which the cord is wound usually has a one-tooth wheel on its axis; and at every revolution of the barrel, a cog wheel is made to advance one tooth. This cog wheel is, of course, always detached from the barrel tooth wheel, except when in the act of advancing the tooth. In fig. 2, we have a vertical view of a portion of the mechanism, showing the method of communicating motion to the screw S. The one tooth wheels, *a a'*, when at rest occupy the positions as shown in the drawing; and being detached from the cog wheel W, it is free to move in either direction. The screw S, which is shown in fig. 1, is raised or depressed by the revolution of the wheel W. The one-tooth wheels *a* and *a'*, moving in the direction of the arrows, give opposite motions to the wheel W; the office of *a* being to elevate the screw, and of *a'* to depress it, corresponding to the fall and rise of the mercurial column.

2.



The mechanism for giving motion to the wheels *a* and *a'* is ordinary clock work, each being directly acted on by the barrel wheel, which is driven by a weight. One revolution of the barrel corresponds to twelve of the wheels *a* and *a'*. The axles, to which are attached *a*, *a'*, carry another wheel having a single half-tooth, as shown in the drawing, fig. 2, which, resting against a little projection on the armature of the magnet, holds the wheel in the position as shown in the figure.

In order that the wheels *a* and *a′* may not revolve with too great rapidity, a train of clock work is connected, consisting of two additional axles, a fan being attached to the latter, by means of which the motion can be regulated to any desirable velocity. Three axles would undoubtedly be sufficient, the barrel axle, the axles *a*, *a′*, and an additional one for the fan. We adopted the present form, because we happened to have a couple of clock movements at hand, and used them just as they were.

In order to prevent the cogs of the wheels *a*, *a′*, from coming to the circumference of W at the same time, during rapid oscillations of the barometrical column, two circuit-"breakers" were connected; so that, at every revolution the circuit is interrupted, and neither wheel can revolve until they both are at rest.

Fig. 3 is a perspective view of the apparatus as it is when in operation. The frame work for supporting the barometer tube and other mechanism is of black walnut two inches thick, which is firmly fastened to the east wall of the west transit room. This wall is built of brick, and is two feet thick, so that the whole apparatus occupies a very firm position.

Having given a general idea of the mechanism for causing the screw S to follow the motions of the barometrical column, we will show how the curve of pressure is recorded, as well as the printed results.

The wheel W, fig. 2, which receives the impulses, has 40 teeth; and the screw S, having 50 threads to the inch, one tooth of the wheel W corresponds to the $\frac{1}{2000}$ of an inch change in the barometrical column, or $\frac{1}{1000}$ of an inch change of pressure. To the wheel W is attached another of nearly the same diameter, having 80 teeth; this wheel is geared into one of 40 teeth carrying an 80-tooth wheel on the same axle. This second 80-tooth wheel is geared into a 50-tooth wheel, which operates the screw S′, fig. 3, of 26 threads to the inch. To this screw is attached an arm, carrying a pencil which traces the curve of pressure on the revolving cylinder *o*.

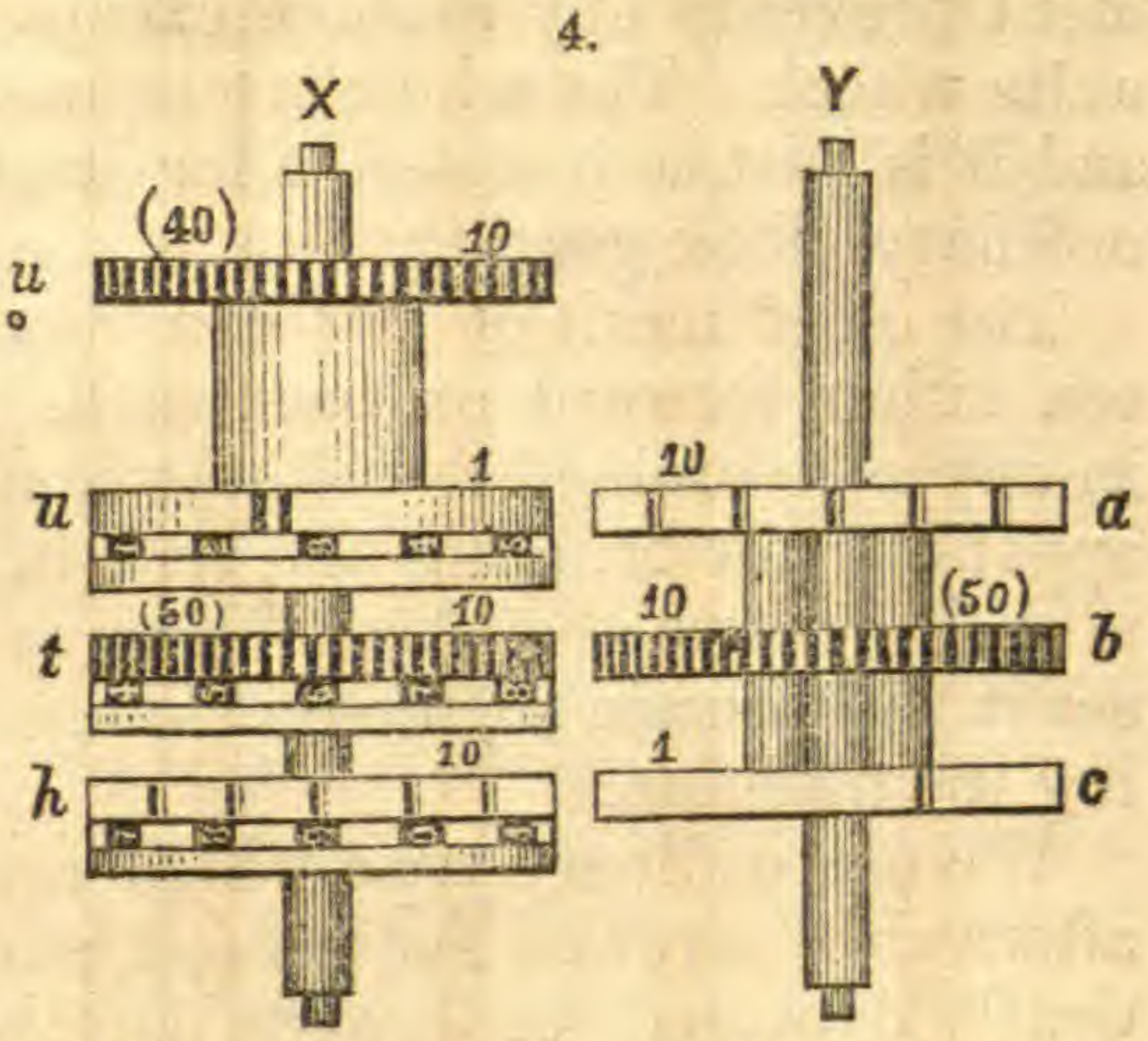
From this arrangement, the curve is magnified a little more than three times the barometrical pressure. It would have been an easy matter to adapt the second screw and cog wheel, so that the curve would be exactly an integer scale—say 1, 2, 3 or 4 times; but as our printed results may be obtained much more accurately, and as often as is necessary, it was not thought of sufficient importance to construct a screw especially for this purpose.

We will now explain the mechanism for printing the results.

3.

A sectional view of the combination is shown in fig. 4, where X and Y are two vertical steel axles. The final result expressed in thousandths of an inch, is found on the axle X, where *u* is the units wheel, *t* tens, and *h* the hundreds; or where the thousandth of an inch is the unit of measure, *u* will represent thousandths, *t* hundredths, and *h* tenths of an inch.

4.



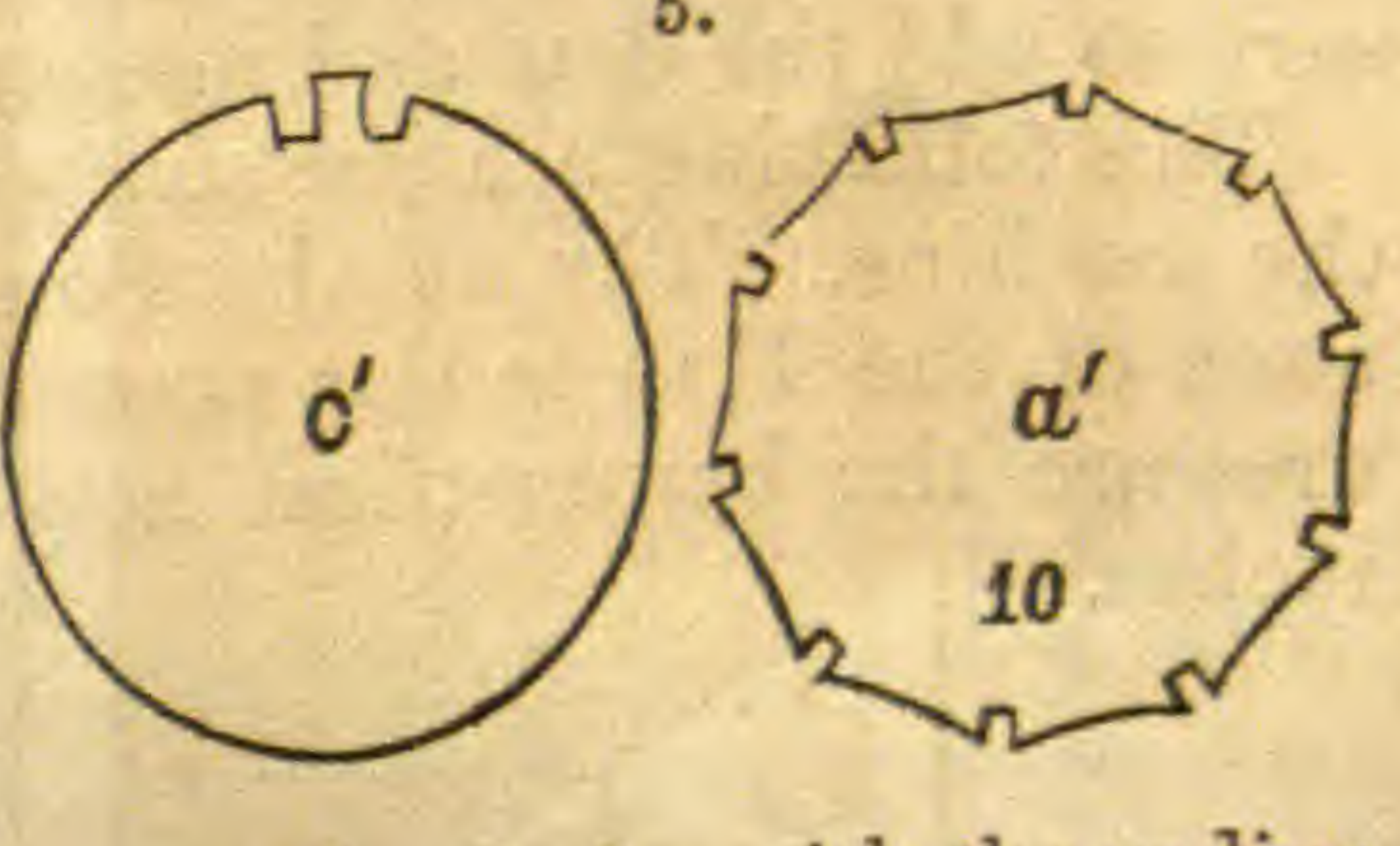
The wheel u_0 may be supposed to have ten teeth, and is connected with *u*, so that they move together. If motion be given to u_0, so that it move one tooth at each impulse, each tooth will represent the $\frac{1}{1000}$ of an inch; and ten impulses, or a whole revolution, will represent the $\frac{1}{100}$ of an inch. The wheel *u* has one tooth, and the wheel *a* on the axle Y has ten teeth. Now when *u* has made a complete revolution, it will have advanced *a* one tooth or one-tenth of a revolution; consequently the wheel *a* will always express the hundredths.

In order to transfer the motion of *a* to the axle X, we fasten to *a* the wheel *b*, having ten teeth; and by gearing this in the wheel *t*, having ten teeth also, we transfer the motion of *a* to *t*, hence we have the thousandths and hundredths expressed on the wheels *u* and *t*.

But let us go a step further, and see how we get our tenths. The wheels *a*, *b*, we have shown, indicate the hundredths; we therefore attach to them another wheel *c*, having one tooth. Let the wheel *h* of ten teeth be placed opposite. Now when the axle X, carrying the wheels *a*, *b*, *c*, has made one complete revolution corresponding to one tenth, the wheel *h* will have advanced one tooth; consequently the tenths will be represented on the wheel *h*.

It is of course understood that the wheels *u*, *t*, *h*, are separate, and free to move about the axis X. By repeating this combination, we can employ any number of figures we choose.

5.



The wheels *u*, *h*, *a* and *c*, are made after the plan employed in the stop work in a chronometer. In fig. 5, *a′* and *c′* indicate this form of gearing. It is seen that the teeth of one wheel are cut in the arc of a circle, with the radius equal to that of the wheel into which it gears. This arrangement prevents any motion, except it be communicated by the units wheel. The whole mechanism is therefore locked together, and it is just as impossible for it to get out of order as it is for ordinary clock gearing.

The chief merit of this combination is, that it will carry for ten either forward or backward. This principle is necessary in any meteorological printing instrument. We need no extra apparatus for bringing the type in line, since if the mechanism is well constructed, it will always arrange itself. When once set it will remain so, for no change can be made without ungearing the machine.

We use ordinary type which are set in separate disks, being afterwards screwed fast to *u*, *t*, and *h*. In case a type is accidently damaged, or broken, another can be inserted in a few minutes. Steel type would undoubtedly be the best, as being more durable and less liable to damage. We should add, that the wheels *t* and *b* have each 50 teeth; five teeth being moved at one impulse.

The printed results are received on the strip of paper *j*, moved by the clock-work *k*, fig. 3, which at the same time regulates the revolving cylinder *o*, on which is traced the curve of pressure. This same clock raises a small hammer *h*, by means of a screw or spiral on the minute wheel arbor, which at every revolution is allowed to strike the small cushion *i*, by that means leaving the impression of the type on the paper strip. In order to secure greater distinctness in the printed results, without employing much power to make the impression, a strip of duplicating impression paper is inserted between the type and ordinary sheet of white paper.

We are not limited in our printing to hourly records, but they can be obtained as often as it is desirable, by supplying the additional power required to raise the hammer. The clock for moving the printed slip and cylinder is an ordinary half-second's pendulum, which we happened to have at hand. It was not thought necessary to print the integer number of inches, nor the time; for the paper slip has the time already printed on the side, so that when the record of the day is completed, it is only necessary to add the date and integer inches.

The following is a *fac simile* copy of the record as printed by the machine. The numbers on the left hand are the hours from noon of the 11th to the noon of the 12th. The remaining figures are the barometrical heights expressed in thousandths of inches.

DUDLEY OBSERVATORY.

May 11*th*, 1865.

Time. HOURS.	Barometer. 29 *in.*		
0	7	0	4
1	6	9	6
2	7	0	9
3	6	8	8
4	6	9	2
5	6	8	1
6	6	9	0
7	6	8	9
8	6	8	0
9	6	6	2
10	6	5	8
11	6	7	0
12	7	3	6
13	7	0	0
14	7	0	1
15	7	1	8
16	7	7	6
17	7	8	3
18	7	8	4
19	7	8	9
20	7	9	0
21	7	8	3
22	7	8	5
23	8	0	1
0	8	0	4

One of the peculiarities of this method is, that we can print our results at any number of places, provided we have telegraphic communication. One standard barometer may be made to record its indications at fifty different points at the same instant.

The accompanying lithographic sheet exhibits a few of the more remarkable diurnal barometric curves as recorded by our apparatus. The first three curves belong to the scale as given at the top of the sheet; the remaining ones to that given at the bottom. The height of the barometer is given for noon of each day. The scale of the curve is 3·077 times the barometric pressure. From these data, the barometric height for any other time can be deduced.

The following remarks will show the apparent atmospheric condition at the time.

May 10th. Bar. 29·91 in. Cloudy, a light breeze from the south. The violent agitation of the barometrical column, clearly indicates an approaching storm. The small amount of depression, however, shows that this storm will not be very violent at the place of observation.

We may here remark, that a few months observation by this method, has led us to surmise, that the barometer as a weather indicator, does not depend so much upon the amount of the variation, as upon its quality. If the barometer is depressed 0·2 or 0·3 of an inch, and the curve is smooth and regular, it does not indicate a sudden change. But, if the curve exhibits a violent tremor, it may be taken as a good indication of an approaching storm. In how far these views are correct can only be determined by a long series of careful observations.

May 11th. Bar. 29·70 in. The curve is rather a remarkable one, from the fact that apparently there was but little atmospheric disturbance at this place. It shows, however, that the atmosphere was in a violent state of agitation, from 3 P. M. of the 11th, to 4 A. M. of the 12th. During the afternoon of the 11th, the weather was very changeable; clouds were continually passing over the heavens. At 6 P. M. it begain to rain; and continued with intervals of intermission until sometime after midnight. During the afternoon and evening, the wind blew rather strongly from the southwest, but was at no time very violent here. But at other points 200 miles to the east and south of this city, the wind blew a tornado, doing considerable damage to property. At New York, it was most violent between 6 and 7 P. M.

June 26th. Bar. 29·68$^{\rm in}$. Cloudy, a heavy shower of rain followed immediately after the depression at 4 P. M. A violent gale of wind 150 miles to the east, about midnight.

July 16th. Bar. 29·81$^{\rm in}$. Rain after 8 P. M.
July 19th. Bar. 29·69$^{\rm in}$. Rain.
July 26th. Bar. 29·60$^{\rm in}$. Cloudy, light breeze from south.
Aug. 4th. Bar. 29·94$^{\rm in}$. Heavy showers from 6 to 10 P. M.
Aug. 12th. Bar. 29·72$^{\rm in}$. Clear and pleasant.
Aug. 16th. Bar. 29·73$^{\rm in}$. Rain—storm between 6 and 8 P. M.
Aug. 22d. Bar. 29·65$^{\rm in}$. Rain.
Aug. 29th. Bar. 29·94$^{\rm in}$. Clear.
Oct. 17th. Bar. 30·20$^{\rm in}$. Clear.

Oct. 18th. Bar. 30·04$^{\rm in}$. Cloudy with some rain. A violent gale of wind on the night of the 19th; most severely felt along the eastern coast. The observations of the 17th and 18th of October were made at New York city. At 14$^{\rm h}$ the weight for driving the mechanism rested on the floor. The barometer at 9 A. M. of the 19th stood at 29·40$^{\rm in}$.

One great advantage in the use of this instrument consists in the ease with which it may be manipulated. All the adjustments are simple and easily accomplished. Any person could learn, in a few days at most, to keep it in running order, and make any adjustments, should it become necessary from accident or other causes. No chemicals are needed, except the sulphate of copper for the battery, which may readily be procured in any town or village. Every part of the action is visible to the eye of the observer, so that in case any part gets out of order, it will readily be seen.

The screw S, on which the accuracy of the results will in a great measure depend, is, as before remarked, 50 threads to the inch, and was cut by Mr. Charles Fasoldt; and is found to be a very perfect one.

Numerous experiments have been made to test the stability of the float and magnetic connections. It will hardly be necessary to give the results in detail. In case there was no friction of any kind, the float ought always to assume the same position for the same height of the mercurial column. The following is the test we have applied. The electrical contact being broken by the key *l*, fig. 3, the screw S was turned so as to force the float into the mercury 0·010 of an inch; after which, the current was established, and the float was allowed to take up a position of equilibrium. The same thing was repeated, by turning the screw in the opposite direction and lifting up the float. From many trials, it was found that there was rarely a difference of 0·002 of an inch, and usually less than 0·001 of an inch, from the original position. The same test was applied for larger disturbances, viz: 0·020 or 0·030 inches, with nearly similar results. This is not a fair test, however, since these conditions are never realized in practice. From all our experiments so far, we see no reason why the machine should change its zero any appreciable amount, during a whole year or greater length of time.

The following extracts from our record book will best illustrate the stability of the mechanism.

July 4th. The machine was "blocked" for 6 hours. During this time, the barometer rose 0·070 of an inch. After the float assumed its position of equilibrium, the zero of the machine, by comparison with the standard, was found unchanged.

July 20th. The float was screwed up and down 0·200 of an inch, to see if there was any friction. After assuming its position of equilibrium, the zero was found unchanged.

Aug. 17th. Float taken out of the barometer tube to put in a heavier platinum wire. The zero was changed 0·005 of an inch; mostly due to the larger wire displacing a greater amount of mercury.

The daily comparison of the printed records, with the readings obtained from the standard barometer (Fastré), gives for the mean error of a single result ±0·0035 in. This determination is based on the hypothesis, that the error of reading the standard barometer, is zero; which we know is not the case. From many experiments we have found that the error of reading a first class standard barometer may amount to 0·003 of an inch; chiefly due to the uncertainty in bringing the mercury in the cistern to the zero of height. This difficulty we have shown can be obviated by using a magnetic connection.

The results of observations during three months by this method has demonstrated its eminent practicability. The following table exhibits the diurnal variation of the barometer for the months of June, July and August.

The 1st column indicates the hours: 0 hours being noon. The next three columns exhibit the mean height at each hour, for the whole month. The 5th column is the mean for the three months. These numbers are thousandths of inches; the integer inches being 29.

In reducing these observations, 4 days in June were rejected because the records were incomplete. On those days the machine was disturbed to make some alteration, or failed to perform its office. As the method was only first tested during the latter part of April, there were many mechanical details to be attended to, in order to insure certainty and accuracy in the performance of the mechanism. It is now believed, however, that we have overcome all mechanical defects.

Hours.	June.	July.	August.	Mean of the three months.
0	887	787	851	842
1	878	778	838	831
2	867	772	824	821
3	854	764	811	810
4	847	759	804	803
5	Min. 842	754	Min. 803	Min. 800
6	842	Min. 754	806	801
7	846	758	816	807
8	852	764	827	814
9	866	777	838	827
10	869	783	841	831
11	Max.$_0$ 872	Max.$_0$ 787	840	Max.$_0$ 833
12	872	781	Max.$_0$ 842	832
13	869	775	840	828
14	869	770	839	826
15	Min.$_0$ 867	Min.$_0$ 768	Min.$_0$ 839	Min.$_0$ 825
16	872	773	842	829
17	883	783	851	839
18	892	791	866	850
19	899	801	870	857
20	Max .902	810	Max. 870	Max. 861
21	900	Max. 811	869	860
22	896	808	864	856
23	892	804	853	850

733

mean 8305

The results for maxima and minima are as follows:

	Min.	Max.$_0$	Min.$_0$	Max.
June,	5 P. M.	11 P. M.	3 A. M.	8 A. M.
July,	6 "	11 "	3 "	9 "
Aug.	5 "	12 "	3 "	8 "
Mean,	5 "	11 "	3 "	8 "

These results differ somewhat from those heretofore adopted. In how far this is due to the season, or the geographical position, can only be determined from a long continued series of observations. The small differences for individual hours near the times of maxima and minima, even in the mean for a month, show us with what small quantities we have to deal in the determination of the principal points in the diurnal curve. In order, therefore, to arrive at any definite conclusions, it is necessary to secure the most accurate results attainable.

One of the greatest impediments in the prosecution of any branch of physical science, is the large amount of personal labor requisite for the reduction of observations. By our method this labor is reduced to such an extent, that the saving in this particular for a single year, would probably be equal to the original cost of the apparatus.

The present barometer has recently been compensated for temperature, by supporting the tube on a brass rod. Previous to this, the instrument was set to the height given by the standard reduced to 32° Fahrenheit; and differential corrections applied to the printed results.

We propose, however, to construct a siphon which shall have the elements of compensation within itself. My attention was first called to this method by Dr. James Lewis, who has discussed the subject, for a steel siphon, in the September number of this Journal.

The whole theory of a siphon compensation depends on this fundamental proposition, viz: If the atmosphere will support 30 inches of mercury at 0° Centigrade, at 100° C. it will support $30+30\times e=30{\cdot}540$ inches; e being equal to 0·018, the expansion in volume of mercury for 100° C. If now in a siphon barometer, the increased length of the whole column, when the temperature is raised from 0° to 100° C., is equal to $30\times e=0{\cdot}540$ inches; the surface of the mercury in the short leg of the siphon will remain at the same zero of height for all temperatures, at 30 inches of pressure. Put $e'=0{\cdot}016$ the expansion of the mercurial column in a glass tube for 100° C.

Let $2m=$ length of mercury in the equal legs of the siphon in which the diameter is unity.
$l=$ length of intermediate column.
$d=$ diameter of intermediate column.
$h=$ height for which the compensation is to be computed.

Then we have the following general formula:

$$(2m+ld^2)e'=he.$$

It is readily demonstrated that all siphons of the same diameter, in the equal legs, will require the same volume of mercury for compensation.

If the siphon be of uniform diameter throughout, it will require 33·7 inches of mercury to compensate at 30 inches of pressure.

A tube of this form will hardly give a sufficient length of mercury in the short leg. In order to attain the necessary length, we connect the two equal legs with a tube of smaller diameter.

The following values have been calculated, to aid in the construction of a tube:

d.	*m.*	D.	W.
0·70	8·5 in.	0·2 in.	0·62 lbs. Troy.
0·75	7·2 "	0·4 "	2·50 "
0·80	6·0 "	0·6 "	5·61 "
0·85	4·6 "	0·8 "	10·00 "
0·90	3·1 "	1·0 "	15·64 "

The following constants and reductions have been adopted.

$h = 30$ inches, $l = 34$ inches.

D = diameter of the equal legs of the siphon.

W = weight of mercury necessary to compensate.

It will be best to adopt $d=0{\cdot}80$. After the tube is filled to the theoretical height, the whole apparatus can be subjected to different degrees of temperature, in the same manner as the compensation of a pendulum. By reading the standard barometer every quarter hour, during the progress of the experiment, the exact error of compensation can be determined; and by adding or substracting mercury, the compensation can be perfected. In a siphon that is compensated for 30 inches of pressure, the correction for different degrees of pressure and temperature will be very small; since for 1 inch and 100° C., the correction will only amount to 0·018 inches. The largest correction required will rarely amount to 0·004 inches.

The principle of electrical contact, on which this method of recording minute changes in the height of the barometrical column is based, can with equal facility be applied to the thermometer, anemometer and rain-gauge, and the results printed if desirable. The same form of mechanism can be used with all the instruments, with, perhaps, some slight modifications in the details.

Dudley Observatory, Oct. 28, 1865.

Art. X.—*Observations upon Shooting Stars in November*, 1865.

1. *At New Haven.*—On Monday morning Nov. 13th, 1865, a party of four observers, Prof. W. D. Whitney, Mr. C. G. Rockwood, Mr. Isaac Pierson, and the writer, watched for an hour and fifty minutes beginning at five minutes before four. Those meteors whose paths if extended backward were estimated to cut across the area bounded by the stars in the curve of the sickle in Leo, that is, by the stars η, γ, ζ, μ, and ϵ Leonis, were counted as conformable. The following was the result of the count.

From	3^h	55^m	to	4^h 0^m,	that is, in	5	min.	2	uncon.	14	conf.
"	4	0	"	4 15	"	15	"	10	"	51	"
"	4	15	"	4 30	"	15	"	7	"	57	"
"	4	30	"	4 45	"	15	"	13	"	63	"
"	4	45	"	5 0	"	15	"	7	"	39	"
"	5	0	"	5 15	"	15	"	13	"	57	"
"	5	15	"	5 30	"	15	"	12	"	45	"
"	5	30	"	5 45	"	15	"	6	"	34	"
					Total in	110	min.	70	uncon.	360	conf.

This gives a total of 430, or 235 per hour. The sky was very clear over head, except for a short time about five o'clock, but distant clouds interfered in the north and west nearly all of the time so as to conceal nearly or quite one-fifth of the sky in those directions. About 4^h 45^m the clouds in the north and west increased, and during the next quarter hour they probably concealed one-fourth of the meteors. They had some effect also in the next quarter-hour. The moon was shining all of the time, being then three days past the quarter. During the last half hour the twilight was increasing quite rapidly.

The position of the radiant was observed with care. It did not seem to be accurately a point, but rather a small area. The center of this area was very near the center of the curve formed by the stars above mentioned, say in R. A. 148°, Dec.+23°. Its dimensions could be only vaguely determined, but were probably not more than 3° or 4° in any direction.

The proportion of the meteors that left trains was larger than usual. The unconformable ones were in general less bright than those that were conformable. It was remarked that more than usual were to be seen near the horizon.

One brilliant meteor which exploded with a green light between Polaris and the zenith left a train for more than a minute. This train shortened and curled up into a crescent, floating to the *northward*, showing thus the direction of the wind in the higher regions of the atmosphere. Such apparent motion might indeed in this case have been due to a descent vertically of the luminous cloud. But a similar train was seen south of the zenith which moved also *northward*. The two motions are inconsistent with a vertical descent of both trains.

On the same morning Mr. F. W. Russell observed in New Haven by himself, beginning at 3^h 35^m A. M. Between that time and four o'clock he saw 25 meteors. Between four and five o'clock he saw 78, making in all 103 in 85 minutes. During the last ten minutes of the watch the clouds obscured the sky, and the moonlight interfered throughout.

The next night was cloudy at New Haven, and nothing could be seen.

On the night of Nov. 14–15th, twelve students began to count at midnight and saw 186 shooting stars in three hours, 69 during the first hour, 52 during the second hour, and 65 during the the third hour. The clouds interfered somewhat in the second hour, and there was a slight haze along the horizon. Seventy of the shooting stars were reported as comformable. A considerable portion of these, doubtless, belonged to the sporadic meteors.

2. *At Philadelphia.*—Mr. B. V. Marsh observed in Philadelphia as follows on Monday morning:

From	$1^h\ 20^m$	to	$1^h\ 40^m$	that is, in	20 min.	16 meteors.
"	1 46	"	2 0	"	14 "	4 "
"	2 8	"	2 28	"	20 "	13 "
"	2 49	"	3 15	"	26 "	24 "
"	3 15	"	3 31	"	16 "	9 "
				Total in	96 "	66 "

Nearly all were comformable. The position of the radiant was carefully noted and located at R. A. 148°, Dec.+24°. Mr. Marsh observed from a window facing northeast. He estimates that had he been in the open air he would have seen about twice as many, that is, that the hourly number for a single observer would have been about 75.

On Tuesday morning, Nov. 14th, Mr. Marsh with a party watched till after 3 o'clock. He says "the weather was good, and we saw a few meteors, but the Leo shower was evidently pretty much spent—so much so that we did not think it worth while to make a record of what we saw. About as many radiated from near the zenith as from Leo, although the latter group was unmistakably represented."

3. *At Bloomington, Ind.*—On the morning of Monday, Nov. 13th, Prof. Kirkwood alone observed 25 meteors in 20 minutes, between $4^h\ 50^m$ and $5^h\ 10^m$ A. M. Of these 22 seemed to radiate from the vicinity of γ Leonis. "On the evening of the 13th arrangements were made for watching through the night. Prof. T. A. Wylie and myself, assisted by Messrs. J. P. Baker, H. C. Meredith, W. L. Polk, H. V. Ferrell, H. Pope, and W. C. Sandifer, members of the senior and junior classes in the State University, commenced at 8 o'clock, but clouds unfortunately interfered with our observations. From 8 to 9 o'clock however we saw 53 meteors, and from 9 to 10 o'clock 51. At 10 o'clock the heavens had become so nearly overcast that our observations were abandoned."

4. *At Marathon, N. Y.*—Mr. Lewis Swift writes from Marathon, N. Y., on the 13th of November as follows: "From the end of twilight last evening to 10 o'clock I saw no more than are usually visible on clear evenings. I resumed observations again this morning at 5 o'clock and during 45 minutes saw 47 meteors, most of them leaving trains of unusual length and distinctness. The paths of 44 of the meteors if traced backward would meet at a point about R. A. 10^h, Dec.+25°. I think the declination of the radiant is now greater than in 1833. An unusual number were visible near the horizon."

5. *At Cleveland, Ohio.*—Mr. W. H. Palmer, Mr. E. A. Palmer, and Mr. C. J. Dockstader counted on the morning of Nov. 14th at Cleveland, Ohio, the following numbers of meteors:

	W. H. Palmer.	C. J. Dockstader.	E. A. Palmer.
From 12^h to 1^h,	18	11	9
" 2 " 3	30	23	23
			Total, 114

The morning was as clear as could be desired, and the meteors were unusually large and brilliant. Many of them left trains.

On the next morning, in the hour between 1 and 2 o'clock, Mr. W. H. Palmer saw 16, and Mr. H. P. Borden saw 23. About half of them seemed to radiate from Leo.

6. It seems from these observations that the number of meteors visible on Monday morning at five o'clock, by a single observer, may be safely called 75 or 80 per hour. Six-sevenths of these were conformable to the radiant in Leo. On the next morning the number per hour if judged by the Cleveland observations between two and three o'clock was 76 for three observers, which is equivalent to about 30 for a single observer. The two hours give an average of about 23 per hour for one person. Not more than half, according to Mr. Marsh, radiated from Leo.

On the next morning the average number seen by each of the twelve observers at New Haven during the three hours after midnight was 13 per hour. Probably less than one-fifth of these belonged to the November group.

It would seem then that we were nearer the node of the orbit of the bodies on Monday morning than on Tuesday morning, and that on Wednesday morning we had passed nearly if not quite through the group. H. A. N.

ART. XI.—*On Molecular Physics;* by Prof. W. A. NORTON.

[Continued from vol. xl, p. 73.]

Terrestrial Magnetism.—In accordance with the ideas already advanced as to the essential nature of electrical excitation (p. 249) we may conceive that the earth may derive its magnetic condition from currents developed in its crust by the impulsive action of the ether of space upon the molecular atmospheres.[1] Both the

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[1] As intimated in a former part of this memoir, the priority in the publication of the general theory that the earth derives its magnetic condition from its collision with the ether of space is conceded to Professor Hinrichs, of the Iowa State University, and formerly of Copenhagen. But the idea was no less an original one with the author; and his conception of the essential nature of dynamic electricity, and the magnetic condition of the earth, and his physical theory of terrestrial magnetic phenomena, as resulting from the same supposed original cause, are materially different from the views advanced by Professor Hinrichs. It will be seen also that the theory now presented is but the complement to a previous series of researches upon Terrestrial Magnetism, prosecuted, at intervals, through a period of about twenty years; and a natural offshoot from the theory of Molecular Physics propounded in this paper.

rotatory and orbital motions of the earth may be concerned in the production of such currents. The rotation of the earth should develop currents at each point of its surface, starting in a direction parallel to the equator, and flowing from east to west. Also if we consider the points of the earth lying on or near the meridian whose plane passes through the sun, and designate the velocity of the earth in its orbit by V and that of rotation by v, the absolute velocity of the points in question, will be $V+v$ on the side opposite to the sun, and $V-v$ on the side toward the sun. The current in the former case, due to the velocity $V+v$, will run from east to west; and that in the latter case, due to the velocity $V-v$, will run from west to east. The intensity of the former may be represented by $m(V+v)^2$, and of the latter by $m(V-v)^2$. Taking the difference between these two expressions we obtain as the excess of the intensity of the east and west current over the other, $4mVv$. Such then would be the intensity of the effective current at any point, due to the combination of the velocity of rotation and the velocity in the orbit. At points of the earth's surface, at any moment in the vicinity of the meridian at right angles to that just considered, the currents developed, so far as they originate in the tangential action of the ether, will be wholly due to the earth's rotation. At certain distances from this meridian the component of the orbital velocity, in a direction parallel to the surface, will exceed the velocity of rotation; and the current developed, on the side nearest the sun, will run from west to east. East and west currents will therefore be developed at every place during the greater part of any single day, and the opposite current will originate only during a certain interval of time before and after the middle of the day. Also the east and west current will be more intense than the opposite current developed in corresponding positions. At the close of a day a certain resultant current, for each place, should remain, running from east to west. As the obliquity of the ecliptic to the meridian at the hour of noon, at any place, is continually changing during the year, this resultant current must be continually changing its direction. This change of direction may be represented by supposing the current developed each day to lie in a small circle traced around the point 90° from the ecliptic on the meridian 90° from the station, and that this magnetic pole is carried through the geographical pole in the course of a year. Under this idea each place will have its separate oscillating magnetic pole. At the end of a year these diverse directions of current will also have a resultant; and by considering contiguous places it may be seen that these annual resultants will lie, for a certain district, in parallel small circles, having a common pole. If we confine our attention to points on the equator, and suppose the magnetic properties of the crust of the earth to be the same at all points, it is plain that every such pole will coincide with the geographical pole; since the annual resultants would be coincident with the equator. But should the conductibility of the earth be unequal in different directions, the final currents developed in such directions should be unequal, and hence the annual resultants should be variously inclined to the equator, and their poles have diverse positions. At points situated without the equator the unequal intensities of the currents, developed at different seasons of the year, will determine at each locality an annual resultant having a certain direction, generally more or less inclined to the equator.

In what precedes we have confined our attention to the action of the ether in directions tangential to the earth. Such currents should be chiefly of the nature of galvanic currents, that is, proceeding from molecule to molecule. Those which result daily from the combined effect of the two motions of the earth will originate in lines parallel to the ecliptic, and follow the directions (or at least in their mean course) of circles traced around the position of the pole above mentioned, on the earth's surface, on the day considered. These may be called ecliptic currents. The currents due to the earth's rotation alone will be of a similar character, and follow circles parallel to the equator. These two sets of currents, especially the former, play the prominent part in originating and maintaining the normal magnetism of the earth, and determining the secular changes that occur in its distribution. The currents resulting from the earth's rotation, can serve only to maintain a uniform normal condition of such currents previously developed. But the ether of space, also impinges normally upon the forward side of the earth. The principal effect of this mode of action, that we have occasion to consider, will be the origination of a series of waves of translation in the sea of electric ether that pervades the interstices of the molecules, spreading out from the most advanced point of the earth. They may be conceived to consist of an endless number of linear currents radiating in great circles from that point. This description of currents exhibit their effects conspicuously in the daily and annual variations of the declination and directive force of the needle. They conspire with the others, and to a certain extent modify them, and originate similar ones.

It should be added that the more permanent magnetic forces developed by the currents above considered may consist, in a great degree, in secondary currents excited within the molecules of the earth. The author's former investigations accord with this view. In a memoir on Terrestrial Magnetism published in this Journal, vol. iv, p. 1, a theory of the magnetic action of the earth was propounded and discussed, based upon the fundamental assumption that "every particle of matter at the earth's surface, and to a certain depth below the surface, is the center of a magnetic force exerted tangentially to the circumference of every vertical circle that may be conceived to be traced around it." This tangential action, upon the north pole of the needle, was conceived to be directed downward on the north side of the particle, and upward on the south side, (see p. 4 of the paper just referred to). Now if we regard the particles of the earth's crust as so many separate magnets;—magnetized by electric currents, developed as we have been considering,—we are conducted, by an inevitable sequence, to this fundamental basis of the theory in question. For, all such molecular magnets will at each station have their axes perpendicular to the resultant currents traversing that station, to which the magnetization is due. The north end of every such indefinitely small magnet will exert an attractive force upon the north end of the needle, and the south end will exert an equal repulsive force upon the north end of the needle. Since the lines of directions of these forces will not be strictly coincident, their resultant will bisect the outer angle between them, and so be perpendicular to the line proceeding from the center of the molecular magnet. A series of such minute magnets, extending for a small distance will form a magnet of finite length, the entire action of which will be sensibly the sum of the individual actions, and will be perpendicular to the line proceeding from the middle of the magnet. The directive action of the earth will be virtually this.

This being allowed, it follows, as deduced in the former paper, that, except in high latitudes, the needle will be perpendicular to the lines of equal molecular magnetic intensity; also that, the horizontal directive force exerted by the earth will be proportional, or nearly so, at each station, to the molecular magnetic intensity; and the vertical force approximatively proportional to the difference of these intensities on one side and the other of the lines of equal force. It may be added here that the above conception brings our theory into essential correspondence (from the mechanical point of view) with Gauss's; and thus that the conclusions of his memoir become deducible from the present physical theory.

If we conceive the magnetic force of the earth to be wholly due to the *direct* action of the electric currents, circulating from molecule to molecule, the force exerted by each element of the current should be of the same character, and have a similar direction to that in the case just supposed. But, since the resultant currents are shifting their position from year to year, it follows that they may differ somewhat from the lines of equal molecular force. In the sequel we shall, in general, for greater simplicity and distinctness of conception, regard the magnetic action of the earth as due to the primary currents, developed as before explained. If these give place, either wholly, or in part, to molecular currents, the results will be essentially the same.

Distribution of Terrestrial Magnetism.—The inequality in the distribution of the magnetism of the earth, upon the same parallel of latitude, may be supposed to arise from differences of conductibility in different parts of the earth. It is conceivable that such differences may exist as a consequence of the existence of two great systems of continental elevations; and that the magnetic condition of the earth may be represented by supposing that two sets of currents, originating in these elevations, are superimposed upon those which are due to the undisturbed condition of the crust of the earth. But there is another conception that may be formed of the possible origin of the unequal distribution of the earth's magnetism, which does not involve the supposition of unequal conductibility. It is that the present magnetic state of the earth originated at a remote period in the history of the earth, when it was still in the process of condensation, and its period of rotation was much longer than at present. It will readily be seen that at every epoch, during this transition period, in which the period of rotation was the $\frac{1}{n}$ part of the tropical year, *n* being an even number, the same region of the earth's surface would, at the close of each successive year, be, for a considerable interval of time, about the autumnal equinox, on the opposite side of the earth from the sun; and thus would come to be traversed by strong currents running from N. of E. to S. of W. (p. 69):—also that at each successive vernal equinox, the same region would be on the side of the earth turned toward the sun, and therefore in the most favorable position for the currents already developed at the autumnal equinox to be reënforced by the new currents.[1] The systems of currents thus originating, at such successive epochs, would not, in general, be coincident; but it will be seen in the sequel (p. 74) that each system should become subject to a motion of revolution, under the operation of the new effective currents annually developed, and that the annual rate of displacement should be different for each system, unless their currents should be of equal intensity, which would be in the highest degree improbable. Now if the shifting movements of the different sets of currents were unequal, the tendency should have been, in the lapse of ages, to bring them all into coincidence, or to consolidate them into one system in each hemisphere. In the light of Gauss's investigations into the magnetic state of the earth, we may conclude that the earth has actually reached this period of its magnetic history.

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[1] It is here implied that the more effective currents are developed at the equinoxes; in explanation of this see pp. 69, 72.

At the epochs for which n was an uneven number, two systems of currents should have been developed, one at each equinox, and the intensity of each of these would have been much less than that of the single system (the sum of the two equinoctial systems), answering to the epoch when n was an even number. These separate systems of currents should, therefore, by reason of their secular movements, have tended to become incorporated with the other more effective ones, which would have been displaced more slowly.

It will be seen, in another connection, that the magnetic state of the earth experiences certain changes, from year to year,—in response to the varying magnetic and electric condition of the sun's surface. We may then conclude, from our present point of view, that the existing system of magnetic currents should bear the traces not only of the changes through which the magnetic condition of the earth has passed, but also of the mighty changes that have passed over the face of the sun.

From our present point of view we may discern the probable link of connection between the magnetism and the temperature of the earth. In the paper already referred to (p. 63) a mathematical exposition was given of the formal relations subsisting between the principles of magnetism and heat in the crust of the earth, based upon certain mechanical ideas. We have already seen (p. 64) that the fundamental ideas then assumed are in essential accordance with the present theory of the origin of terrestrial magnetism. It may now be added that the mathematical relations shown to subsist, between the intensity of the magnetic action and the temperature, may be seen to have a physical basis. The dependence here alluded to arises from the fact that the electric currents developed by the impulsive action of the ether of space, within the crust of the earth, must, to a certain extent, pass off in the form of heat; and that the earth may derive a large portion of its heat from this source. Inequalities in the mean temperature of the earth's crust, at equal distances from the equator, should result from inequalities of elevation, &c., and from variations in the intensity of the resultant currents traversing the localities. It will be readily seen that, if the inequalities of the mean temperature of the crust of of the earth resulted entirely from the heat developed by the supposed action of the ether of space, the distribution of the temperature and magnetism would entirely correspond; that the poles of greatest cold would coincide with the magnetic poles, and the thermal equator with the magnetic equator.

Periodical Variations of the Magnetic Elements.—In a paper published in this Journal, vol. xix, p. 183; the author undertook to show that these variations are such as should result from two supposed sets of currents, traversing the photosphere of the earth, or two corresponding sets of currents traversing the earth's crust. These currents were called, respectively, *radial*, and *ecliptic;* the radial currents radiating from the region of the photosphere most directly exposed to the impulsive action of the sun's rays, and the ecliptic originating on the side of the earth toward the sun, and in directions parallel to the plane of the ecliptic. We have now to observe, (1.) That the ecliptic currents running from east to west, formerly supposed to be developed in the earth's photosphere, have their counterparts in currents running from west to east in the crust of the earth, and developed by the orbital motion of the earth, on the side nearest the sun. (2.) That the orbital motion of the earth develops, within the mass of the earth, currents running from east to west on the side of the earth opposite to the sun. (3.) The impulsive action of the ether upon the forward parts of the earth, as it advances in its orbit, must originate currents radiating from those regions, over the earth; and will especially give rise, in the early morning hours, to currents running toward the north in latitudes lying to the north of the ecliptic, which will deflect the needle toward the east. Strictly, the two sets of ecliptic currents, the one having an easterly and the other a westerly trend, will be developed, at various points on one side and the other of the circle of intersection with the earth of a plane passing through the most advanced point and the geographical pole. The special currents developed on the circle perpendicular to this, will have the greatest intensity on the side opposite to the sun, as already shown. The effects of the diverse currents, originating in the impulsive action of the ether of space upon the preceding half of the earth, are conspicuously observable in the variations of the declination and horizontal force during the last half of the night and the earlier part of the day. As the day advances, the radial photospheric currents (see this Journal, vol. xix, p. 190) come into more effective action, and greatly modify the magnetic variations that would result from the currents just mentioned. They augment the diminution of the horizontal force in the forenoon and deflect the needle farther to the west at midday.[3] They are also the principal cause of the increase of the horizontal force in the afternoon. The change of the hours of the morning maxima and minima with the seasons, is mainly a consequence of the changes experienced during the year, in the position of the circle of the earth, perpendicular to the radius of the earth's orbit at 6 A. M., with respect to a meridian passing through the most advanced point of the earth's surface, at that hour. The circle in question coincides with the meridian at the two equinoxes; is inclined 23½° to it, on the west side, at the summer

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[3] The special effects here alluded to, and in general the effects referred to in what follows, are those observed in our latitudes.

solstice; and under the same angle on the east side at the winter solstice. In consequence of the change of position of this circle the radial currents tend to alter the critical hours above referred to. For the rest it should be observed that the phenomena all show that the temporary currents by which they are produced, do not come into most effective action until a certain interval of time after the moment of most intense excitation; because, doubtless, of the residual currents that continue in action, with diminishing energy.

The two sets of currents, that have been specified, afford a complete explanation of the observed periodical variations of the declination and directive force of the magnetic needle. In considering their separate action it is to be distinctly observed: (1) that the currents produced in the earth's crust by the impulsive action of the ether of space are developed at each station, between the hours of midnight and noon—though the currents thus excited will be propagated on and produce a certain effect at other stations, before midnight and after noon;—(2) that the radial photospheric currents are chiefly effective between the hours of 6 A. M. and 6 P. M.—though their influence extends, especially during the summer, into the earlier and later hours of the night. In their effect upon the declination, the marked tendency of the first set of currents is to deflect the needle toward the east for a certain interval of time before and after 6 A. M., while the conspicuous tendency of the second is to deflect the needle toward the west for a certain interval about the middle of the day. Another effect of the latter set of currents is, when the sun is north of the equator, to augment the morning easterly deflection produced by the former currents. In their effect upon the horizontal force of the needle, the tendency of the radial photospheric currents is to diminish its intensity between midnight and noon, and increase it between noon and midnight; but these effects are especially produced during the forenoon and afternoon. On the other hand, the other set of currents tend especially to augment the horizontal force, during the latter half of the night, and to diminish it during the forenoon. The morning increase of the horizontal force is more conspicuous during the winter than during the summer months, for the reason that the diminishing action of the radial currents in the morning hours, is greater in summer than in winter.

In studying the *Annual Variations*, we must take note of any changes that may occur during the year in the intensity of the two sets of currents by which all the phenomena are conceived to be produced. In fact both sets of currents have varying effective intensities. In these latitudes the radial currents are most effective toward the summer, and least effective toward the winter solstice;—as a natural result of the varying positions of the point of the earth's photosphere directly underneath the sun.[4] The other set of currents, have a maximum of effective action at the autumnal equinox, and, considered individually, a minimum at the vernal equinox.[5] For at the autumnal equinox the most advanced point of the earth's surface, upon which the impulses of the ether fall normally, will lie 23½° to the north of the equator; and at the vernal equinox it will lie 23½° to the south of it. Owing to the annual change in the intensity of the radial currents, the diurnal variations, both of the horizontal force and declination of the needle, that occur during the forenoon and afternoon, are greater in the summer than in the winter. The maximum variations occur after the summer solstice, and the minimum after the winter solstice. By reason of the annual change in the effective action of the other set of currents, the morning variations of the horizontal force and declination (i. e. for a certain interval before and after 6 A. M.) are greater at the autumnal than at the vernal equinox. The more effective action of these currents at the autumnal than at the vernal equinox is conspicuously seen in the higher maximum of the horizontal force at 5 A. M. to 6 A. M., and the lower minimum about 10 A. M. (See Prof. Bache's Discussion of the Magnetic Observations made at Philadelphia, in 1840 to 1845, p. 45.)

We would here call attention to a special fact, from which it results that the currents developed by the ether, both on the side of the earth toward the sun, and on the opposite side, are especially effective about the equinoxes. It is that, for a considerable period before and after these epochs, such currents, excited at any one place, have very nearly the same direction, and so coöperate more effectually. (See additional remark on page 72).

Among the annual variations of declination may be specified an easterly movement of the needle at the hour of 6 A. M. from the winter to the summer solstice. The author has already shown in his previous paper (this Journal, vol. ix, p. 196) that such an effect should result from the action of the radial currents. Another annual variation that has been detected is an augmentation of the mean monthly intensity of the horizontal force, from winter

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[4] The precise epoch when the radial currents are most effective should vary with the latitude of the station. It is plain that near the tropic of Cancer it should be some weeks before or after the summer solstice; for at the summer solstice at the hour of noon, the currents, or waves, that reach the station from the different points of the photosphere that receive the sun's rays, should exactly neutralize each other. The epoch, or epochs, in question, it is obvious should approach the summer solstice as we recede from the Torrid Zone. The observations made at Philadelphia on the horizontal force, indicate that the radial currents are most effective in determining the diurnal variation of the horizontal force about a month and a half before and after the summer solstice.

[5] Just as with the radial currents, the epoch of maximum effect, must vary with the latitude, and in the lower latitudes should occur before and after the autumnal equinox.

to summer. (Prof. Bache's Discussion, &c., p. 59). To understand how this may result, it is to be observed, that, since the effective radial currents steadily increase in intensity from winter to summer, and since the action in the afternoon of each day is to augment the horizontal force, and in the forenoon to diminish it, whatever effective residual current may remain, as the result of the entire action of the currents in question during a single day, must have the direction of the currents that augment the force. By the continual accumulation of such residual currents, there must accordingly be a tendency to an increase in the intensity of the horizontal force from winter to summer.

But the other system of radial currents should also coöperate with these in producing variations in the intensity of the horizontal force, from one month to another. Since the effective action of these increases, as we have seen, from the vernal to the autumnal equinox, and an action to augment the horizontal force, each day, is followed by one to diminish it, the tendency of the daily accumulation of residual currents should be to diminish its mean daily value, from the vernal to the autumnal equinox. Such a tendency does in fact manifest itself. As the result of the observations at Philadelphia, already referred to, the mean monthly value of the horizontal force was 0·0018 of its absolute value less in September than in March.[6]

In the former memoir it was maintained that the *Irregular Disturbances* of the magnetic needle might be satisfactorily explained if we admit the existence of occasional photospheric currents proceeding from various points over the preceding and following hemispheres of the earth, and that the ordinary region of maximum excitation lies in the plane of the ecliptic, from 60° to 90° to the west of the point of the earth's surface that has the sun in the zenith; and that the region diametrically opposite to this is a secondary region of special excitation. In special instances the point of maximum excitation may have other posi-

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[6] There are still other operative causes that tend to produce annual variations of horizontal force; viz., all the changes that occur annually in the effective action of the ecliptic currents, whether developed in the crust of the earth or its photosphere. The general causes of change are: (1), a variation in the velocity of the earth in its orbit; (2), a variation in the direction of the currents excited; (3), a change in the extent of the portion of each parallel of latitude that is exposed to the impinging action of the ether, or auroral matter; (4), *a change in the direction of the progressive motion of the solar system, as compared with the direction of the orbital motion of the earth.* The epochs of maximum and minimum, dependent upon the first cause, should fall near the solstices; and those dependent upon the third and fourth causes should fall near the equinoxes. The effects of the second cause will vary with the locality. *The currents due to the general motion of the solar system are most intense just before the vernal equinox, and least intense just before the autumnal equinox.*

The conjoint action of the two systems of currents, that have been under consideration, in determining the annual variations, might be strikingly exemplified by considering those which occur at the intertropical station of St. Helena.

tions nearer the meridian in which the sun lies. An adequate cause for such occasional currents may be found if we conceive that they result from the penetration from time to time into the earth's photosphere of bodies of auroral or vaporous matter, expelled from the sun, and arriving with absolute velocities, ordinarily less than that of the earth in its orbit. The photospheric currents, may be conceived to result either directly from the impact of the auroral matter, or indirectly from electric discharges at special localities within the photosphere, consequent upon the reception and distribution of such bodies of matter.

This conception of the origin of the irregular disturbances links them theoretically, as they are in fact, on one side with the physical changes observed in the photosphere of the sun, and on the other with the auroral phenomena that occur in the photosphere of the earth. It contemplates the coruscations of the aurora and the sympathetic tremblings of the magnetic needle, as but one phase of the "magnetic storm" of subtile vapor that descends upon the earth from the regions of space.

One of the most conspicuous facts relative to the disturbances under consideration is that the disturbances of the horizontal force that diminish its intensity prevail at all hours over those which augment it. This fact may be attributed, from our present stand-point, to the circumstance that the descending masses of auroral matter, in receiving the velocity of rotation of the photosphere of the earth, must generate electric currents, or progressive waves, directed toward the west. There is still another effect that theoretically should result from the arrival of these cosmical masses. The electrical excitation that should thereby be produced in the photosphere will act indirectly, in a greater or less degree, upon the earth's surface, and develop currents running over it in every direction from the locality immediately underneath the region of excitation in the upper atmosphere. The increase in the morning maximum of horizontal force, in the years of greatest disturbance, gives indication of the existence of this effect. The tendency of such currents will be almost identically the same with the currents we have supposed to be directly developed in the earth's crust by the impact of the ether of space.

The electrical action upon the crust of the earth here considered may be in a great degree direct rather than inductive. That is, the penetration of the subtile cosmical matter into the earth's photosphere may occasion streams of electricity in the direction of the impact, that may penetrate the atmosphere and take effect upon the earth's surface. The physical cause here supposed to be in operation should coöperate with the others that have been noticed in determining regular variations of the declination and directive force, that would be observable in the mean daily variations, for a month, or a year, even after these have been freed from the greater disturbances.

It is conceivable that the effects which have been ascribed to the radial photospheric currents might be produced by an analogous system of currents within the earth's crust, directed toward the region directly underneath the sun. But no plausible cause can be assigned for the existence of such currents; since if the sun be supposed to produce tides in the vast sea of electric ether that pervades the earth's crust, and thus originate the currents supposed, the consequent effects upon the declination and horizontal force should be of the same character, if not of equal amount, at midnight and at noon. Besides the moon, by this sort of action, should produce greater effects than the sun. The moon, as a matter of fact, does exercise a disturbing action upon the magnetic needle, but the perturbations produced by it have only been detected by the closest scrutiny.

We may here take occasion to remark that the lunar diurnal variations of the declination, and of the horizontal force, are, in their nature, such, as should result from a tidal action of the moon upon the terrestrial sea of electric ether. Thus there should be, theoretically, a maximum of west declination at the upper culmination, or thereabout, and another maximum at the lower culmination. There should also be a maximum of horizontal force a few hours after each culmination, and a minimum a few hours before each culmination. For, the rise and fall of the electrical tide should be attended with currents, or rather waves of translation, setting from all directions toward the point underneath the moon, or a point somewhat in advance of this; and also toward the diametrically opposite point.

Secular Variations.—The secular changes experienced by the declination and directive force of the needle appear to be *the natural consequence of the continual operation of the physical process by which the earth was originally magnetized.* It will be recollected that this consists principally in the development of ecliptic currents on the side of the earth farthest from the sun, which have a greater intensity than the oppositely directed currents developed on the side toward the sun; also that these preponderating currents which originated at any station, at the solstices, run from E. to W., while those developed at the vernal equinox proceed from S. of E. to N. of W., and those developed at the autumnal equinox from N. of E. to S. of W. It is also to be observed that, *in the Northern Hemisphere, the currents which originate at the autumnal equinox exceed in intensity, or quantity, those which originate at the vernal equinox;* for the reason that a greater portion of each northern parallel of latitude is exposed to the impulsive action of the ether. Now conceive all the currents in question that originate during the year, at any station, to be decomposed into two, one running from E. to W., and the other from S. to N. or from N. to S. It will be seen that the annual resultant of the one set of components will constitute a current from E. to W., which will be equal to the sum of the individual components; while that of the other set will be equal to the excess of the currents that run from N. to S. over those that run from S. to N. These general facts being borne in mind it may be seen that the secular variations of the declination result from the combined operation of two causes, viz:

(1.) The prevailing annual action of the resultant E. and W. current, or of the resultant N. and S. current, according to the declination of the needle; except when the declination is easterly, when the two currents will coöperate.

(2.) The varying action of the impulses proceeding from the resultants of the new currents and those previously existing, shifting and changing in intensity from year to year, which run through all the places that lie on the east and west sides of the magnetic meridian of the station.

Let us conceive the diverse directions of the needle on different meridians to be represented by a sinuous curve, alternately concave and convex toward the north, to which the needle is perpendicular; a certain point of the concave portion being on the meridian of Philadelphia, and a point of the convex portion on the meridian of London. Now confining our attention to the first operative cause, on the concave part where the declination (E. or W.) is small it is plain that the N. and S. current should prevail, and therefore the needle have an annual westerly movement. But at a point of the ascending curve where the declination (W.) is large, the other current should prevail, and the needle turn toward the east. Both of these cases are represented by the present secular variations at Philadelphia and London. On the higher part of the curve, where the declination (E. or W.) is small, the N. and S. current should prevail again, and the needle be deflected toward the west. The neutral, or transition points in the curve, should fall at about equal distances on opposite sides of the point of maximum declination (W.).

If we follow the curve ascending toward the west, from the line of no declination on this continent, both sets of currents will coöperate, and the needle should turn toward the west, as it now does throughout the United States. It appears then, that throughout Western Europe and the United States the actual progressive movements of the needle are precisely those which should result from the operation of the first cause above mentioned; that is, from the direct action of the new currents developed at the station of the needle.

To understand how an alternation of movement may occur at a given station, we must consider the probable and possible effects of the other general cause. Under the operation of the first cause the present westerly movement, at Philadelphia, should continue until Philadelphia has magnetically the position of the more westerly of the two neutral points above mentioned. But the needle will not in fact remain stationary when this position has been reached; this could not be the case unless the effects of the varying resultants of the new and old currents should exactly counterbalance each other. In reality, those on the east side should preponderate over those on the west side because they will be more displaced, and the currents of impulses proceeding from the same number of points will correspond more nearly in direction on the east than on the west side. The tendency of the second general cause should then be, to give the needle at Philadelphia a motion toward the east, in the magnetic position in which it would otherwise remain stationary.

If we now revert to London, as a type-station for Western Europe, the present easterly movement of the needle should continue until the magnetic position of the more easterly of the two neutral points, so called, is reached. But at this position the resultant currents at places lying to the west, should, in the existing condition of the currents of the eastern continent, preponderate over those lying to the east, and the easterly movement should therefore continue. The continued operation of the second general cause may thus keep up an easterly movement until the needle attains to a certain easterly declination. But the direct tendency to a westerly movement that increases as the easterly declination becomes greater, must ultimately prevail, and the needle begin to turn toward the west.

It is obvious that the general result is the same as if the whole system of currents were gradually transferred to the west; or the representative sinuous curve had such a motion,—its folds at the same time changing more or less. Or rather, to obtain a comprehensive view of the entire process, we should conceive of a system of such representative curves, traversing the earth's surface, at various distances from the equator, and suppose the whole system to be carried bodily toward the west.

To explain completely the secular variations, especially of the *horizontal force*, we must take into account another cause in operation, not yet mentioned. It is that the resultant currents, at any station, may either be increasing or decreasing in intensity from year to year; for the reason that the annual diminution of intensity of currents already existing may be over-compensated by the new currents, or the reverse.[6] During the period of over-compensation, or of increasing intensity, the period of the secular change of declination should increase, and decrease in the

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[6] A tendency to a diminution of the horizontal force may arise from two causes, viz: a gradual decline of existing currents, and an increase in the ecliptic photospheric currents developed by the impact of the auroral matter received from the sun.

succeeding period. Since it appears from Mr. Schott's discussion of the secular variations (see Report of Coast Survey for 1855, p. 337), that the secular period is shortening on the western coast of the Atlantic, we have to infer that we are at present in that magnetic phase in which the reinforcement of intensity, from the new currents, is less than the annual diminution. In this circumstance we have the probable explanation of the annual diminution of the horizontal force in the United States and Canada. An increase of the photospheric currents may coöperate.

Another general principle should be had distinctly in mind, in this connection; it is that the action of the auroral matter received from the sun, upon the photosphere of the earth, develops there a system of currents, the tendency of which should be the reverse of that of the corresponding system continually developed in the crust of the earth, by the ether of space. The relative direction in which the solar matter approaches the earth, is also approximately the same as that of the impulsive action of the ether; only that in proportion as the velocity of recess from the sun, is greater, the direction of approach is displaced toward the sun. As already intimated, the impinging solar matter, also develops radial currents, by direct action propagated to the crust of the earth. This effect we have recognized in the partial dependence of the morning variation of the declination, and of the horizontal force, upon the eleven-year period of the sun's spots. It is also strikingly manifest in determining the principal deflections of the needle during an Aurora Borealis; at the same time that the ecliptic and equatorial currents, from E. to W., developed in the photosphere, have the effect to diminish the horizontal force. This supposed action of the solar matter upon the crust of the earth may arise either from the direct propagation of the impulses, as already intimated; or more probably from an increase in the density of the ether, resulting from the acceleration of the fall of the matter in question, produced by the earth's attraction.

The secular variations should also be dependent, in some degree, upon the electric currents due to the solar matter. In fact there is abundant evidence of such dependence. The annual rates of variation of all the magnetic elements, vary during the eleven-year period as they should do upon this supposition. Thus the tendency to a westerly deflection of the needle, and to a diminution of the horizontal and vertical forces, is least in the year of minimum spots and magnetic disturbances. It is interesting to observe, in the Philadelphia Observations, how manifestly this minimum tendency existed in the case of each of the three elements, in the years 1842, and 1843. Another evidence of the dependence in question is afforded by the fact that the annual rate of the secular variation of declination, in this country, reached its maximum about the year 1855; and that this is near the maximum epoch of the secular period of the sun's spots. In Europe the tendency of the same general cause is to make the secular rate the least at the same epoch. In this way, probably, it has happened that the increasing secular rate of the easterly movement there has become nearly constant.[7]

Observation has furnished the means of testing the explanation we have given of the progressive change of declination. Dr. Loyd, in his discussion of the Dublin Observations (between 1840 and 1843), has established that the needle at Dublin has, from the vernal equinox until after the summer solstice, a motion in a direction opposite to the annual progression, and a motion in the other direction from the autumnal to the vernal equinox. The discussions of the observations at Philadelphia, and Toronto, have revealed a similar law at those stations, though the direction of the annual progression is reversed. Now, at Dublin the new currents developed at all seasons tend to give

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[7] From our present stand-point we may obtain a distinct view of the origin of the diverse luminous phenomena of the Aurora Borealis, as well as of the attendant magnetic phenomena. We may perceive that the Aurora is a combined magneto-electric and electro-magnetic phenomenon:—that the auroral light results from electric discharges along the lines of magnetic polarization that traverse the masses of solar matter, while passing over from the preceding to the following side of the earth's photosphere: that the discharges are in a great degree due to the demagnetizing action of the electric currents developed by the solar matter impinging upon the preceding side of the photosphere; but in part also to a direct disturbance of the electric equilibrium, along the lines of polarization, by these currents, or by the free electricity in the photosphere. We here allude, especially, to the more conspicuous auroras. It is conceivable that should there be an intermission in the reception of auroral matter from the sun, or the supply feeble, the currents continually excited in the earth's crust by the ether of space, may by augmenting the intensity of the earth's magnetism, originate currents in the photosphere, directed upward instead of downward. Such effects should be especially observable in the regions of greatest directive force. It is to be observed that the tendency of the demagnetizing action accompanying the more conspicuous auroras, with the attendant electric currents, is to disperse the auroral matter, and in this way to occasion its expulsion to an indefinite distance, under the operation of the repulsive force of the earth exerted upon single molecules, or minutely divided masses (see this Journal, vol. xxxviii, p. 70. The decrease of the earth's magnetizing action coöperates in this.

There are several important probable inferences that may be drawn from the preceding discussion, which it may be advisable to state here, very briefly.

1. The sun must have become magnetized after the same manner as the earth, by reason of its rotation, and of its motion of rotation combined with its progressive motion through space. As in the case of the earth, there must be a continual development of new currents, tending to exalt its magnetic state. These new currents by this mode of action should condense the auroral matter of the photosphere, along the lines of polarization, and so develop both light and heat. The spots on the sun are probably due to an inverse effect (that is, demagnetizing and dispersing), produced by the electric currents directly developed in the photosphere, by the descent into it of cosmical matter, as the sun moves forward in space. According to this the faculæ and accompanying dark spots, have a similar origin to terrestrial auroras. Upon this theory the dark spots should be wanting at the magnetic equator, and at the poles. They should also be mostly confined to low latitudes (heliographical).

It is probable that a large fraction of the heat by which the temperature of the body of the sun is maintained is the result of the continual recurrence of the prothe needle an easterly deflection; except near the autumnal equinox when their effect upon the declination will be slight. For the currents will run from S. of the magnetic E. to N. of the magnetic W., except at the autumnal equinox when they will be nearly perpendicular to the needle. In the annual inequality, therefore, the needle should be in its most easterly position at the vernal equinox, when the currents will be most oblique to the needle, and at its most westerly position toward the autumnal equinox. At Philadelphia and Toronto the secular change is due to the excess of the N. to S. currents, from the summer to the winter solstice, over the S. to N. currents from the winter to the summer solstice. Under the influence of these currents the needle should be in its most westerly position near the winter solstice, or near the close of the period during which the N. to S. currents are developed; and at its most easterly position near the summer solstice. The observations at these stations give results in entire accordance with these theoretical conclusions. But for the influence of the currents at other localities the amount of the inequality should be equal to the annual secular change. This was the case at Toronto (each 2′, in the

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cess of magnetization by the impinging action of the ether of space (p. 66). The penetration of cosmical matter into the photosphere is another source of heat.

2. Similar inferences may be drawn with respect to the magnetic and thermal condition of the planets; and an approximate estimate may be made of the comparative condition of the different bodies of the solar system.

3. The continual development of heat in the entire mass of the earth, by the action of the ether, is probably the origin of those subterranean Titanic forces, which have so repeatedly, in past geological ages, fractured and upheaved certain portions of the earth's crust; and whose effects are now observable in earthquakes and volcanic eruptions. Upon this idea there should probably be certain lines of upheaval corresponding to the magnetic currents, in some of their shifting and comparatively stationary positions.

4. The rotating and revolving nucleus of a comet should become magnetized and heated in the same manner as the earth, and the sun, both in its mass and photosphere. In this fact we have the apparent origin of the formation and detachment of successive nebulous envelops, and of the emission of luminous jets from the nucleus;—the process of detachment and indefinite expulsion being the same as already alluded to, as in operation in the photosphere of the earth (p. 76). The same process attends the formation of the solar spots, and originates streams of nebulous matter, seen in the zodiacal light. The residual cometary phenomena, which remain unaccounted for by Olbers and Bessel's theory, as applied and amplified by the author (see this Journal, vols. xxvii, xxix, and xxxii, [2]) may be understood, in their minute details, in the light of the present conception.

5. It may be added, in confirmation of the theory of the continual descent of auroral matter, derived from the sun, into the earth's photosphere, that the diurnal variations of the electric tension near the earth's surface, are in accordance with the idea that free atmospheric electricity, for which no adequate terrestrial cause has yet been ascertained, is derived from the auroral matter thus received. Also, the diurnal variations of the barometer are other observed effects that should result, on mechanical principles, from the same general cause.

Again, the diminution in the hourly fall of the temperature, during the latter part of the night, for which no sufficient meteorological cause can be found, would seem to afford direct evidence of the heating effect that has been attributed to the resisting impulses received from the ether of space.

years from 1845 to 1851). At Philadelphia the annual progression, in 1843, was (4′·4); more than double the annual inequality (2′). This must be attributed to the preponderating action of the currents traversing those localities at which the needle was turning toward the west.

Unequal Magnetic Intensities of the two Hemispheres.—This has its origin in the *unequal absolute velocities of the earth, near the equinoxes, resulting from the progressive motion of the solar system.* A calculation from the most reliable data gives for the ratio of the maximum velocity (March 4,) to the minimum velocity (Sept. 6), 1·29. Now the ver. equi. currents determine the magnetic intensity of the southern hemisphere, in high latitudes, and the aut. equi. currents that of the northern hemisphere; and the ratio of intensities at the poles (dip 90°) should be nearly equal to that of the max. and min. velocities (1·29). According to Gauss's charts, its actual value is 1·32.[8]

[To be concluded.]

ART. XII.—*The Distribution and Migrations of North American Birds;* by SPENCER F. BAIRD, Asst. Sec. Smithsonian Institution. (Abstract of a memoir presented to the National Academy of Sciences, Jan., 1865.)

IT is well known to all students of Natural History, that the zoology of America or the new world is very different from that of the old world, and that with these two grand divisions, there are in each various subdivisions of greater or less importance. To Dr. Sclater[1] is perhaps due the merit of having been the first clearly to define the "Regions" into which the animal life of the terrestial globe, the birds especially, may be divided, and to point out approximately their relative magnitude and boundaries as well as their comparative richness in species of birds. Some of his details have been corrected and improved by Mr. Wallace,[2] but the conclusions of Dr. Sclater are in the main those which have received the support of most naturalists of the present day, and his details will ever mark an era in the science of zoölogical geography.

Dr. Sclater, in the article above alluded to, presents the follow-

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[8] It should have been stated in the text (p. 67) that the rotation of the earth virtually shifts the point of normal impact of the ether to the east of the 6 A.M. meridian; and so delays the morning critical hours.

We propose to discuss, very briefly, in the next No. of this Journal the remaining topic of our memoir,—Chemical Action.

[1] Journal of proceedings of the Linnæan Society: Zoology, ii, 1858, 130. (Read June 16, 1857.)

[2] Ibis, 1859.

ing scheme of the arrangement of "regions" as best illustrating their relationship.

PALÆOGEAN OR OLD WORLD CREATION.			NEOGEAN OR NEW WORLD CREATION.
	I. Palæarctic or North Old World Region.		V. Nearctic or North American Region.
II. Western Palæotropical or Ethiopian Region. ..	III. Middle Palæotropical or Indian Region. ..	IV. Eastern Palæotropical or Australian Region.	VI. Neotropical or South American Region.

The boundaries of these regions, as defined by Dr. Sclater with Mr. Wallace's corrections embrace the following countries.

I. *Palæarctic Region.*—All Europe and Africa north of the Sahara, and all continental Asia north of about the parallel of 30° N. lat. including the whole mountainous country and plateaus of Central Asia, as well as Japan and the Kuriles. The Aleutians, assigned by Dr. Sclater to this region, appear to belong more to North America.

II. *Ethiopian Region.*—This embraces all of Africa south of the Sahara, and on the eastern side all south of about 30° N. lat., as well as most of Arabia, except the portion along the Indian ocean and the Persian gulf. It includes also Madagascar, and the adjacent islands as Mauritius, Bourbon, etc. The Sahara Mr. Wallace considers as belonging to neither the Palæarctic nor the African region, but to occupy the position of a sea, and to be essentially destitute of land species.

III. *The Indian Region.*—This includes the low lands of continental Asia, about south of 30° N. lat. and the portion of Arabia excluded from the Ethiopian region, as well as Ceylon, Sumatra, Java, Borneo, and the Philippines. It is the country washed by the Arabian Sea, the Persian Gulf and the China Seas, and its southeastern limit passes between the islands of Bali and Lombok, between Borneo and Celebes, and between the Philippines and the Moluccas.

IV. *The Australian Region.*—This includes Australia, New Guinea, Tasmania, New Zealand and Polynesia, also Lombok, Celebes, the Moluccas, and the Sandwich Islands. Mr. Wallace calls attention to the fact of the very great dissimilarity between the faunæ of Bali and Lombok, and of Borneo and Celebes, although geographically very near each other, while islands of the Indian region, as well as of the Australian, are respectively very closely allied, although much more remote from each other than those just contrasted. The explanation of this difference he finds in the comparatively slight depth of water between islands of the same region, while the channel separating those of the different regions is almost unfathomable. By an elevation of 50 fathoms, all these islands of one region would almost become joined to the main land of their respective regions, while the channel separating the latter would still constitute a physical barrier. Hence he infers that subsequent to the original peopling of the Indian and Australian regions, a subsidence into the sea and the consequent production of islands, while it ultimately modified the minor characters of the faunæ, left the broad outlines unchanged.

V. *North American Region.*—Dr. Sclater divides this from the South American somewhere in Mexico, the line reaching farther north on the coast, and more to the south in the central mountainous portion. Wallace draws the line about the parallel of 22°, or near the Tropic of Cancer. To the north it includes Greenland.

VI. *South American Region.*—This embraces, according to Sclater and Wallace, the rest of continental America, the West Indies, the Galapagos, the Falklands, etc., while Wallace even includes (very erroneously, however,) the Sandwich Islands.

Of the regions thus sketched out, I propose to confine myself to the two last mentioned, or those of the new world, and more especially the portion included in the United States and north of it, and to point out the minor subdivisions and peculiarities of the ornithological faunæ of the same. Before proceeding however to this subject, I may premise that I cannot quite agree with Dr. Sclater in referring the West Indies to the South American Region, but prefer to consider it as having independent rank as:

VII. *West Indian Region.*—In winter a large proportion of the inhabitants of the islands are visitors from North America, but the summer fauna is very distinct. The islands nearest to North and South America have of course an impress of the characteristics of these continental areas respectively, but as a general law it may be stated that of the species of land birds peculiar to the West Indies, exclusive of the diurnal Raptores and Columbidæ, a large proportion belong to genera found equally in North and South America, as *Vireo*, *Turdus*, *Mimus*, *Polioptila*, *Dendroica*, *Tyrannus*, *Myiarchus*, *Contopus*, *Myiadestes*, *Progne*, *Petrochelidon*, *Icterus*, *Sturnella*, *Colaptes*, etc.: an almost equal proportion belong to genera peculiar to the West Indies, and characterizing several islands, as *Gymnoglaux*, *Mimocichla*, *Spindalis*, *Phonipara*, *Tachornis*, *Loxigilla*, *Saurothera*, *Blacicus*, *Todus*,[3] etc. or else more or less peculiar to one island respectively as *Teretristis*, *Melopyrrha*, etc., to Cuba, *Siphonorhis*, *Polytmus*, *Glossiptila*, *Hyetornis*, *Laletes*, etc., to Jamaica, *Dulus*, etc., to

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[3] *Todus Mexicanus* of Lesson is a Porto-Rican species.

Hayti. Where the species belong to continental genera not represented in North America, they are more generally of Mexican and Central American forms and rarely of strictly South American.

The following table of resident land birds of Cuba and Jamaica, exclusive of diurnal Raptores and Columbidæ, although approximately complete only, may serve to illustrate more fully the preceding remarks.

	Cuba.	Jamaica.
South American genera,	..	1[4]
Central American and Mexican,	..	1[5]
South and Central American,	2	3
North and Central American,	5	2
North, Central and South American,	16	10
West Indian,	8	6
Peculiar to the Island,	3	6
Total,	34	29

The species of truly West Indian birds are remarkable for their local distribution, comparatively few being found on more than one of the larger islands, and, what is still more remarkable when the contrary is the case, an intervening island may be destitute of the species. Thus Cuba lacks several species common to the Bahamas and to Jamaica.

Professor Agassiz (Types of Mankind, 1854), has urged very strongly the recognition of an Arctic and an Antarctic region or "realm," a point in favor of which there is much to be said, but which cannot be discussed in the present article. He also anticipates Dr. Sclater in regard to some of his views, but the facts at command at the time did not allow him to define the boundary lines of the regions with the same precision. Still more recently Dr. Pelzeln (Reise der Novara, 1865) insists likewise upon an Antarctic region.

Proceeding now to the especial subject of the present article, the mapping out of North America with reference to the geographical distribution and migrations of North American birds, it may be premised that in the article above referred to by Professor Agassiz, in Nott & Gliddon's Types of Mankind, we find the first attempt to mark off the zoological provinces of the New World—and very successful considering the insufficient data accessible at the time. In 1859[6] Dr. Leconte sketched out their

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[4] Nyctibius. [5] Phonipara.

[6] Coleoptera of Kansas and New Mexico, Dec. 1859, Smithsonian Contributions, vol. xi.

I may also refer to incidental mention of the same law in a paper by myself on the birds of Cape St. Lucas, in the Proceedings of the Philad. Academy for Nov. 8th, 1859, p. 299.

boundaries, in North America, with more precision, having particular reference to the distribution of Coleopterous insects.

The subdivisions by Dr. Leconte of these provinces, as based on the study of their Coleoptera, do not agree strictly with those of the ornithological faunæ, especially in the considerable number of local areas which he has adopted. This difference is, however, easily intelligible when we bear in mind the much superior power of flight and innate tendency to migration of the bird as compared with the insect; the distribution of reptiles agreeing much better with his outline than that of birds.

To present the general principles of distribution to which I have been led by an examination of the large collection of specimens in the museum of the Smithsonian Institution, I may say that as far as its ornithology, and to a considerable degree its vertebrate zoology in general is concerned, North America appears to be divided into two great regions, an eastern and a western, which in the United States are of approximately equal extent, but very unequal farther north. The eastern division extends from the Atlantic seaboard, westward across the Alleghanies (which affect the distribution of species but little) and over the valley of the Mississippi and its fertile prairies to about the 100th degree of longitude, or to the beginning of the sterile plains. Its western border is not sharply defined, nor strictly in a meridian line, but somewhat oblique, and interdigitates with the western division by extending westward along the river bottoms, some species, as *Galeoscoptes Carolinensis*, *Vireo olivaceus*, &c. occurring as far west as Fort Benton, or even Fort Colville.

The western division begins at the western border of the eastern, or along the sterile plains of the trans-Mississippi country and extends across to the Pacific ocean. The character of the ornithological fauna of this division is much the same through and beyond the Rocky Mountains to the eastern slope of the Sierra Nevada and Cascade Mountains of California and Oregon, but changes somewhat on the western slope and thence to the Pacific, and although to a considerable extent uniform, yet exhibits some modifications which may warrant a separation into a western and middle division, making three in all, which we may call provinces, of very unequal extent, and exhibiting further modifications or subdivisions with latitude, as I shall proceed to explain, taking into consideration the whole continent north of Mexico.

As previously remarked, the eastern province or division extends from the Atlantic ocean to about the meridian of 100° west from Greenwich, or 23° west from Washington. The line of division on the Gulf of Mexico, starts near the eastern border of Texas, perhaps between the Brazos and the Sabine, and following up the direction of the former river to the approaches of the Great Desert nearly on the meridian mentioned, proceeds northward, forced sometimes more or less westward, especially along the Platte, sometimes eastward. It crosses the Platte between Forts Kearney and Laramie and intersects the Missouri between Fort Randall and Fort Pierre, perhaps near Fort Lookout, as it is between the first mentioned two points that in ascending the river we find the change to take place in the ornithology of the country. Soon after crossing the northern boundary of the United States and to the western side of Lake Winnipeg, the line rapidly inclines westward, especially beyond the Saskatchewan, and extends to the Rocky Mountains, including the valleys of Athabasca and Great Slave Lakes, and both sides of the Mackenzie River, north to the Arctic ocean, even crossing the Rocky Mountains to the Porcupine river and into Russian America at least to 145°, or beyond the forks of the Yukon, where Mr. Kennicott found many of the most characteristic summer land birds to be almost identical with those of Slave Lake, Lake Winnipeg, and Northern Canada.

The western province occupies the western slope of the Cascade and Sierra Nevada ranges of mountains in the United States, although its extent southward along the peninsula of Lower California is not well determined. To the northwest it extends at least to the 140th meridian, beyond that probably replaced by a more Arctic fauna. We are not sufficiently familiar with the birds occurring between the northern Rocky Mountains and the coast, to tell how far inland in Stickin Territory or even in northern British Columbia, the coast fauna extends, perhaps not farther than in California or Oregon, although it is possible that, owing to the absence of a continuous longitudinal range of great height, the western and middle regions may there be more thoroughly blended into one.

The middle province, or that of the great plateau, occupies the space between the two just mentioned, probably not passing in its integrity, or as a peculiar province north of the valley of the Saskatchewan and is thus wedged in between the two. As already stated, it extends along the eastern slope of the Cascade and Sierra Nevada mountains, and apparently along the east side of Lower California to Cape St. Lucas, at least the birds of the Cape, as will hereafter be explained, belong much more emphatically to it than to the Western province. A break in the mountains opposite San Diego explains the appearance at that point on the coast of a few species like *Tyrannus vociferans*, *Sialia arctica*, *Polioptila melanura*, &c., so characteristic of the middle province. The southern boundary of this province during the summer may be considered as occupying the valleys of the Rio Grande and Gila but along this line it is greatly mixed up with the peculiar fauna of Northern Mexico, which as far as its summer birds indicate, is almost entitled to be considered as a fourth main province.

The eastern province to the north merges into the Arctic, and southward exhibits a very important subdivision in the hot region of the south Atlantic and Gulf States, which is bounded to the north by the isothermal of 80°, extending however up the coast to the Dismal Swamp of Virginia, or even to the James river. To the west it ranges along the isothermal of 83° or 85° following the line to the N.N.W. along the valleys of the Brazos, Red river, the Washita and the Canadian. Most of the species belonging to this subdivison reach along the valley of the Mississippi to a point far north of their limit on the Atlantic slope; the Swallow-tailed-Hawk, Parakeet, and other characteristic species, being well known visitors to Cairo, St. Louis, and even as far north as Wisconsin. This subdivision of the eastern province experiences a still further modification in the southern part of Florida in consequence of the proximity of the Bahamas and Cuba, which causes stragglers of the West India fauna to enter its limits, especially along the south eastern keys. Some of these are *Certhiola Bahamensis*, *Progne cryptoleuca?* *Vireo barbatula*, *Quiscalus aglaeus* (*Q. baritus*, Baird, B. N. A., 556), etc. The only really peculiar indigenous land bird in Florida is the Florida Jay (*Cyanocitta Floridana*), seldom, if ever, found out of that State. As far as is known, there is no corresponding southern subdivision on the west coast in the western province, although California and Washington Territory have each some peculiar species.

As in the eastern province, so in the middle, there is a subdivision along the southern border inhabited by species belonging more particularly to northern Mexico, and occupying the valleys of the Rio Grande and Gila, extending northward along the Rio Grande and Colorado far into the United States. It is the species of this subdivision, that, with those peculiar to Cape St. Lucas, characterize the summer fauna of the latter region. In winter, both there and along the Mexican boundary line, these species are mingled with others coming from the more northern portions of the middle province.

In addition, however, to possessing certain species of the boundary line fauna, Cape St. Lucas has other peculiarities which entitle it to especial consideration.[7]

It forms a distinct subdivision of the boundary sub-province even more peculiar in its relations than Florida, where the characteristic species (excepting the Florida Jay) are stragglers of the West Indian type from the Bahamas, while as shown by the

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[7] See Baird, Pr. Acad. Nat. Sci., Nov. 8th, 1859.

indefatigable researches of Mr. Xantus,[8] there are at least twenty species found at Cape St. Lucas not known elsewhere.

Very few of the birds of the coast of California, or of the western province, winter at Cape St. Lucas, the species being almost entirely those of the middle province. The new and peculiar species in all cases belong to genera of the middle province, especially of its boundary subdivision, and no genera are peculiar to it. Furthermore, in no instance do we find species of the *Tierra Caliente* of Mexico not belonging to the United States, nor of any Mexican genera that do not possess representatives in the United States. The difference between the species of birds of Cape St. Lucas and of Mazatlan is very great, although separated only by the breadth of the Gulf of California.

From all these considerations we are legitimately entitled to claim Lower California, or at least its southern extremity, as belonging to temperate North America, even more positively than Florida itself.

Peculiarities in regard to the size of Cape St. Lucas birds will hereafter be referred to.

There is of course an Arctic province which melts gradually into those great provinces mentioned, and along the mountainous ranges extending far southward, in fact almost into Mexico, as shown by the occurrence in summer at Cantonment Burgwyn, near Lat. 37°, of *Lagopus leucurus*, *Pinicola Canadensis*, *Curvirostra Americana*, *Hesperiphona vespertina*, etc., while the two last mentioned species, with *Carpodacas cassini*, are even found in summer on the highlands about Orizaba, as shown by specimens transmitted to the Smithsonian Institution by Dr. Sartorius. Similar intrusions of species belonging to the North Mexican fauna take place up the valleys of the Colorado and the Rio Grande, and of those of the eastern province westward along the Missouri and along the Canadian, etc., but they do not affect the general plan. Although characteristic of the eastern province, as already stated, the Cat-bird, (*Galeoscoptes Carolinensis*), Red-eyed Vireo (*V. olivaceus*), and Wild-pigeon (*Ectopistes migratoria*), are found along the northern boundary of the United States to the Cascade Mountains, while specimens of *Dendroica coronata* have even been taken at Fort Steilacoom on Puget Sound. On the other hand, *Turdus nævius*[9] has been shot on Long Island and in New Jersey, *Helminthophaga celata* in the Atlantic states, and *Zonotrichia Gambelli*, and *Spizella pallida*,

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[8] See Xantus, Pr. A. N. S., Nov. 1859.

[9] I am informed by Dr. Cabot that a third specimen has recently (Dec. 1864) been shot near Boston and presented to the Natural History Society. As it has been met with as far east as Fort Franklin, it may not improbably reach our eastern coast in company with some of our eastern species bred in the Mackenzie River valley and returning southward to the Atlantic.

are well known and constant visitors in the region of the Great Slave Lake.

Several species of water birds that belong to the winter fauna of the Pacific coast resort to the Slave Lake region and north of it to breed, crossing the Rocky Mountains for the purpose. Among them may be mentioned *Larus Californicus* and *brachyrhynchus*, *Colymbus Pacificus*, *Bernicla nigricans*, *Anser Rossii*, etc. This, however, may be in consequence of their migrations being along a meridian line, or north and south; the meridian of the westernmost point of California and even of Vancouver's Island passing east of the mouth of the Mackenzie River.

In any investigation into the reasons why the eastern province is of so much greater extent than the others, and exhibits such a trend westward in British America as to reach and even cross the Rocky Mountains, we will be greatly aided by the examination of Prof. Guyot's Wall Map of North America. On this map the country, not exceeding 800 feet in height, is colored green, and this portion is almost exactly coincident with the limits of the eastern province just defined; reaching west of the Mississippi, almost to the edge of the fertile plains (the true zoological boundary), passing up the Mississippi via St. Paul to the Winnipeg valley, involving the whole shores of Hudson's Bay, thence in a northwesterly direction, a little south of Slave Lake to the foot of the Rocky Mountains, and north to the Arctic ocean on both sides of the Mackenzie. Within this vast country are "islands" of more elevated land; the whole Appalachian range, from New Brunswick to Central Georgia and Alabama; the height of land between Hudson's Bay and the St. Lawrence system of waters (nearly parallel with the latter), the plateau of Iowa and Northern Wisconsin, and that east of Slave Lake,[10] etc, being more or less completely encircled by the lower level referred to. The highlands within this region have to a certain extent a peculiar fauna, characterized by the presence of such species to a considerable degree even in summer, as *Junco hyemalis*, *Perisoreus Canadensis*, *Chrysomitris pinus*, *Curvirostra Americana* (more rarely *leucoptera*), *Pinicola Canadensis*, etc., most of which are known to breed in the high mountain region of Georgia. These highlands do not, however, materially alter the summer distribution of our birds, especially in the interior, and there is no physical obstacle, not even that

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[10] This region, bounded west by Coppermine river, Slave, Athabasca, and Wollaston lakes, and south by Churchill river, is known as the Barren Grounds of Arctic America, and is a great granitic or azoic region, more or less barren of vegetation, destitute of large trees, and having few inhabitants. It is, however, the especial home of the Musk Ox, the Barren Ground or Small Reindeer, the Barren Ground Bear, the Polar Hare, and other species.

of temperature, to interrupt or affect their passage by way of Rupert's land to the shores of the Arctic ocean."

The southern division of the eastern province is also quite well outlined by Prof. Guyot's limits of the cotton-producing region, although running much farther to the northwest in Arkansas and the Indian Territory than there indicated.

The much greater tendency of the southern birds, or those belonging to the cotton region, to go northward in the Mississippi valley than along the Atlantic slope is explained not only by the ascent there of the isothermal lines, but by the absence of any such obstacle to their journey as is furnished by the Appalachian range.

The great central plateau region of Prof. Guyot's map corresponds quite closely with the middle ornithological province, reaching north to the Saskatchewan and west to the Pacific slope. The close relationship of the western province to the middle is illustrated by the fact that the region of country exceeding 800 feet in height, extends quite to the Pacific in most places, leaving only a few narrow borders and perhaps the valley of the San Joaquin and the Tulare lakes below that level.

It is a fact not without its significance that the depressed lowland area of eastern America is characterized by the existence of certain genera of fishes and reptiles not found in its Appalachian "island." Thus we have *Amia*, *Lepidosteus*, *Micropterus* (*Grystes*), and various other forms of fishes throughout the Mississippi valley as far north as the Great Lakes, while in the Atlantic slope they do not pass the James or Lower Potomac except as stragglers. The soft shelled turtles, and the great mass of the

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" The Appalachian Region towards the north and northeast passes into a well marked subdivision, called by Prof. Verrill in his paper on the birds of Norway, Maine, the "Canadian." This he correctly characterizes by the presence of certain species during the breeding season, replacing certain near allies, in what, with Prof. Agassiz, we may term the Alleghanian subdivision. Some of the characteristic and more or less parallel species of birds in these two subdivisions he considers to be the following:

Alleghanian.	*Canadian.*
Dendroica discolor,	Dendroica striata,
Pipilo erythrophthalmus,	Chrysomitris pinus,
Spizella socialis.	Curvirostra leucoptera,
	Junco hyemalis,
	Perisoreus Canadensis,
	Picoides arcticus,
	Tetrao Canadensis.

The Canadian sub-province includes especially the highlands between Hudson Bay and the St. Lawrence waters and across them into Northern Wisconsin, the higher portion of the Adirondack, Green, and White Mountains, Northern Maine, and, according to Prof. Verrill, the coast region from Mt. Desert to the southeastern part of New Brunswick, including the islands in the Bay of Fundy. Even far to the south, the high mountain regions of the Alleghanies to Georgia have the same fauna, their most characteristic species of bird being the common blue snowbird, *Junco hyemalis.*

Emydidæ belong to the same low region also, as well as most of the American Perennibranchiate Amphibia, *Menopoma* (more rarely *Menobranchus*) alone penetrating into the Appalachian region, while *Siredon* belongs exclusively to the high central plateau, being found from the Missouri plains to the Cascade mountains of Oregon and south to the city of Mexico.

The *Unionidæ* and *Melaniadæ* seem likewise to belong more especially to the depressed portion of eastern North America.

I may also mention in this same connection that as might be expected, the entire eastern province is characterized by its abundance of Chelonians and Amphibians; the middle and western, by their Saurians. Among fishes the Etheostomoids, Esoces, Siluridæ, the fresh-water Ganoids, (*Amia*, *Lepidostei*, etc.), the fresh-water Percoids, etc., are peculiar to the eastern province, while the great abundance of unusual forms of the *Cyprinidæ* is equally distinctive of the middle and western. As regards the fishes, however, the boundaries of the provinces are considerably changed, the eastern including all the waters emptying into the Missouri river and Gulf of Mexico, the middle embracing the region of the Great Basin and the drainage of the Colorado river, and the western, the waters discharging into the Pacific.

The following tables present the species of birds most characteristic of each province—the selection having been mainly confined to what may be considered as representative species, or those which would formerly have been considered as identical. The isolated species of each province have not been included.

Western.	*Middle.*	*Eastern.*
Buteo montanus.	montanus.	borealis.
elegans.	elegans.	lineatus.
Athene cunicularia.	hypogæa.	
Picus Harrisii.	Harrisii.	villosus.
Gairdneri.	Gairdneri.	pubescens.
Nuttalli.	scalaris.	borealis ?
Sphyropicus nuchalis.	nuchalis.	varius.
Colaptes Mexicanus.	Mexicanus.	auratus.
Trochilus Alexandri.		colubris.
Chætura Vauxii,	Vauxii ?	pelasgia.
Chordeiles popetue.	Henryi.	popetue.
Myiarchus cinerascens.	cinerascens.	crinitus.
Contopus Richardsonii.	Richardsonii.	virens.
Empidonax pusillus.	pusillus.	Trailli ?
difficilis.	difficilis ?	flaviventris.
Turdus nanus.	nanus.	Pallasii.
ustulatus.	ustulatus.	fuscescens.
Sialia Mexicana.	arctica.	sialis.
Geothlypis Macgillivrayi.	Macgillivrayi.	Philadelphia.
Icteria longicauda.	longicauda.	viridis.
Dendroica Audubonii.	Audubonii.	coronata.
Collyrio excubitoroides.	excubitoroides.	ludovicianus.
Vireo Swainsoni.	Swainsoni.	gilvus.
Mimus var. caudatus.	caudatus.	polyglottus.
Harporhynchus redivivus.	crissalis.	
	Harporhynchus longirostris.	rufus.

	Thryothorus Berlandieri.	ludovicianus.
Thryothorus spilurus.	leucogaster.	Bewickii.
Troglodytes Parkmanni.	Parkmanni.	aedon.
Sitta aculeata.	aculeata.	carolinensis.
Lophophanes inornatus.[11]	atricristatus.	bicolor.
Parus occidentalis.	septentrionalis.	atricapillus.
Psaltriparus minimus.	plumbeus.	
Carpodacus Californicus.	Cassini.	purpureus.
Zonotrichia Gambelii.		leucophrys.
Junco Oregonus.	Oregonus.	hyemalis.
Spizella Breweri.[12]	pallida.	pusilla.
Melospiza Heermanni.	fallax.	melodia.
Peucæa ruficeps.	Cassini.	æstivalis.
Passerella Townsendii.	schistacea.[13]	iliaca.
Pipilo Oregonus.	arcticus.	erythrophthalmus.
" fuscus.	mesoleucus.	
Agelæus gubernator.	phœniceus.	phœniceus.
Sturnella neglecta.	neglecta.	magna.
Scolecophagus cyanocephalus.	cyanocephalus.	ferrugineus.
Cyanura Stelleri.	macrolophus.	
Cyanocitta Californica.	Woodhousii.	Floridana.
	Meleagris Mexicana.	gallopavo.
Callipepla Californica.	Gambelii.	
	Ortyx texensis.	virginianus.
Tetrao Obscurus.	Richardsonii.	
"	Franklinii.	canadensis.
" Sabini.	umbelloides.	umbellus.
Ibis guaruana.	guaruana.	ordii.[14]
Bernicla nigricans.		brenta.
leucopareia.	Hutchinsii.	
Querquedula cyanoptera.	cyanoptera.	discors.
Pelionetta Trowbridgii.		perspicillata.
Larus occidentalis.		Smithsonianus.
	Chroicocephalus franklini.	atricilla.
Sterna elegans.		regia.
Uria columba.		grylle.

To sum up in brief the conclusions reached in the preceding remarks, it may be stated that the ornithological provinces of North America consist of two great divisions of nearly equal size in the United States, meeting in the vicinity of the 100th meridian, the western half divisible again into two, more closely related to each other than to the eastern, though each has special characters. These three sections form three great provinces to be known as the western, middle, and eastern; or those of the Pacific slope; of the great basin, the Rocky mountains and the adjacent plains; and of the fertile plains and region generally, east of the Missouri. A northern or sub-arctic fauna mixes with and melts into the three, extending far to the south (even into Mexico) along the Rocky mountains. The middle and eastern provinces have each a southern subdivision, the one bordering on Mexico, the other on the Gulf and the Atlantic, and each of these also exhibits a differentiation, the former having a special

[11] Found also in the middle province.

[12] Extends also to the Rocky Mts.

[13] Found also at Fort Tejon?

[14] Found all the way across to the Pacific.

subdivision again into Cape St. Lucas, and the latter into Florida. Northward the eastern province extends more and more westward reaching the Rocky mountains and even westward of them towards the Yukon.

The southern boundary of the middle province of North America may be arbitrarily established as a straight line, drawn from the mouth of the Rio Grande to that of the Yaqui near Guaymas on the Gulf of California, thus throwing into North America the whole of Florida and Lower California.

[To be continued.]

ART. XIII.—*Experiments on Mechanical Polarity*;[1] by PLINY EARLE CHASE. M.A., S.P.A.S.

[Continued from vol. xl, p. 316.]

C. APPARATUS-POLARITY.

FRICTION and the jarring of the apparatus, modified by the degree of velocity imparted to the ring, produce a polarity of their own which should be carefully estimated, and due allowance made for its influence in all delicate and doubtful experiments. In order to determine the directivity of the normal vibrations, independent of any mere current influence, the needle was shielded by a glass, as in the ordinary surveyor's or mariner's compass.

27. When the axis is in the meridian, the polarity appears to be meridional.

28. With the axis in the equator, the polarity is also meridional.

29. If the northern extremity of the axis is inclined to the west, the needle declines to the east.

30. Giving the axis an easterly inclination, the needle declines to the west. The declination is, therefore, *from* the axis in all cases, and we may infer that the earth's rotation exerts a constant tendency to increase the normal declination of the needle.

31. In all positions of the axis there appears to be a slight disposition in the needle to decline to the east, independent of the motion produced by the mere vibration of the apparatus. If this disposition is owing to terrestial currents, it is probable that the declination would be westward in the southern hemisphere, in accordance with Ferrel's law, that, "*in whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern.*" (Math. Monthly, i. 307.)

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[1] From the Proceedings of the American Philosophical Society, vol. x, pp. 155–161.

32. If a candle-flame, or the smoke of an extinguished taper, be brought near to the revolving ring, it will be repelled from the equator, attracted to the poles, and neither attracted nor repelled at a distance of about 30° from the equator.

33. If a magnetic needle is substituted for the taper, it tends to parallelism with the axis at the equator, and dips toward the center as it approaches the poles, in accordance with its general disposition to range itself in the line of strongest vibration. (Exp. 3, Proc. A. P. S., ix, 359.)

D. Revolving Discs attached to the Ring.

a. *Discs Axial.*

34. Whatever may be the position of the axis, there is a very slight axial polarity.

b. *Discs Perpendicular to Axis.*

35. There is no current-polarity.

c. *Discs with* 45° *East Declination.*

36. If the axis is in the meridian, the needle declines to the east.

37. If the axis is in the equator, when the top of the ring moves south the needle declines to the east, but when the ring moves north the declination is westerly.

38. If the axis is inclined to the meridian, and the disc passes over the needle in the magnetic equator, the declination is easterly; but if the disc is meridional, I am unable to discover any decided current-polarity.

d. *Discs with* 45° *West Declination.*

39. Placing the axis in the meridian, the needle declines to the west.

40. When the axis is equatorial, the declination is westerly.

41. When the axis is inclined to the meridian, and the disc is equatorial, the needle declines to the west; but if the disc is meridional, it produces no marked polarity.

42. All of the experiments with revolving discs, as well as many of those with fixed discs, appear to be affected by changes in the earth-currents, especially when the motion of the ring is northerly.

The foregoing results are in precise accordance with the theoretical deductions contained in my papers on the "Numerical Relations of Gravity and Magnetism," on the "Influence of Gravity on Magnetic Declination," and on "Gravity and Magnetic Inclination" (Amer. Phil. Soc., Dec. 16, 1864, April 21 and May 19, 1865, and this Journal [2], xxxix, 312; xl, 83, 166), as well as with Dove's discovery that analogous at-

atmospheric states are more frequently found under the same meridian than under the same parallel, and with Mr. Ferrel's demonstrations of the tendency in fluids gyrating normally to move towards the pole, the parabolic route of the cyclones, the lateral pressure of moving bodies, and the disposition of the axis of rotating bodies to parallelism with the earth's axis.[2] (Math. Monthly, i, 307; ii, 95, 380, 382.) The rationale is generally so obvious that the necessity of the experiments may reasonably enough be doubted by some, while others may question the validity of any inferences as to magnetic motions that are drawn from the effect of impulses which are confessedly purely mechanical.

Such doubts may perhaps be removed by considering, 1st, the well-known danger of being led astray by the simplest undetected fallacy in *à priori* reasoning, which renders it desirable to obtain experimental verifications of every philosophical inference; 2d, that if all forms of force are, as is so generally supposed, mutually convertible, the convertibility can only be discovered through their mechanical momentum; and 3d, that *all the experiments illustrate the magnetic influence of a fluid controlled by the reaction of disturbed gravitation.* I have shown that forces proceeding in lines corresponding to those which represent solar and planetary[3] influence produce magnetic deflections equivalent to the observed solar-diurnal, annual, decennial, and secular variations; and if it can be also shown that gravitation is an adequate force, we need seek no farther for a *vera causa*, or for conclusive evidence of the correlation of *all* the great cosmical forces.

Whatever theory we may favor respecting the nature of force, and the manner or medium of its transmission,—whether we consider, with Fresnel and Grove, that the luminiferous and kinetic æther is material and ponderable; with Mossotti and Faraday, that it is imponderable; or with Dana, that the hypothesis of any medium is entirely superogatory[4] (this Journal [2], iv, 379, 382), it will be generally admitted that the quantity of motion is the proper measure of force. In an ordinary tempest, every flash of lightning is followed by a thunder-clap, which is occasioned by the reacting gravitation of the air in the restoration of disturbed equilibrium; and, on the

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[2] Mr. Ferrel refers, for a beautiful illustration of some of his propositions, to Foucault's experiments with the gyroscope. (This Journal, [2], xv, 263; xix, 141).

[3] The connection which has been pointed out by Sabine between Schwabe's theoretic course of the solar-spot phenomenon and the magnetic 10-11 year period (Phil. Trans., 1852, Art. VIII) acquires a new interest from Prof. Wolf's continued investigations into the influence of the several planets upon the sun-spot curve. (See Monthly Notices of the Royal Ast. Soc., May 12, 1865.)

[4] Is the "*pulsating molecular force*" of Prof. Dana's hypothesis material or immaterial? If the latter, is it intelligent or unintelligent? How can momentum be imparted by velocity without material mass, unless it be by the direct and voluntary act of a competent intelligence?

other hand, in water-spouts and tornadoes, the flashes seem to follow, instead of preceding, the equalizing action of aërial gravitation. We have never yet been able to measure the electrical and gravitating momenta in such instances of violent commotion; but we can hardly doubt their exact equivalence, in view of the well-established law, that "action and reaction are always equal and in opposite directions." And in consideration of such probable equivalence, it does not seem unreasonable to quote them as standing evidences of that long-desiderated link in the chain of kinetic unity, for the recognition of which the way has been partially prepared by Henry's discovery of the tendency to equality of electric momenta, and the correlation of intensity and quantity-currents (this Journal, [1], xxxviii, 218), Challis's hydrodynamic researches (Phil. Mag., vol. i, sqq.), especially in their application to the explanation of gravity as a necessary resultant of universal æthereal vibrations (Ibid. [4], xviii, 321, 443), Helmholtz's paper, "in which he has pointed out that the lines of fluid motion are arranged according to the same laws as the lines of magnetic force, the path of an electric current corresponding to a line of axes of those particles of the fluid which are in a state of rotation" (Crelle's Journal for 1859, referred to by Prof. Maxwell in Phil. Mag. [4], xxi, 348), Rankine's "Summary of the Properties of Certain Stream lines" (Phil. Mag., Oct. 1864, pp. 282–8), Norton's recent articles on "Molecular Physics" (this Journal, [2], vol. xxxviii, sqq.), and a variety of other physical discussions, some of which I have already cited.

The analogies which were pointed out by Gen. Sabine between the thermal and magnetic curves (Hobarton Obs., I, xli; Toronto Obs., I, xxxviii; St. Helena Obs., I, 38, &c. &c.) have been very fully, and, generally speaking, satisfactorily discussed by Profs. Norton (this Journal, [2], vols. 4, 8, 10, 19, 20) and Secchi, (Phil. Mag. [4], vols. 8, 9), the former directing his attention exclusively to the correspondence between the magnetic and thermal variations, the latter to a hypothetical specific magnetism resident in the sun. *All of the reasoning of both these distinguished physicists can be applied, even more convincingly, in support of the hypothesis that simple gravitation-disturbances correspond to those of magnetism, and many of the difficulties in the way of other theories disappear before such an application.*

Having established the coincidence and equivalence (with opposite signs) of the magnetic and gravitating lines of force (Trans. A. P. S., vol. xiii, Art. VI), the modifying magnetic influence of rotation (Ibid., pp. 120, 129), barometric tides (Ibid., pp. 123–7), winds (Ibid., p. 121, and Proc. A. P. S., x, 104), thermal changes (Gen. Sabine, loc. cit.), and lunar attraction (Proc. A. P. S., ix, 434–8; Trans. A. P. S., xiii, 129; and Gen.

Sabine's Diagrams, Toronto Obs., vol. iii, plate 2), and the probable, if not certain, dependence of the variations of long period upon trade-winds (supra, Exp. 19–24) and planetary positions (Sabine and Wolf, loc. cit.), the hypothesis of any peculiar magnetic æther, electric currents, or specific solar and lunar magnetism, to explain the normal perturbations of the needle, appears to be entirely superfluous and unphilosophical. Every particle of the earth's atmosphere is continually receiving and imparting the heat which is radiated from the earth and sun, its specific gravity constantly changing in such manner as to produce incessant rapid and short oscillations, both in the planes of the earth's thermal meridians[5] and in the great circles which pass through the centers of the earth and sun. The consequent disturbance of equilibrium, which is still further increased by the condensation of vapor, the sun's direct attraction, and the earth's rotation, is counterbalanced by terrestrial attraction, acting most forcibly where the sun is in the horizon, and with the least relative efficiency when the sun is in the zenith (or at noon in the summer solstice, provided the station is extra-tropical).

The pressure thus exerted varies from 0 ℔. to 15 ℔. per square inch. Taking the mean (7½ ℔. per square inch or 1080 ℔. per square foot) as the average equilibrating tendency, we have a force nearly fifteen times as great as that which produces, and more than twenty-eight times as great as that which is produced by a violent hurricane. (Enc. Britan., 8th edit., xiv, 647.) Only an insignificant portion of this mighty energy is exerted in the production of the various atmospheric currents, the remainder being quietly transmitted from molecule to molecule, and manifesting itself in barometric,[6] magnetic, and other meteorological perturbations. The adequacy of our supposed cause will therefore hardly be doubted; and, since its penetrating, pervading influence can be impeded by no material shield or screen, the demonstration of a correlation of heat and magnetism with the force which keeps the planets in their orbits appears to be complete and conclusive.

It is possible that a careful study of the relation of the winds to the various magnetic variations would bring to light other evidences of parallelism as striking as the one I have already pointed out (Proc. A. P. S., x, 104) between the curves of vertical magnetic force and force of wind. Such a study might require special attention to the pressure and velocity of the wind, the times of maxima and minima, and other particulars, the need of which would be suggested by experience.

[5] The earth's most powerful radiation is vertical, or in radial lines; next in intensity is the radiation towards the thermal poles, or along the thermal meridians; on the isothermal parallels, the radiation is comparatively insignificant.

[6] The morning and evening maxima, and the moon minimum of effective pressure, combined with rotation, are the principal causes of the daily barometric tides.

Whatever cause affects at the same instant the magnetic and aërial currents should first manifest itself through its influence upon the needle, on account of the amount of inertia in the air. Upon examining the second volume of the St. Helena Observations, which contains a record of the direction of the wind at intervals of six hours, so arranged as to facilitate a comparison with the magnetic declination, I find in each year, from 1844 to 1847 inclusive, that at one hour before the observation of the wind (and in each year except 1846, at the hour of observation) there was a greater average westerly declination when the wind was nearly east than when it was nearly S. by E. This is shown by the following table, which embraces all the tabulated instances when the wind was E. by N., E., E. by S., or S.S.E., S. by E., or S.

The variation of declination is ascertained, 1st, by subtracting from the observed declination the monthly mean at the same hour; 2d, subtracting the monthly average of the daily means from the mean variation of the day; and 3d, subtracting the latter result from the former. One scale division of the declinometer =0′·711. Increasing numbers denote decreasing westerly declination.

Year.	E. by N., E., or E. by S.					S.S.E., S. by E., or S.		
	No. of observations.	Var. of decl'n 1 h. before obs. Scale divisions.	Average.	Var. of decl'n at hour of obs. Scale divisions.	Average.	No. of observations.	Var. of decl'n 1 h before obs. Scale divisions.	Average.
1844	11	−5·11	−·46	−10·66	−.97	81	+ 4·77	+·06
1845	10	−3·09	−·31	− ·52	−·05	283	−18·28	−·06
1846	20	−1·16	−·06	+ 4·37	+·22	191	+ 6·78	+·03
1847*	85	−4·96	−·06	−12·95	−·15	12	+ 1·52	+·12
Total,	126	−14·32	−·11	−19·76	−·16	567	− 5·21	−·01

The recent experiments of Marcus, showing the direct conversion of heat into electricity, (see London Chemical News, No. 286; Journal of the Franklin Institute, No. 478,) the well-known atmospheric daily cycles, with two maxima and two minima of electrical intensity,[7] and the tendency of the disturbance-variations of declination, inclination, and total force, to fluctuations which follow the solar-tidal and barometric-tidal hours,[8] are all noteworthy in this connection.

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* January to July inclusive.

[7] For some recent interesting observations upon atmospheric electricity, see communications of Dr. A. Wislizenus in the Transaction of the Academy of Sciences, St. Louis.

[8] The long series of observations at Toronto show this correspondence in a very striking manner. See Gen. Sabine's Report, iii, 63, table lvi.

ART. XIV.—*Notice of a new group of Eocene Shells;* by T. A. CONRAD.

IN dividing the Tertiary deposits into groups, according to difference of genera and species, it is objected by some naturalists that the diversity might be occasioned by a difference in depth of water at the same period of time. This and other causes originate a marked variation in the Miocene deposits of Maryland and Virginia, but the palæontologist is never in doubt of the relations of these Miocene localities. When, however, we find two beds in juxtaposition, the testacean groups of which differ entirely in species, and the evidence is clear that they must have lived and died in or near where they are now found, we are justified in giving each group a distinct name, and in supposing that they represent different periods of time. The strata at Vicksburg, Miss., as represented from the base at low water to the top of the Oligocene, decide a point of great importance in Tertiary geology. Neither Lyell, Ruffin, nor Tuomey, who all give a slight notice of Shell Bluff, on Savannah river, say anything of the age and relations of the large Ostrea Georgiana, so abundant there. Fortunately, at Vicksburg this shell occurs in the lower part of the bluff, below the Orbitolite limestone of the Jackson Group, associated with a distinct group of shells peculiar to a well-marked subdivision of Eocene strata. We know nothing from the geologists who have examined Shell Bluff of any species of shell associated with O. Georgiana; but at Vicksburg the species are well preserved, and are remarkable for having no affinity with species above or below them. I propose therefore to distinguish this assemblage of testacea by the name of the Shell Bluff group, the situation of which is in the Upper Eocene. There is no town near its outcrop other than Vicksburg by which its locality could be more precisely indicated, but it is only in Warren Co., Miss., that the group can be clearly defined by other fossils than Ostrea Georgiana.

The following section will show the relative position of this group:

VICKSBURG BLUFF.

Calcareous silt with land shells of recent species,	10 to 20 feet.
Bluish and yellowish hardpan, often pebbly,—orange sand,	5 " 20 "
Vicksburg Group.—Marl, etc.,	60 " 65 "
Jackson Croup.—Orbitolite limestone.	
Shell-Bluff Group.—	
Black lignite clay and gray sand with *Ostrea Georgiana* Conrad, *Corbula alta* Con., *Natica? Mississipiensis* Con., *Clavella Vicksburgensis* Con., *Triptonopsis subalveatus* Con., *Busycon nodulatum* Con.,	5 feet.
Gray or black lignitic clays and sands,	25 "
Solid lustrous lignite,	3 "

ART. XV.—*Professor Treadwell's Improvements in constructing Cannon;* Address of the President of the American Academy of Arts and Sciences (Prof. ASA GRAY) upon the presentation of the Rumford Medal to Professor TREADWELL, November 15, 1865.

[Extr. from the Proceedings of the American Academy, vol. viii.]

AT the Anniversary Meeting last May, upon the unanimous recommendation of our Rumford Committee, the medal founded by Count Rumford was by the Academy awarded to Prof. Daniel Treadwell, for certain improvements in the management of heat. This medal is now before us. It is the first which the Academy has ever bestowed upon one of its immediate members.

As your organ upon this occasion, before we place this testimonial in the hands of our distinguished associate, it is proper that I should briefly specify the grounds upon which your Committee proposed, and you made, this award. It is well understood, and the terms of the vote distinctly show, that this medal was awarded for an invention or an improvement in the management of heat. It is also well known that this particular improvement is a part,—the initial part, indeed,—of a series of inventions,—applicable to other uses, no doubt,—but through which the character of ordnance has been changed, and its power immensely increased. This was the end and aim of the improvement for which the medal is given.

We may, therefore, and we must upon this occasion, speak of this particular improvement in the management of heat in connection with the mechanical inventions which accompanied and followed it, and to which indeed the former is incidental. For the whole important series of mechanical inventions which I am to recapitulate, the Academy must regret that it has no honors which it can bestow. But their history is upon our records, embodied in the communications addressed to us by their author from time to time; and we can only hope that the country and the world, when at length sensible of their obligations, may render the tardy meed of justice, if not of gratitude.

In his earliest communication,—a pamphlet published in the year 1845,—Mr. Treadwell seems to think that the appropriateness of the term "useful," as applied to an improvement in implements of destruction, may be questioned. We need have no misgivings in this respect. So long as life and property, which the ravages of war destroy, are not the most valuable of human possessions, they may be justly yielded and taken, if need require, for the preservation of those that are. And so nations must always count among their greatest benefactors those whose inventions increase their strength and defense in war. And certainly those men who, by their inventive genius, revolutionize the art of war, exert a most powerful and enduring influence upon the fate of empires, the course of history, and the progress of civilization.

We in our day, within the last fifteen years, have witnessed a change in the means of attack and defense greater than any made in the two hundred years previous, a change involving a complete revolution in tactics, both on land and on sea. To take a single illustration from heavy ordnance,—in which the importance of the change impresses us when we are told that our strongest forts, armed with the best guns we had ten years ago, could oppose no effectual resistance to the entrance of such ships as are now built into any of our harbors; and that a ship could now be built and armed, which, singly, would overmatch our whole navy as it was in 1855.

Fortunately, the balance is redressed by equal improvement in defense.

The improvement in fire-arms, both great and small, is in their increased range and precision. When the effective range of a musket-bullet was extended from 200 yards to 1400 or more, it became imperatively necessary that ordnance should be improved in the same ratio, or it would be useless, as gunners and horses would be picked off by small arms long before they could effectively reach the enemy. This improvement in guns of great calibre has been made, with consequences the importance of which, present and prospective, cannot be overestimated.

But the point which we have to consider is, that this increased range and precision are entirely dependent on the augmented strength of the gun. The weakness of the gun is the only thing that imposes a limit to the range, short of the absolute strength of the explosive material used. It is the strength of the gun which not only gives the range, but makes rifling possible, with precision and all the advantages of elongated shot. All inventions relating to the different modes of rifling, the form of the projectile, and the devices for breech-loading, are necessarily subordinate to the question of strength: with this sufficient, those become simple problems, to be rapidly determined by the ingenuity of many inventors.

Now the limit of strength of cast-iron and of bronze cannon had long ago been reached. Excepting Captain Rodman's improvement, and certain modern advantages in working and casting metals, no material advantages had been gained over guns cast in the reign of Queen Elizabeth.

But the most effective guns of the present day embody new principles of strength. They are all *built-up* guns. With them are associated the names of Armstrong, Blakely, Whitworth, Parrott and others. Whatever may be the relative merits of these several varieties, our interest is confined to the question of their strength, that is, to the principles of their construction which have made them stronger than common guns, and rendered their respective subordinate improvements possible.

These principles are two, and their introduction at different times into the manufacture of cannon constitutes two successive steps, and the only steps, which give distinctive character to the guns under consideration. Both originated with Mr. Treadwell.

These two inventions are often confounded, although more than ten years elapsed between them. The confusion is doubtless owing in some degree to the fact that the two are found combined in nearly all the modern built-up guns. The first initiated a system of construction which may be designated as the *coil system ;* the second, what may be named the *hoop system.*

The first was successfully applied to the making of cannon by Mr. Treadwell in the year 1842, and a full account of it was published in 1845 ; the gist of the invention being in so constructing the gun that the fibres of the material shall be directed around the axis of the calibre.

This method of construction is described in Prof. Treadwell's own language as follows: "Between the years 1841 and 1845 I made upwards of twenty cannon of this material [wrought iron]. They were all made up of rings, or short hollow cylinders, welded together endwise; each ring was made of bars wound upon an arbor spirally, like winding a ribbon upon a block, and, being welded, and shaped in dies, were joined endwise when in the furnace at a welding heat, and afterwards pressed together in a mould by a hydrostatic press of 1000 tons' force. Finding in the early stage of the manufacture that the softness of the wrought iron was a serious defect, I formed those made afterwards with a lining of steel, the wrought iron bars being wound upon a previously formed steel ring. Eight of these guns were 6-pounders of the common United States bronze pattern, and eleven were 32-pounders of about 80 inches' length of bore and 1900 pounds' weight."

The soundness and value of this principle of construction were fully confirmed in England by the experiments of Sir William Armstrong in 1855, and attested by his evidence before a committee of the House of Commons in 1863. He there describes his own gun as one "with a steel tube surrounded with coiled cylinders,"—as "peculiar in being mainly composed of tubes, or pipes, or cylinders, formed by coiling spirally long bars of iron into tubes and welding them on the edges, as is done in gun-barrels." His indirect testimony to the originality of Mr. Treadwell's process is equally clear; viz: that, within his knowledge, no cannon had ever been made upon this principle until he made his own in 1855,—he being, as we must suppose, ignorant of what Mr. Treadwell had done thirteen years before. The statement of Mr. Anderson (witness before the Commons' Select Committee), made before the Institute of Civil Engineers in 1860, is equally explicit as to the nature and value of this method of constructing cannon. And, finally, the high estimate of its importance abroad is shown not only by the honors and emoluments conferred by the British government on the re-inventor, but still more by the actual adoption of this gun as the most efficient arm yet produced. For it must be borne in mind that the faults or failures, complete or partial, of the Armstrong and similar guns, are not of the cannon itself, as originally constructed, but of breech-loading contrivances, of the lead coating of the projectile, or of other subsidiary matters.

That our colleague's original invention, the value of which is now so clearly established, should have been so generally unacknowledged by inventors abroad is his misfortune, not his fault. For, not only were his guns made and tested here, and their strength as clearly demonstrated before 1845 as they have been since, not only was a full account of the process and of the results published here in that year, but a French translation of his pamphlet was published in Paris, in 1848, by a professor in the school of artillery at Vincennes, and Mr. Treadwell's patent, with full specifications, was published in England before Sir William Armstrong began his experiments.

The difficulties to be overcome in making such a gun,—great at all times, as Sir William Armstrong and Mr. Anderson testify,—were far greater in 1842 than in 1863. These difficulties were mainly, if not wholly, in welding large masses of wrought iron in the shape of tubes or cylinders. It is for overcoming these difficulties that this medal is bestowed, and especially for the means and appliances by which this difficult mechanical achievement was effected in the furnace "by the agency of fire."

An incidental but noteworthy part of the improvement was the welding by hydrostatic pressure,—an operation which is just now coming into use in England, but has not yet attracted attention in this country.

We come now to the second improvement in the construction of artillery, the invention of the *hooped gun.*

This is not always clearly distinguished, even by those occupied with the subject, from the gun formed of coiled rings. But a simple statement will bring into view distinctly the new principle of strength here introduced.

If an elastic hollow cylinder be subjected to internal fluid pressure, the successive cylindrical layers of the material composing it, counting from within outwards, will be unequally distended, and the resisting efficiency of the outer layer will be less than that of any layer nearer the axis. And if the walls of the cylinder are thick, and the internal pressure surpasses the tensile strength of the material, its inner layer will break before the outer one has been notably strained. Hence the tensile strength of a square inch bar of the material is the measure of the maximum pressure the cylinder can bear, when constructed as guns were before the introduction of the improvement now under consideration. The improvement does away with this limit, and enables us to go indefinitely beyond it.

This is accomplished by so constructing the gun that the inner layers are compressed by the outer; whereby the internal pressure is first resisted by the outer layers, which must be distended enough to allow the internal compressed portion to attain its normal condition, before this internal portion, (which is the first to break in the common gun) is subject to any strain at all. It will be perceived that if this principle could be rigorously applied, a cannon could be made so perfect that, when subjected to a bursting pressure, every fibre, from the internal to the external surface, would be at that instant equally extended, each contributing its full share of resistance to fracture. The whole resistance would be proportional to the area of fracture.

This was supposed to be the case in common cylinders before the error was pointed out by Barlow, and also by Lamie and Clapeyron. And it was this erroneous supposition that led Count Rumford to his exaggerated estimate of the force of gunpowder, as tested by its power of bursting gun-barrels. If he had used the theory which gave origin to the hooped gun, his results would nearly have agreed with modern observations.

The demonstration of the superiority of the hooped gun, with detailed directions for its construction, is contained in a paper read before this Academy in February, 1856, and published at the beginning of the sixth volume of our Memoirs. This was the first published account of the invention, which had been patented nearly a year before. Captain Blakely's pamphlet, published in England in 1858, sets forth the advantages of this construction by similar arguments; as also does an elaborate paper read by Mr. Longridge before the Institution of Civil Engineers in February, 1860. Both these gentlemen, however, were engaged in researches upon this subject at an earlier date, but not so early, it would appear, as Mr. Treadwell was.

The validity of the principle, and the soundness of Mr. Treadwell's views upon the whole subject, as set forth in his memoir, have been amply confirmed by special experiments made in England with the Blakely and Whitworth guns, and by experience in this country during the last four years with the Parrott and the Blakely guns.

It must not be supposed that the earlier invention is superseded by the later one. That is used in forming the hoops of the Parrott gun, and in most of the British guns. And the best gun which could now be made, as experience has shown, would be composed of a barrel of cast iron or steel, inclosed and compressed by a cylinder of coil.

We need not discuss the question of priority of invention between Mr. Treadwell and others, competitors for a share in the honor of producing the modern cannon. His independence of each and all of them has never been called in question. Nor will it ever seriously be thought that the previous futile attempts at constructing wrought-iron and banded guns,—foredoomed failures both in theory and practice, and destitute of all pretension to a knowledge of the guiding principles now clearly seen to be essential to success,—should detract in the slightest degree from the great honor which our associate has, by a clear insight into the conditions of the problem and the resources of physical science, so fairly and completely won.

Upon these two inventions has been set the seal of experience. But there is still another memoir, read by Prof. Treadwell before this Academy in April, 1864, and printed soon afterwards, which promises to add a third important improvement in the construction of artillery.

Perceiving that the body of a hooped gun, if made of unmalleable cast-iron, compressed by a soft wrought-iron hoop, must give way, by the fracture of the cast iron, before the hoop can approach the ultimate limit of its strength, and that this was, in fact, a principal cause of the failure of so great a part of the large guns of Blakely and Parrott, Prof. Treadwell, as the principal result of this third investigation, proceeds to show, that, to attain with effect the end sought for by hooping a cast-iron gun, it is necessary to harden the wrought-iron hoop by cold hammering and severe stretching before placing it upon the gun-body. He computes, that, by this simple means, a hooped gun may be made *more than twice as strong* as those which have been constructed by Blakely and Parrott, the materials being in both cases the same.

In this important discovery, as also in other matters discussed in his latest memoir, we are gratified to see, that, although now carrying the weight of more than three score and ten years, our veteran colleague still keeps the lead, which he gained at the start, of his competitors in this race of improvement.

So completely do these three improvements cover the ground, that if the works of all other inventors who claim a share in the great gun of the nineteenth century were lost, the gun could be restored (rifling excepted) from Mr. Treadwell's papers alone.

And now, Mr. Treadwell, in delivering into your hands this beautiful gold medal and its silver duplicate, I have much pleasure in conveying with them the congratulations and best wishes of your associates here assembled; also the expression of their hope that you may yet longer lead the race; and especially that you may long enjoy the scientific honors which you have worthily won; and with them, if it may be so, have the full recognition of the rights, and possession of the advantages, which pertain to your inventions.

SCIENTIFIC INTELLIGENCE.

I. *Correspondence of Prof.* Nicklès, *dated Nancy, France, Oct.* 12, 1865.

1. *Jean Thiébaut Silbermann.*—Among the losses which science has experienced of late in France we have to mention that of the Superintendent of the Conservatoire des Arts et Metiers, Mr. Silbermann, the elder, —distinguished as a physicist, and also for his admirable researches in thermal chemistry in which he was associated with Mr. Favre. To a spirit of observation he added extraordinary skill in devising experiments and contriving apparatus and in discovering and remedying defects in the latter. He was obliging to an extreme, and so much interested in the labors of others as to forget what was due to himself. He died without honors or fortune, and left his wife and children almost in a state of poverty.

The following facts are from an autobiographical notice which he prepared some years since at our request. A list of his principal works is added at its close.

J. Th. Silbermann was born Dec. 1st, 1806, at Aspach le Pont, in that part of Alsace which forms the department of the Haut-Rhin. His father, who was a Captain of Artillery, put him early at his scientific studies, and later, let him take the course of the Faculty of Sciences at Strasbourg. Here the young man learned drawing, and acquired a decided taste for physics and chemistry.

Thus prepared, he went to Paris and became apprenticed to Mr. Tecker, a distinguished manufacturer of physical apparatus, where he was able to indulge his taste for experimental physics.

While laboring under this accurate instructor he attended the courses of lectures of the Faculty of Sciences at Paris, and soon attracted the attention of Prof. Pouillet, an associate of Gay-Lussac. Prof. Pouillet made him his experimenter, and also his associate in the investigations he had in process on electricity and heat in which Mr. Pouillet acquired the most of his reputation. Mr. Silbermann thus helped his master to obtain a seat in the Institute.

In 1830, Mr. Silbermann quitted his uncertain position, which gave him unceasing occupation, to accept a place as Engineer of bridges and causeways. He was attached to the works for diking the Rhine, and continued in this capacity until 1836.

But topography and hydraulic works could not make him forget experimental physics. He returned to Paris at the call of Prof. Pouillet, but under better circumstances than before, to be experimenter in physics in the Faculty of Sciences, and also at the Conservatory of Arts and Trades where Pouillet also gave a course on physics.

Here he remained till 1848, at which time he was appointed Superintendent. It was during this period that his taste for exact workmanship became manifested in lasting results. It was he who engaged Ruhmkorff to make the Melloni apparatus used for repeating Melloni's experiments on the radiation of heat; and Soleil to construct the diffraction and interference apparatus, adapted for exhibiting experiments on these subjects in a course of public lectures. He was the first also to project upon a screen the beautiful phenomena of the polarization of light; they were shown for the first time in 1838, during the course of physics at the Faculty of Sciences.

Exhibitions of this kind on a grand scale were rendered possible by the *heliostat*, which he had constructed, and which is now in common use. It is true that many heliostats were known before, among others those of S. Gravesende, Fahrenheit, Charles, and finally that of Arago, executed by Gambey; but all these instruments were too difficult of use for the lecture room, and even for private study were hardly available. The necessity of these "porte lumières" was keenly felt especially in optics. The heliostat of Silbermann was presented to the Academy of Sciences, on the 27th of February, 1843. It was promptly adopted by physicists, for it met all the mathematical conditions of the problem without loss of precision, and cost but one-third that of Charles, or of Gambey.

It was while he was laboring for the reputation of Pouillet (in 1838) in investigations upon the dilatation of gases, that he had occasion to demonstrate the property of gases of condensing on the surface of thin plates of platinum. It was also about this time that, in a series of experiments on the density of liquids, he employed as *tare* a glass vessel identical in density, form, and capacity with the flask, and in this way arrived at a method always available when it is desired to avoid errors arising from hygrometric or barometric variations.

Silbermann was a man of extraordinary manual dexterity. With the most restricted and the simplest means, he improvised the most delicate apparatus. He justified completely the portrait that Franklin drew of a true philosopher: "He should be able to saw with a file, and to file with a saw." The physicists of Paris knew him well; and when an experiment did not succeed, they resorted to Silbermann, who could generally relieve them of their embarrassment. He was thus the great resource of inventors of all kinds; and not seldom it happened that he left his own labors and sacrificed his time to undeceive the searcher for the philosopher's stone, or for the secret of perpetual motion.

Silbermann was an excellent draftsman. It was he who made the drawings for the plates in Pouillet's Treatise on Physics. He modelled admirably in wax, and without having even learned the art. These artistic gifts show how it happened that his labors sensibly wore upon his system, and finally terminated his career.

By his labors Silbermann was entitled to honors and dignities; but, as with Laurent, his modesty constantly held him back from them. For, at Paris, merit alone is not always enough to ensure elevation; a degree of audacity, tact, and some patronage are also required. Poor Silbermann had nothing of all this; he did not express himself easily either in words or in writing.

He died July 4th, 1865, well satisfied that, as some return for his services, he should be remembered by those who survive him. Will he be mistaken in this hope? In the giddy steeple-chase which occupies the scientific world of Paris, there is no stopping for those who fall; the prize is for those who reach the goal; it matters little by what means.

List of the Scientific labors of J. Th. Silbermann, taken from Poggendorff's Handwörterbuch.

Instrument for measuring the focal distance of lenses and mirrors, (28 Feb., 1842). This instrument is known as the Focometer.

Heliostat, to direct the beams of the sun into the interior of the camera, as well as into the lecture room, (Feb. 7th, 1842). This instrument is known in science under the name of Silbermann's Heliostat.

Apparatus for demonstrating the phenomena of reflection, refraction and polarization, applicable also to the determination of the angles of crystals, (June 17th, 1844).

Sympiesometer, perfected (1845).

Cathetometer for measuring barometric heights, &c. (July 7th, 1845).

Experiments on the rapidity of motion of Electricity, (March 27th, 1847).

Centesimal alcoholometer.

Apparatus for the comparison of measures.

Apparatus for linear dilatation.

"Comparateur a levier" for measuring meters.

Air-pyrometer for measurement of high temperatures. This apparatus gives the temperature of fusion from 150° to 1,500° C.

Metrical measurements of the human body. Mean of human size. Law of length and breadth. Origin of measures of length, and their relation to the mean stature of the human body.

Finally, those beautiful researches now classic, upon the heat of combination, carried on with Prof. Favre, researches which occupied him more than three years and find their place in all treatises. They are published entire in the "Annales de Chimie et de Physique" for 1853. They are illustrated by some hundreds of experiments.

2. *The works of Lavoisier.*—Chemists who have read the "Chemical philosophy" of Prof. Dumas, know the earnest words with which that chemist, in 1836, entered upon the task of getting out a complete edition of the works of Lavoisier. Our readers are aware from our former communications (this Jour., xxxii, 98, xxxv, 262) that this engagement is on the point of being fulfilled, that the edition is in the press, and that three volumes have already been published at the expense of the State.

Many events have prevented the prompt publication of this important work, although, in 1843, Dumas, then President of the Academy of Science, obtained from the Minister of Public Instruction permission that the publication should be made at the expense of the department. It was not till 1861 that his plan began to be executed; three volumes have appeared; the fourth is in the press; this will be followed by two others, treating of questions on administration, agriculture, political economy, &c.

Lavoisier was a complete man. He was not only remarkable as a chemist and physicist; he was an administrator of no ordinary merit. This is evident in the papers which he has left, and which will appear with the series of unpublished documents that Dumas has collected in part from the family of Lavoisier, and in part from notes made by this unfortunate savant during his journeys, which, as well as his laboratory notes and other papers, were happily preserved, they having been long in the hands of Arago to whom they were confided by the daughter of Lavoisier.

3. *Magnesium Light.*—The remarkable properties of magnesium light are now familiar to all. (See this Jour., xl, 287.) Some facts have been recently observed that are not yet generally known. As regards its chemical effects, this light is well fitted to render luminous phosphorescent bodies, as was fully ascertained by Mr. Chautard in the month of January, 1865. This is now a lecture-room experiment. Take a series of wide tubes enclosed in a box and filled with phosphorescent substances. All these tubes are white; but when struck by the magnesium light each becomes phosphorescent, taking its own special color. About a year since, also, Mr. Lallemand discovered that a mixture of chlorine and hydrogen will explode under the influence of magnesium light; and, moreover, that this explosion does not take place in darkness, nor under the influence of the red or yellow rays, as had already been remarked for common light by Gay Lussac and Thenard.

Magnesium ignites even in the vapor of water, when it is brought in contact with it in a tube containing magnesium heated over an alcohol lamp; the metal burns with brilliancy, disengaging the hydrogen. Under the same circumstances zinc will not burn except at a much higher temperature. This observation has just been made by Messrs. Deville and Caron; these chemists satisfied themselves that magnesium, when cold, decomposes water in the presence of the feeblest acids, even of carbonic acid.

If this metal were not so expensive its light could be applied to numerous uses. A recent invention of an Italian, Mr. Carlevaris, may perhaps prove to be a successful application of it. In place of the metal, he takes the chlorid of magnesium, which he exposes to a jet of ordinary illuminating gas and atmospheric air with a tenth part of oxygen. The light thus produced is very brilliant and appears to answer admirably for the production of photographic images, or for magnifying them.

At first Mr. Carlevaris used magnesia, and also carbonate of magnesia. But he found afterwards that the chlorid gave better results.

4. *New facts concerning Thallium. Position of Thallium in classification.*—Mr. Crookes persists in arranging thallium near lead (Journ. Chem. Soc., April, 1864), while Mr. Lamy is equally decided in placing it among metals of the 1st section. Each cites facts favorable to his own views. In a review of all these facts and considerations in the Journal of Chemistry and Pharmacy (Nov. 1865) I have shown the possibility of resolving the question by placing thallium with the alkali metals, but also including with it lead and silver. This opinion confirms a theory brought forward twenty years since by Mr. Baudrimont, who even then ranked lead with barium. Now that we have an alum with a base of oxyd of silver, isomorphous with the alum of thallium, that of potassium, etc., there is less objection to putting in the same group all these metals, although in other respects they are quite dissimilar. The facts mentioned tend to show that thallium should be considered as establishing a point of union between the alkali metals on one side, and lead and silver on the other.

5. *Bromo-thallic and Iodo-thallic acids.*—After having established the fact that thallium forms with bromine and iodine the compounds $Tl\,Br^3$, $Tl\,I^3$, I have found also that these compounds act like acids and form with the bromids and alkaline iodids, bromo-thallates and iodo-thallates, perfectly definite and crystallizable (Feb. 1864). These compounds are isomorphous with one another. Further, the acids $Tl\,Cl^3$ and $Tl\,Br^3$ are capable of combining with several equivalents of ether. $Tl\,I^3$ however does not so combine under these circumstances; it has not yet been isolated.—*Comptes Rendus, March*, 1864.

6. *Separation of lead and of bismuth by means of Bromo-thallates.*—There has been till now no process known by which lead can be easily separated from bismuth. The alkaline bromo-thallates, of which I am speaking, furnish us with the means. In fact, when these salts are pure and free from chlorids or from bromids in excess, they do not act upon the salts of lead, while they yield with the salts of bismuth a white precipitate of bromo-thallate of bismuth. This white precipitate is soluble in a concentrated solution of sal-ammoniac. The reagent employed is one of the salts which I have described.

$Br^3\,Tl,\ Br\,K+4HO$; rhombic tables.
$Br^3\,Tl,\ Br.Am+8HO$; crystallized in yellow needles.
$Br^3\,Tl,\ Br\,Am+4HO$, isomorphous with the first.

Having a limpid solution containing a salt of lead, as well as one of the bromo-thallates of which we have been speaking, it is sufficient to add some nitrate of bismuth to obtain immediately a marked reaction; all the bismuth is found in the precipitate when a sufficient quantity of the bromo-thallate has been employed.—*Journal de Pharm. et de Chim.*, [4], ii, 218.

7. *On detonating Antimony.*—This metal, as Mr. Gore has observed, attaches itself to the negative pole of a pile, when a solution of the chlorid, bromid or iodid is subjected to voltaic action. Various explanations have been given of this peculiarity, and it is not surprising that it has been attributed to catalysis, or to a peculiar condition of the antimony. In preparing this metal, I have found that the deposit of detonating antimony is formed only when operating with a compound containing chlorine, bromine or iodine; and that, moreover, detonating antimony always contains a sensible proportion of a halogen element. I hence conclude that detonating antimony is not a metal in a peculiar condition, but that it owes its explosive property to the presence of a small quantity of a compound similar to chlorid of nitrogen. This explanation, which I first proposed in 1858, is in no way contrary to facts, for chlorid of nitrogen also is produced under the influence of the voltaic pile.

We may then expect to see formed an explosive phosphorus, arsenic, or bismuth, because of the analogies between these elements and nitrogen or antimony.

8. *Existence of chlorids corresponding to peroxyds.*—In treating peroxyd of manganese with hydrochloric acid, free chlorine is obtained, in accordance with the equation $MnO^2+2ClH=2HO+Mn\,Cl+Cl$ (1.)

The treatises add that half the chlorine is set free because the compound corresponding to MnO^2, that is to say the perchlorid $MnCl^2$, does not exist; for if so the equation would be $MnO^2+2ClH=2HO+MnO^2$ (2), with consequently, no free chlorine.

I have ascertained that the perchlorid $MnCl^2$ can really be obtained, and that the same is true of $MnBr^2$ and MnI^2. Various processes lead to this conclusion; the most important requisite is to use as little water as possible. On shaking in a tube, well cooled, peroxyd of manganese with a little ether saturated with chlorhydric gas, a liquid is immediately obtained of a green color which is nothing but a compound of $MnCl^2$ with C^4H^5O. This compound is rapidly reduced and discolored by SO^2, S, Ph, Al, Fe, Zn, PbS, SbS^3, &c.; it takes moistures from the air, and speedily undergoes alteration, giving out the gas ClH. In the presence of much ether it dissolves, changes color and becomes red, like mineral chameleon.

To perform the experiment in a public lecture, a little MnO^2 in powder is put into a white dish, and ether saturated with chlorhydric gas is poured upon it. It is stirred with a glass rod, and immediately the liquid becomes of a beautiful green color.

In default of ether saturated with ClH, chlorhydric acid in a saturated aqueous solution may be used; in this case the liquid becomes at first brown, but it turns green when ether is added. It is a very beautiful experiment.

The bromohydric and iodohydric acids act in the same manner. The products, however, are less stable than those obtained with MnO^2. The sesquioxyd of manganese gives similar results. At the same time I ascertained that the formation of the sesqui-iodid, Fe^2I^3, whose existence has been denied by Gmelin and others, is nevertheless possible when iodohydric gas is made to act upon sesquioxyd of iron and anhydrous ether in a very cold tube. Its stability is not great.

In France the perchlorids (perchlorures) bear the name of singulo-chlorids (chlorures singuliers) conforming to the denomination of singulo-oxyds which Dumas has imposed upon peroxyds, such as MnO^2, PbO^2, BaO^2, &c.—*Annales de Chimie et de Physique*, [4], v, 161.

9. *Combinations of Boron with the Halogens.*—Anhydrous boracic acid dissolved in absolute alcohol, and treated with a current of ClH, or BrH, acts like the oxyd just spoken of; that is, its oxygen separates itself from the chlorine and bromine so that it forms chlorid or bromid of boron, which remains in combination with the organic molecule.

Chlorid of boron, $BoCl^3$.—A solution of boracic acid in absolute alcohol absorbs with avidity the anhydrous gas ClH, and becomes oily. It fumes in the air. Water decomposes it, producing boracic acid, chlorhydric acid, and alcohol. It is not volatile. Although the liquid appears to be only a solution, it has a definite composition, expressed by the formula $3BoO^3, 3ClH+5(C^4H^5O)$. Heated, it emits torrents of the gas ClH, containing boron; the thermometer rapidly rises to 85° C. The residue is boracic acid. The volatile part is chloro-boracic ether, $BoO^3+5(C^4H^5O)+9HO$.

With boracic acid, anhydrous ether, and dry ClH, analogous results are obtained, if heat at 100° be employed.

Bromid of boron, $BoBr^3$.—The acid BrH gives very nearly the same results. The ethereal liquid collected at 115° C. has the formula $BoBr^3+13(C^4H^6O^2)+3HO$; or rather $BoBr^3+13(C^4H^5O)+16HO$.

All these ethers are alike in their acrid taste, the white fumes which they emit, and which contain some boracic acid, the accompanying compounds, and finally in their property of coloring dry tumeric brown, a property belonging also to dry chlorhydric gas.

These new compounds act with MnO^2 like ether charged with ClH; that is to say, it transforms it into $MnCl^2$ or $MnBr^2$; the sesquioxyds are equally attacked by it.

10. *Acclimatization of the Ostrich.*—In my letter of April, 1861, I have spoken of the attempts to acclimatize the Ostrich. The Society of Acclimatization continues to watch and encourage these efforts. They now begin to hope that even in temperate climates, the Ostrich may figure among the useful animals. The following are the facts upon which these hopes are founded. We have already seen that these animals can reproduce in captivity, but as yet only in the warm regions of Europe, at Florence, Marseilles, Madrid, or in Algiers. This year, however, a birth of ostriches has taken place in the cooler region of Grenoble, in the garden of acclimatization of the Regional Society of the Alps.

The ostriches at the time of breeding were kept in a chamber. After 46 days two young ones appeared, to which the female seemed as devoted as she had been indifferent to the eggs. On this occasion, as has been before observed, the little ones placed themselves only under the male, and received no nourishment from the parents.

After the results obtained in Spain, and since in England, we may hope also to acclimatize the Cassowary.

11. *Acclimatization of Salmon in Australia.*—After many unsuccessful attempts, arising from the eggs of the Salmon being hatched on the journey, they have at last succeeded in acclimatizing the Salmon in the fresh waters of Australia, and simply by retarding the hatching by keeping them in ice. We have already spoken of these attempts. The Society of Acclimatization at Paris learn from Mr. Ed. Wilson, President of the Society of Acclimatization of Victoria (Australia), that the young fish hatched in 1864 have done wonderfully well, and encourage the belief that their acclimatization and reproduction are assured facts.

12. *Vitality of the Salmonidæ.*—On this occasion, we may recall the results of some experiments that Mr. Millet has undertaken on the circulation in young Salmonidæ, such as the European Salmon, Trout, Greyling (Thymallus), and Coregonus. The result is very important to practical pisciculture.

In the earlier state, the vitality of the Salmonidæ has as its inferior limit −2° C, and as the higher +30° C. With trout, and with the Salmonidæ in general, the necessities of respiration increase with the temperature. Water in which the fish live should be much more aërated, or more frequently renewed, when the temperature is above +15° C. than when it remains below +10° C.

The transportation of embryonic eggs and of young Salmonidæ requires much less air, or less water, at a low temperature, than at a high temperature. The fertilized eggs will bear long journeys, and may be carried great distances, if kept moist at a temperature a little above zero. The most favorable temperature for the development of the young Salmonidæ is between 10° and 15° C.

13. *On the origin of terrestrial magnetism.*—Under this title I have pointed out in this Journal in 1854 (xvii, 116, xviii, 386, xix, 104,) that terrestrial magnetism has no other origin than that of the rotation of the earth; that the sun is a magnet, and also derives its magnetism from its rotation. I recall these facts with reference to a note on this subject published in this Journal, vol. xxxviii, p. 420, Nov. 1864.

14. BIBLIOGRAPHY.—*Archives of the Scientific Commission to Mexico,* vol. i. Paris, Imperial Press. 1865.—Besides the regulations organizing the Scientific expedition, decreed Feb. 27th, 1864, this first volume contains a series of memoirs and of instructions, of the highest interest, on the following subjects: On Anthropology, by M. Quatrefages; on Zoology by Milne Edwards; on Botany by Decaisne; on Geology and Mineralogy by Ch. Deville. There are also memoirs and reports by Messrs. Milne Edwards, Boussingault and Vaillant on different interesting Mexican subjects; and others by Baron Gros, &c., relate to the exploration of ancient monuments in Mexico and Xochicalco; on the manufacture of Aztec knives, in obsidian; on the ruins of Yucatan, and finally on different subjects connected with medicine, metallurgy, meteorology, natural history, and the agriculture of Mexico.

15. *Memoirs on the use of iodine and potassium in treating diseases from lead and mercury, and syphilis;* by M. MELSENS. Paris, 1865. In 8vo.—The object of this memoir is to show by experiments, the importance of iodine and potassium in the treatment of the diseases above mentioned. This treatment is founded on the power of iodine and potassium to render soluble, and eliminate from the state of double iodids, the metallic compounds which have been introduced into the organism. The facts cited by Mr. Melsens, and the cures performed appear conclusive. He gives also a brief review of experiments in Austria in the mercury mines of Idria, and in the Wieden hospital at Vienna.

16. *Figuier: La Plante.*—Botany illustrated, for popular use. One large vol. in 8vo, with handsome plates and beautiful drawings.—A work well adapted to the parlor from the facility with which the dryest details of natural history are made intelligible to the uninitiated.

17. *Victor Meunier; Science and its followers in* 1864. 2 vols. 12mo. —A critical review of the labors and achievements of men of science, written with much sprightliness and force. Among the principal questions treated are—"Aërial navigation, spontaneous generation, lake dwellings," &c., &c.

18. *Review of Medical Hydrology, both French and foreign, 8th year.*—This review is published every two months at Strasbourg, under the direction of Dr. Aimé Robert, chief editor. It treats of whatever relates to mineral waters, and also is occupied naturally with hydropathy, etc.

19. OBITUARY.—Dr. LEREBOULLET. While bringing this letter to a close the sad intelligence reaches us of the death of the geologist Dominique Auguste Lereboullet. He was Dean of the Faculty of Sciences at Strasbourg, and at the same time Professor, with great success, of zoology. He was also Director of the Museum of Natural History in that city. Time fails us to notice his life, which was devoted to constant study, or to speak of his labors, which have given him all kinds of recompense and a high rank among men of science. He died at Strasbourg, Oct. 6th, 1865, at the age of 61. He had been more than 40 years in the Faculty of which he was Dean.

II. CHEMISTRY AND PHYSICS.

1. *On Niobium and its compounds.*—**Blomstrand**, **Marignac** and **Hermann**, have published, respectively, investigations of the compounds of niobium; unfortunately, however, without disposing of the extraordinary difficulties of the subject, and without agreement of results. Blomstrand's conclusions may be briefly stated as follows: There are but two tantalum metals, niobium and tantalum, and these form but two acids, namely, niobic acid, NbO_2, and tantalic acid, TaO_2. Hyponiobic, dianic and ilmenic acids have no existence, and there are no peculiar acids in euxenite. The hyponiobic chlorid of Rose, Nb_2Cl_3, is a peculiar oxychlorid, probably $Nb_4Cl_5O_3$. The hyponiobic acid of Rose is the true niobic acid, and in a purer state is also the dianic acid of v. Kobell; Rose's niobic acid (at first called pelopic acid) is a mixture of niobic acid with tantalic acid, and Hermann was right in asserting that he had found tantalic acid in the columbite of Bodenmais. The equivalent of niobium is about 40. The native tantalates and niobates may be included under the general formula $2RO,5R, O_2$, and there are various mixed or intermediate minerals between the true tantalite of Kimito, $2FeO, 5TaO_2$, and the true niobite of Greenland $2FeO, 5NbO_2$.

Marignac has studied the fluorine compounds of niobium. He arrives at the conclusion that the hypo-fluoniobates contain three atoms of fluorine and that hyponiobic acid has a higher equivalent than that assigned by Rose, namely, 266 in place of 243·2. The crystallographic examination of the hypo-fluoniobates leads to the remarkable result that these salts are isomorphous with the fluo-stannates and fluo-titanates, so that $HnbF_3$ replaces Ti_2F_4 and Sn_2F_4. To explain this isomorphism Marignac assumes that the so-called hypo-fluorid of niobium is an oxy-fluorid and he exhibits the relations between the oxyfluo-niobates, fluo-titanates, and oxyfluo-tungstates, by the following formulas in which it must be observed that atoms and not equivalents are used:

Potassium compounds,	$TiK_2F_6 . H_2O$	NbK_2F_5O , H_2O	$WK_2F_4O_2 , H_2O$.
Copper compounds,	$TiCuF_6 . 4H_2O$	$TiCuF_5O , 4H_2O$	$WCuF_4O_2 , 4H_2O$.

According to this view the so-called hypo-niobic chlorid is an oxychlorid $Nb_2O_2Cl_3$, and hypo-niobic acid is Nb_2O_5, and might better be termed oxy-niobic acid. Marignac further shows that the formula $Nb_2O_2Cl_3$ agrees better with Rose's analyses than that given by Rose himself, Nb_2Cl_3. The author promises a further investigation of the subject.

Hermann has published a very extensive and elaborate memoir on the tantalum metals. He admits the existence of three distinct metals, namely: tantalum, niobium and ilmenium. Tantalic and ilmenic acids have respectively the formulas Ta_2O_3 and Il_2O_3; hypo-niobic acid is represented by the formula Nb_2O_3, and niobic acid by NbO_2. The columbite of Middletown contains both ilmenic and hypo-niobic acids; for Hermann's methods of separating the different acids from each other we must refer to the original memoir. According to him the equivalent of ilmenium is 52·37, and that of niobium 52·80, a degree of coincidence which does not increase our confidence in his results.—Blomstrand *in Ann. der Chemie und Pharm.*, cxxxv, p. 198; Marignac in the same, cxxxv, 49; Hermann *in Journal für prakt Chemie*, xcv, p. 65. W. G.

2. *On methyl-benzyl.*—The identity of toluol with methyl-phenyl, $\left.\begin{matrix}C_2H_3\\C_{12}H_5\end{matrix}\right\}$, was demonstrated some time since by Fittig and Tollens, but these chemists found that xylol was not identical with ethyl-phenyl $\left.\begin{matrix}C_4H_5\\C_{12}H_5\end{matrix}\right\}$, though isomeric with it. Fittig and Glinzer have now shown that xylol is identical with methyl-benzyl, $\left.\begin{matrix}C_{14}H_7\\C_2H_3\end{matrix}\right\}$, which may be obtained by the action of sodium upon a mixture of bromid of benzyl $C_{10}H_7Br$, and iodid of methyl, C_2H_3I. As thus prepared xylol boils at 139°. Ethyl-benzyl, $\left.\begin{matrix}C_{14}H_7\\C_4H_5\end{matrix}\right\}$, prepared in a similar manner boils at 150° C., and appears not to be identical with cumol.—*Ann. der Chemie und Pharm.*, lvii, p. 47. W. G.

3. *On the detection of chlorine, bromine, and iodine, by means of the spectroscope.*—A. MITSCHERLICH has succeeded in applying the spectroscope to the detection of extremely minute quantities of chlorine, bromine and iodine, and has thus materially extended the use of the instrument. His process is as follows: The dry solid substance to be examined is to be mixed with half its weight of sulphate of ammonia and one-tenth of its weight of oxyd of copper. The mixture is to be brought into the bulb of a glass tube which is connected at one end with an apparatus for generating hydrogen, while the other end near the bulb is open. Hydrogen is then to be passed through the tube and kindled, after which the bulb with the substance is to be heated slowly. The flame is at first colored by copper, but after the oxyd is reduced the spectrum of the haloid salt of copper makes its appearance as described and figured by the author in a former paper. In this manner without further practice, $\frac{1}{4}$ of 1 per cent of chlorine, $\frac{1}{2}$ per cent of bromine, and 1 per cent of iodine may be detected. As sulphate of ammonia gives a spectrum of its own, its use is disadvantageous when small quantities of chlorine, bromine and iodine occur together. In this case it is better to precipitate with a salt of silver, mix the precipitate with twice its weight of oxyd of copper, and proceed as before. In this manner we may detect $\frac{1}{10}$ per cent of chlorine, $\frac{1}{9}$ per cent of bromine, and $\frac{1}{8}$ per cent of iodine in the precipitate. The spectra follow each other in regular order: first that of chlorid, then that of bromid, and lastly that of iodid of copper; an effect which is due to the different degrees of volatility. When very small traces of bromine and iodine are present with a great excess of a chlorid, a decigramme of nitrate of silver may be added to the solution and the precipitate after standing a short time examined as above. In this manner five milligrammes of bromid of sodium were detected in one pound of chlorid of sodium, the spectrum of bromid of copper lasting five minutes. The process again repeated gave a second spectrum lasting six minutes. Since $\frac{1}{10}$ of a minute is sufficient for the recognition of the spectrum it follows that one ten-millionth of bromine can be detected by the spectroscopic method, and the reaction of iodine is equally delicate. In $6\frac{1}{2}$

pounds of sea water the author detected bromine, the spectrum lasting seven minutes, but the iodine reaction could not be obtained from this quantity of water. When organic substances are to be tested for bromine and iodine a tube with two bulbs must be employed. The oxyd of copper is to be placed in the bulb nearest the flame, and the organic substance in the other; the products of the distillation of the organic matter are thus carried over the heated metallic copper, and in this manner the smallest traces of chlorine, bromine and iodine may be detected even when traces of one are present with a large excess of the others. The author did not succeed in making satisfactory quantitative determinations by the above mentioned process. In conclusion, Mitscherlich states his conviction, based upon spectroscopic investigations, that iodine and nearly all the other metalloids are compound bodies, and promises to describe the experiments upon which this conclusion is founded.—*Pogg. Ann.*, cxxv, p. 629. W. G.

4. *On silicium-methyl.*—Friedel and Crafts have described the preparation and properties of silicium-methyl. By the action of chlorid of silicium upon zinc-methyl the authors obtained a limpid liquid lighter than water boiling at 30°–31° C., and burning with a bright flame which gives off a siliceous smoke. The analyses and vapor density agreed with the formula $\mathrm{Si(Ꞓ H_3)_4}$.† It is worthy of notice that the boiling point of silicium-methyl is 122° C. below that of silicium-ethyl, which makes a difference of about 30° for each $\mathrm{Ꞓ H_2}$. By the action of wood-spirit upon silicate of ethyl the authors obtained a liquid boiling between 143° and 147° C., and having the formula $\mathrm{Si\,Ꞓ_6 H_{16} \Theta_4}$, which corresponds to a diethyl-dimethyl silicate. The action of chlorid of silicium upon purified and dehydrated wood-spirit produces normal silicate of methyl and hexa-methylic bisilicate. The former is a colorless liquid with an agreeable ethereal odor, very soluble in water, and burning with evolution of white vapors. Its formula is $\mathrm{Si(Ꞓ H_3)_4 \Theta_4}$. The other silicate is also liquid; it boils at 201°–202·5°. Its formula is $\mathrm{Si_2(Ꞓ H_3)_6 \Theta_7}$. The difference between the boiling-points of the normal silicates of methyl and ethyl is 44° C., or only 11° for a molecule of $\mathrm{Ꞓ H_2}$. The difference between the boiling-points of the disilicates is 33°, or about 5° for $\mathrm{Ꞓ H_2}$. —*Bulletin de la Société Chimique*, May, 1865, p. 356. W. G.

5. *On the organo-metallic radicals.*—The researches of von Oefele upon the compounds of sulphur with ethyl have already been mentioned in this Journal. Cahours, without, as it appears, waiting for the completion of von Oefele's investigation, has taken up the subject and has prepared a number of analogous bodies of much interest. By the action of bromine upon sulphid of methyl $(C_2H_3)_2S_2$ the author obtained a body crystallizing in beautiful octahedral amber-colored crystals having the formula $S_2\left\{\begin{matrix}Me_2\\Br_2\end{matrix}\right.$. Oxyd of silver decomposes this substance and yields $S_2\left\{\begin{matrix}Me_2\\O_2\end{matrix}\right.$ which is entirely neutral to test paper. Iodid of methyl acts energetically upon sulphid of methyl and yields a white crystalline mass having the formula $S_2\left\{\begin{matrix}Me_3\\I\end{matrix}\right.$. The crystals become brown under the in-

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† Si = 28.

fluence of light, and with oxyd of silver yield $S_2\left\{\begin{matrix}Me_3\\O\end{matrix}\right.$, which possesses extremely energetic alkaline properties. The salts of tri-methyl sulphurine crystallize well, but are usually deliquescent. The iodid of ethyl-dimethyl sulphurine $S_2,\left\{\begin{matrix}Me_2\\Et\\I\end{matrix}\right.$, may be prepared in a similar manner, and yields a basic oxyd and crystalline salts. Iodid of methyl unites with tellurid of methyl to form a crystalline mass which has the formula $Te_2\left\{\begin{matrix}Me_3\\I\end{matrix}\right.$. With oxyd of silver this salt yields a basic oxyd. A similar ethyl compound also exists as well as analogous bodies containing selenium in place of tellurium or sulphur. Sulphid of allyl also combines with iodid of methyl, yielding the iodid of tri-allyl sulphurine $S_2\left\{\begin{matrix}(C_6H_5)_3\\I\end{matrix}\right.$. Bromid of ethylene, $C_4H_4Br_2$, unites with sulphid of methyl to form a bromid having the formula $C_{12}H_{16}Br_2S_4{=}S_4\left\{\begin{matrix}(C_2H_3)_4\\(C_4H_4)''\\Br_2\end{matrix}\right.$. This bromid yields a basic oxyd and well defined salts. Brominated bromid of ethylene $C_4H_3Br_3$ unites with sulphid of methyl to form a bromid having the formula $S_6\left\{\begin{matrix}(C_2H_3)_6\\(C_4H_3)'''\\Br_3\end{matrix}\right.$. Iodoform C_2HI_3 gives an analogous iodid. It is easy to see that all the above mentioned compounds belong to the types S_2X_4, S_4X_8, or S_6X_{12}, and that sulphur, selenium and tellurium must be regarded in these compounds as tetratomic.—*Bulletin de la Société Chimique*, July, 1865, p. 40. W. G.

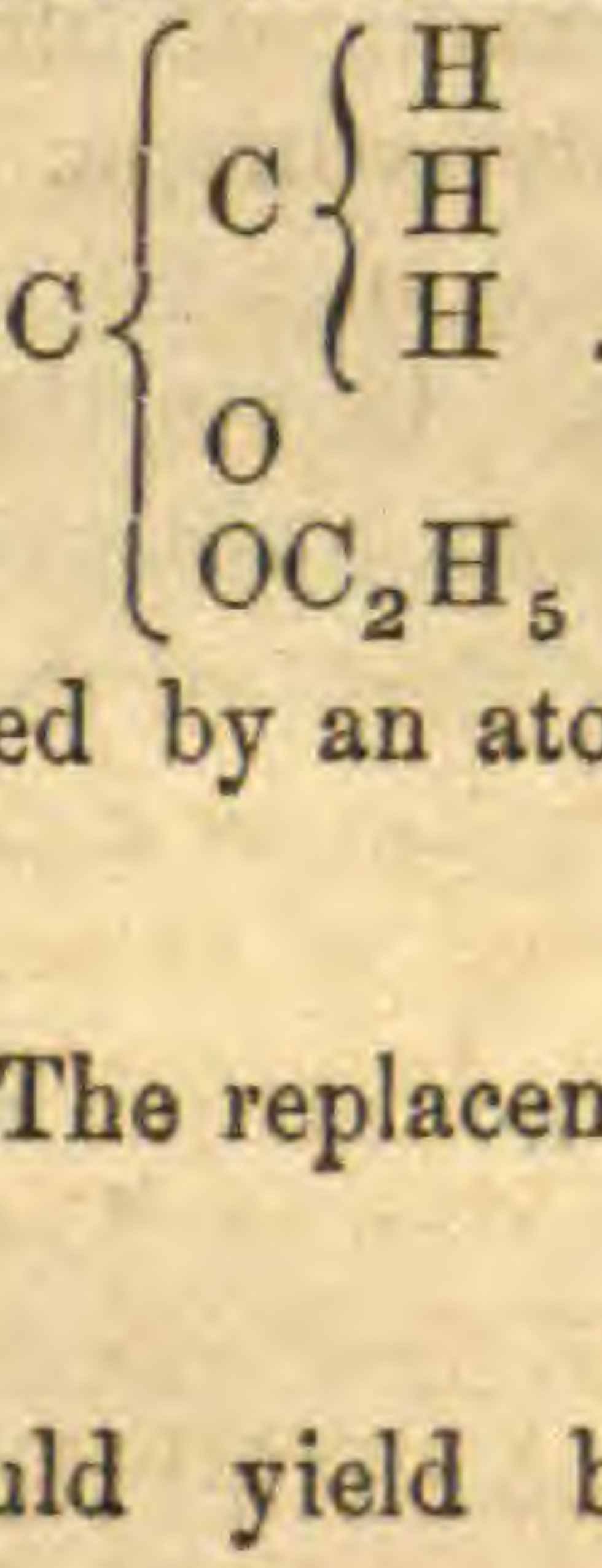
6. *On some salts of teroxyd of thallium.*—STRECKER has described several interesting salts of the teroxyd of thallium which possesses well marked basic properties. Raw chlorid of thallium crystallizes from a solution of carbonate of soda in white feathery groups of crystals, while a small portion remains in solution and may be precipitated by iodid of potassium. In alkaline solutions thallium is easily though not completely reduced by organic substances, such as grape, or milk sugar; on boiling the metal separates as a gray porous mass. When hypo-chlorite of soda is added to a solution of proto-chlorid of thallium in carbonate of soda, a brown precipitate of teroxyd of thallium is gradually formed which settles slowly and may be washed by decantation. According to Strecker the teroxyd is anhydrous; warm dilute sulphuric acid readily dissolves it to a salt which, dried in air, has the formula $TlO_3.3SO_3+7HO$; the salt when dried at 220° C. contains only one equivalent of water. Heat decomposes the sulphate according to the equation

$$TlO_3, 3SO_3+HO=TlO.SO_3+SO_3+HO.SO_3+2O.$$

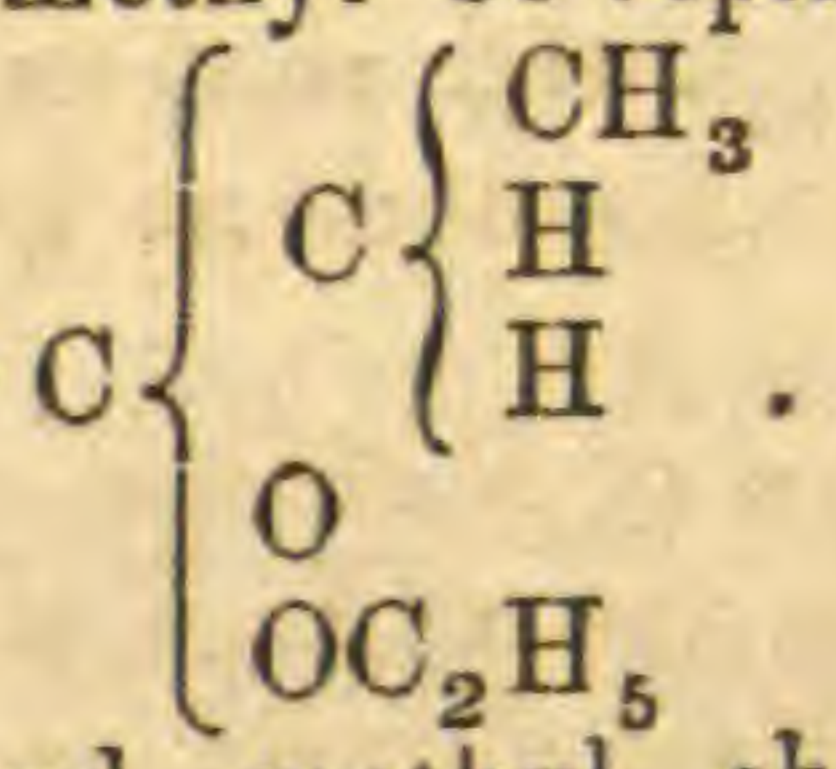
The sulphate combines with the sulphates of soda and potash to form double salts which have respectively the formulas

$$TlO_3, 3SO_3+NaO, SO_3 \text{ and } TlO_3, 2SO_3+2(KO, SO_3).$$

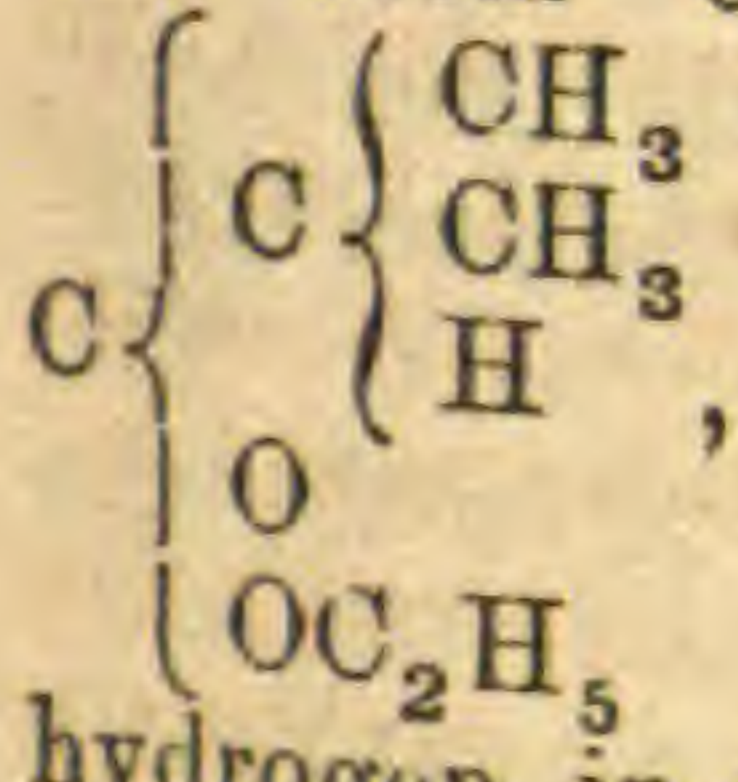
Oxalate of ammonia gives a heavy white precipitate in a solution of the sulphate of teroxyd of thallium in dilute sulphuric acid. The precipitate may be washed with cold water in which it is quite insoluble. Boiling water decomposes this salt with evolution of carbonic acid. Heated in a glass tube the thallium is reduced and is easily fused to a single globule. The salt has the formula $TlO_3, 3C_2O_3+NH_4O, C_2O_3+6aq.$ Strong nitric acid dissolves teroxyd of thallium, forming a crystalline nitrate which has the formula $TlO_3, 3NO_5+6aq.$ The solution of this salt gives a siskin-green precipitate with ferro-cyanid of potassium and a yellow precipitate with the ferrid-cyanid. Iodid of potassium produces a black precipitate which is doubtless a ter-oxyd. Strecker suggests that thallium presents analogies both with monatomic and triatomic elements and does not lend support to the theory of the invariability of atomicities.—*Ann. der Chemie und Pharm.*, lix, p. 207. W. G.

7. *On the synthesis of butyric and capronic ethers.*—FRANKLAND and DUPPA have published a preliminary notice of the very interesting and important results of their investigation of the alternate action of sodium and iodid of methyl or ethyl upon acetic ether. Frankland and Kolbe in 1857 proposed to refer acetic acid and many other organic bodies to the type of carbonic acid, an atom of methyl taking the place of an atom of hydrogen. In this manner the formula of acetic ether, using atomic instead of equivalent weights, becomes 

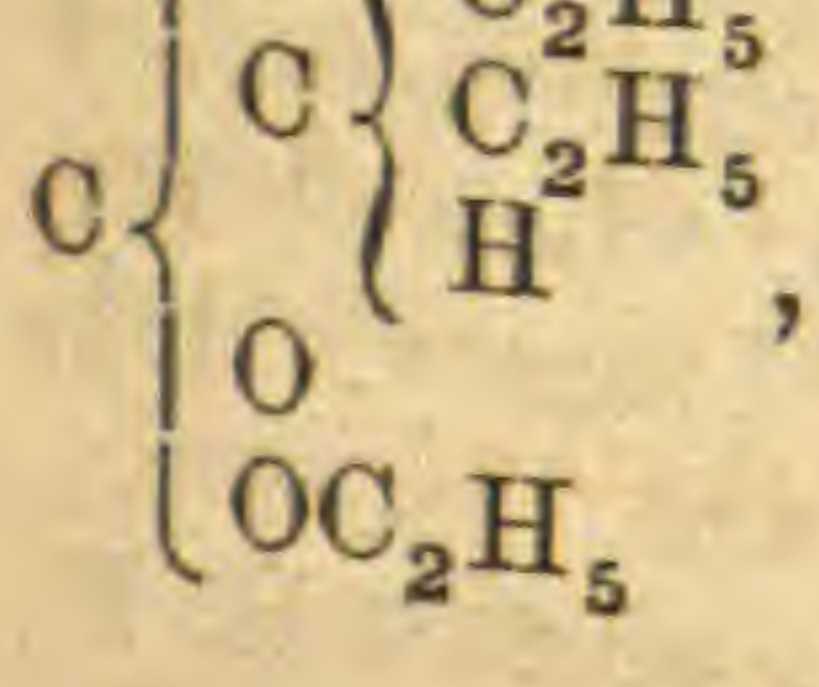
$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}H\\ H\\ H\end{array}\right. \\ O \\ OC_2H_5\end{array}\right.$$

. If one atom of hydrogen in the atom of methyl be replaced by an atom of methyl we shall have propionic ether 

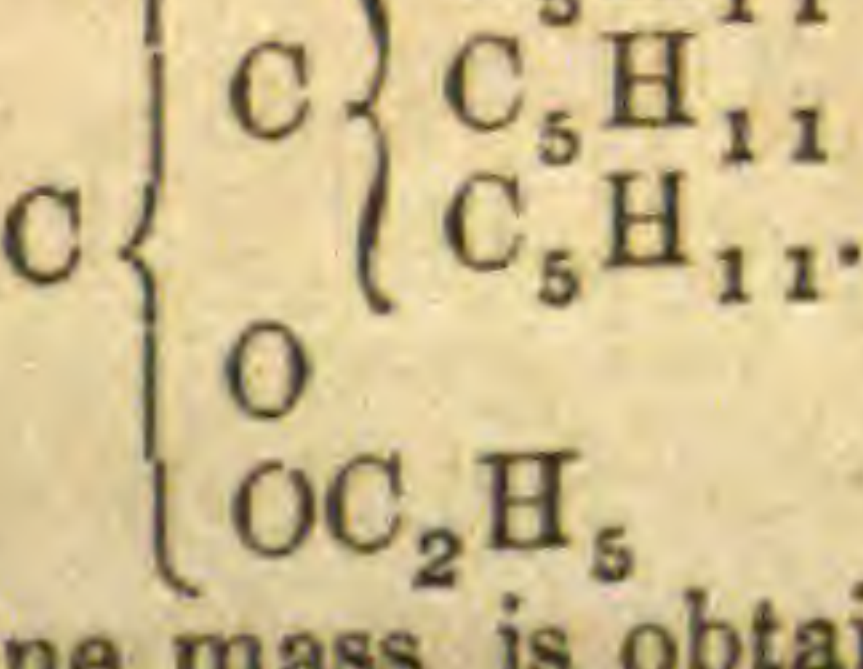
$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}CH_3\\ H\\ H\end{array}\right. \\ O \\ OC_2H_5\end{array}\right.$$

. The replacement of a second atom of hydrogen and methyl should yield butyric ether 

$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}CH_3\\ CH_3\\ H\end{array}\right. \\ O \\ OC_2H_5\end{array}\right.$$

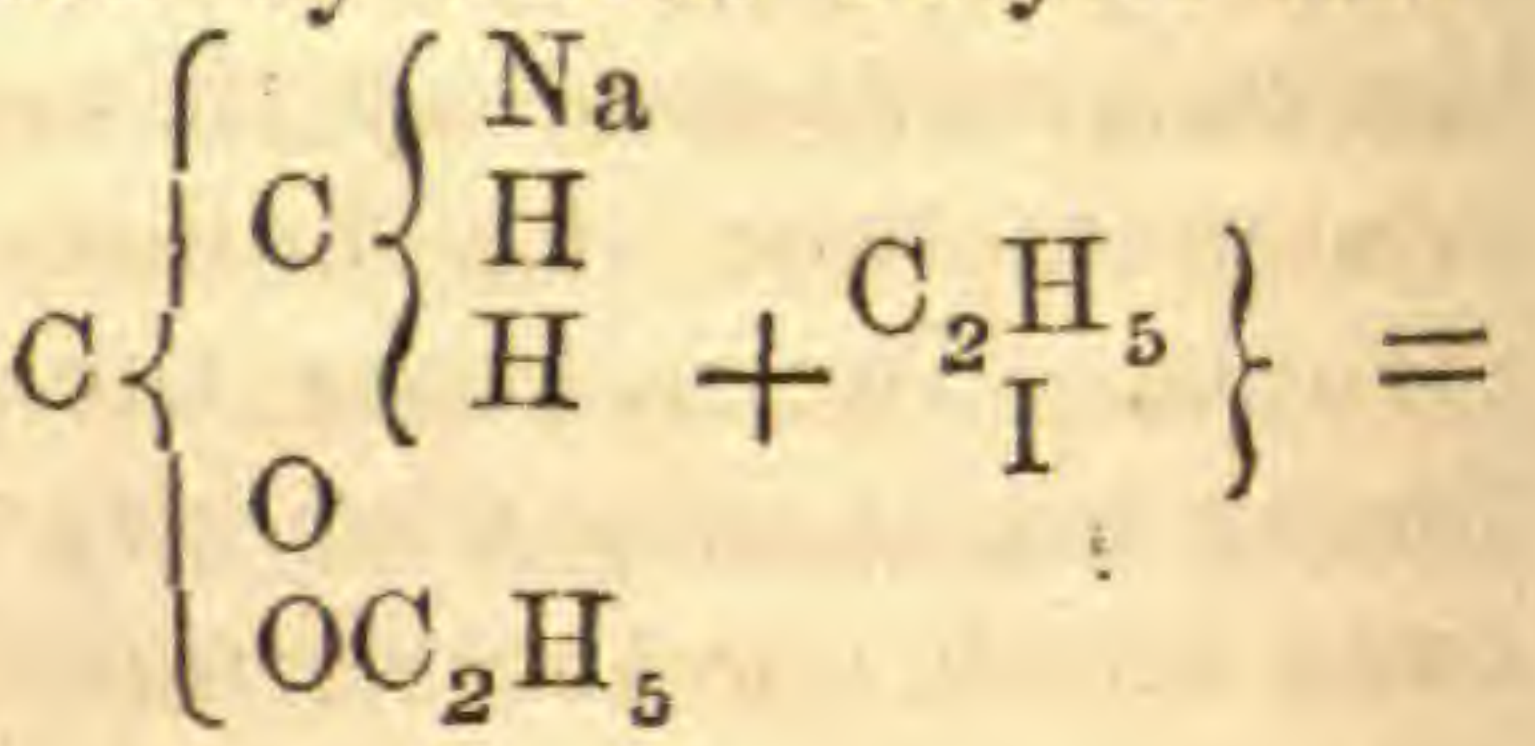
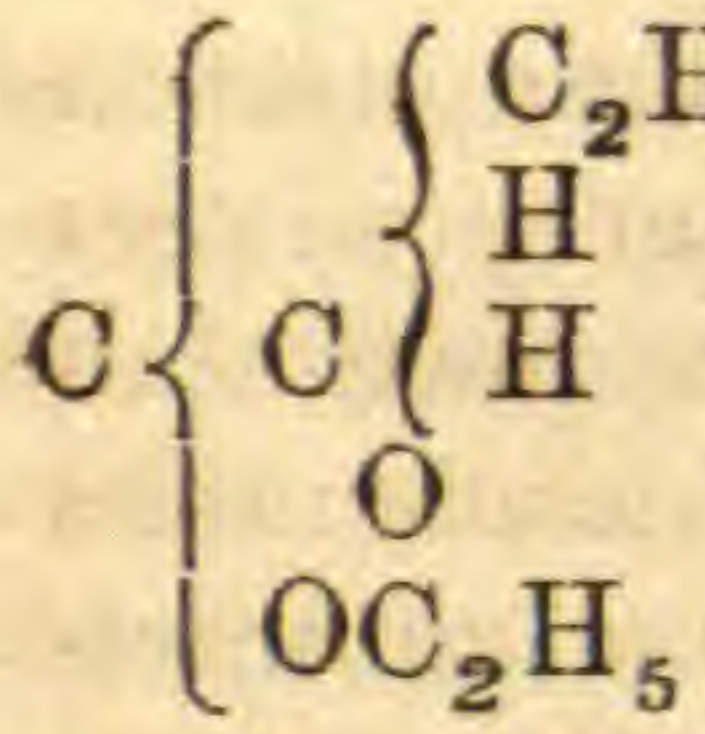
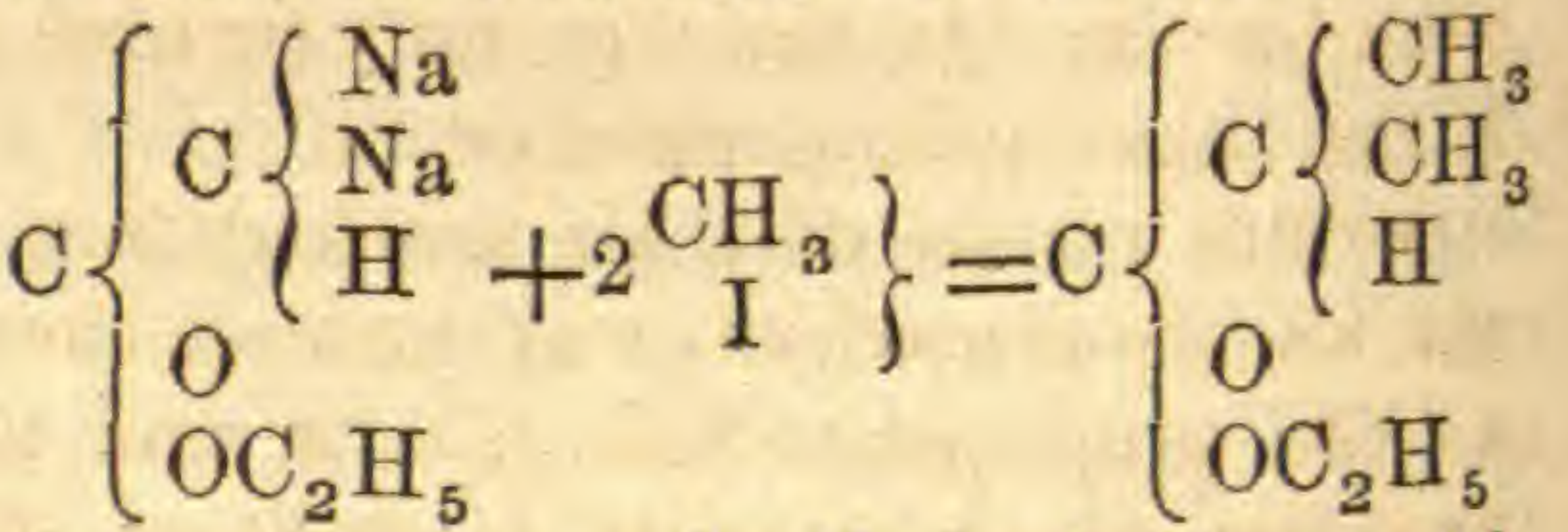
, which would also be formed by replacing one atom of hydrogen in acetic ether by ethyl. The replacement of two atoms of hydrogen in acetic ether by two of ethyl should yield capronic ether 

$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}C_2H_5\\ C_2H_5\\ H\end{array}\right. \\ O \\ OC_2H_5\end{array}\right.$$

, and finally the replacement of three atoms of hydrogen by three of amyl should yield margaric ether 

$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}C_5H_{11}\\ C_5H_{11}\\ C_5H_{11}\end{array}\right. \\ O \\ OC_2H_5\end{array}\right.$$

. By the action of sodium upon acetic ether a crystalline mass is obtained which

with iodid of ethyl yields, among other products, butyric ether from which the acid may easily be obtained. The reaction by which butyric ether is obtained may be expressed by the equation 
$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}Na\\ H\\ H\end{array}\right.\\ O\\ OC_2H_5\end{array}\right. + \left.\begin{array}{l}C_2H_5\\ I\end{array}\right\} =$$

$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}C_2H_5\\ H\\ H\end{array}\right.\\ O\\ OC_2H_5\end{array}\right.$$
+NaI. By the action of iodid of methyl upon disodium-acetic ether the authors obtained an acid also identical or isomeric with butyric acid, the reaction being 
$$C\left\{\begin{array}{l} C\left\{\begin{array}{l}Na\\ Na\\ H\end{array}\right.\\ O\\ OC_2H_5\end{array}\right. +2\left.\begin{array}{l}CH_3\\ I\end{array}\right\} = C\left\{\begin{array}{l} C\left\{\begin{array}{l}CH_3\\ CH_3\\ H\end{array}\right.\\ O\\ OC_2H_5\end{array}\right.$$
+2NaI. The authors leave it for the present undecided whether acids having the formula of butyric acid, obtained by different processes, are identical or only isomeric. By the action of iodid of ethyl upon disodium-acetic ether the authors obtained an ether isomeric or identical with capronic ether. Chemists will await with impatience the completion of this investigation, promising, as it does, to lead to results of the greatest theoretical interest.—*Ann. der Chemie und Pharm.*, lix, p. 217. W. G.

8. *On the heat of friction;* by Prof. JOSIAH P. COOKE, Jr. (Proc. of the Amer. Acad. of Arts and Sci., vi, April, 1865).—An accident to one of the large turbine wheels employed by the Merrimack Manufacturing Corporation of Lowell has furnished a most remarkable illustration of the modern mechanical theory of heat, and through the kindness of Mr. Isaac Hinckley, the accomplished agent of the Corporation, I have the pleasure of bringing the facts to the notice of the Academy. I cannot do better than to begin by reading Mr. Hinckley's own statement, in a letter addressed to me, dated December 30th, 1864. The specimens referred to in the letter I have placed on the table for the inspection of the Academy.

"In accordance with your request, I herewith send you five pieces of metal, once portions of one of our turbines. I have placed these pieces in the box in the same relative position which they occupied when they made a part of the turbine. To make my statement clear to you, I would refer to Plate I, of Mr. Francis's admirable work, 'Lowell Hydraulic Experiments,' which you will find in the College Library. Our turbines are similar to the Tremont turbines therein shown.

"The turbine of which these pieces were a part is one of 250 H. P., under a fall of 32 feet, using 75 cub. ft. of water per second. The wheel is of 58½ inches diameter, with depth of float of 6 inches, and a velocity of 144 revolutions per minute. Its position is horizontal, and at a level of 3 feet below the surface of Merrimack River at its ordinary stage. It is mounted upon a vertical wrought-iron shaft 25 feet long and 6 inches diameter at smallest place. This shaft is fitted at its upper end with a series of disks, by means of which it is supported in its box, which is again supported by a massive cast-iron frame. This frame supports the entire weight of the wheel and shaft. The shaft at its lower end is bored in the line of its axis to a depth of 5½ inches to receive a steel pin of 17½ inches in length and 2½ inches in diameter, and which projects from the shaft 12 inches. The steady-pin has no function to perform other than that of restraining the shaft from lateral aberration. It is free to revolve in a box made of three pieces of case-hardened iron, so placed in a cast-iron frame as to allow free play to the steady-pin and the free access of water to it. Each of these three pieces composing this box is kept up to its place by following-screws working in the cast-iron frame which is bolted to the stone floor of the turbine pit. In the Tremont turbine this floor is of wood, and in Plate I, the steady-pin is marked 'I.'

"The pieces sent are marked Nos. 1 to 5. No. 1 is the portion of the steady-pin which was nearest the shaft; No. 2, the other extremity of the same pin; Nos. 3, 4, 5, the three pieces of case-hardened iron forming the box, with portions of the steady-pin attached. You will at once perceive that this steel has been partially fused, and can thus account for its attachment to the iron.

"The facts are, that on noticing some irregularities of motion on the part of the wheel, it was stopped, and the water pumped from the pit until the floor was bare. Inspection showed that the following-screws had not done their duty uniformly; and the three pieces, Nos. 3, 4, 5, no longer preserved their proper relative positions, nor allowed free play to the steady-pin. The consequence was, an amount of friction causing heat sufficient to fuse steel, although the latter was immersed three feet deep in a raceway ten feet wide, through which was passing seventy-five cubic feet of water per second.

"A similar accident happened thrice to our turbines, which are now, however, safely guarded against such mishaps."

There are two points in connection with these facts to which I wish especially to call attention. In the first place, the weight of the wheel did not rest upon the surfaces of friction. The three pieces of case-hardened iron in their displaced position acted simply as a brake upon the revolving shaft, so that the heat must have resulted wholly from the destruction of mechanical motion. The immense moving power of the wheel, instead of being directed wholly into its appropriate channel, was in part transformed into that mode of atomic motion called heat. In the second place, the temperature attained was at least the welding-point of iron, and this, too, although the heated metal was immersed in a stream of flowing water. It is undoubtedly true, that the spheroidal condition of the water would greatly retard the loss of heat, but still the loss must have been exceedingly rapid. Now the loss, even at the highest temperature attained, must have been fully supplied by the heat generated during the same time; and this must, therefore, have been evolved with equal rapidity at the surfaces of friction. No change in the molecular condition of the iron, and no abrasion of the metal, is at all sufficient to account for this continuous, prolonged, and immensely rapid evolution of heat, and the facts force upon us the conclusion, that the destruction of mechanical motion is the one and only efficient cause. Moreover, if we admit the generally received principle of mechanics, that motion cannot be annihilated, the conclusion that heat is a mode of motion is equally irresistible. Lastly, it is evident that the facts here stated perfectly accord with the well-known experiments of Rumford and Davy; only since the moving power of the Merrimack turbine is so much greater than that employed by these distinguished experimentalists, the results which I have had the pleasure of exhibiting are more striking and conclusive than any which have been previously obtained.

9. *On the Magnetic effects of the Aurora.* (In a letter to the editors from Mr. Moses G. Farmer, dated Salem, Mass., Oct. 2, 1865.)—In the Boston Evening Transcript of Aug. 4th, 1865, was published an account of some observations made by Mr. Geo. F. Milliken, manager of the Boston office of the American Telegraph Company lines, upon the magnetic effects of the aurora.

Mr. Milliken says that in one case, the deflection of the needle of his galvanometer reached 78°, and remained at that deviation for about two minutes. I had the curiosity to insert my Gaugain galvanometer into this same circuit, in order to ascertain the actual value of this deflection. I found it to correspond to the evolution of $\frac{683}{1000}$ of a cubic centimeter of mixed oxygen and hydrogen gases per minute, equal to the decomposition of $\frac{339}{1000}$ of a grain of water per hour.

Let us assume for the unit of strength of current the evolutions of one cubic centimeter of mixed gases per minute, and let S signify strength of current measured according to this unit. Let the unit of resistance be that offered by one foot of a round wire, one twentieth of an inch in diameter, and made of pure copper, (nearly $=130000$ foot-seconds,) and let R denote units of resistance. Denote units of electromotive force by E, then will $E=RS$. Furthermore, denote units of electrical energy by E, then will $E=RS^2=ES$ express the relations between electrical energy and its corresponding resistance, electromotive force and strength of current. The mechanical value (denoted by M) of this unit of electrical energy is equal to $\frac{1914}{1000000}$ foot-lbs. per minute, or $M=\cdot 0019\ E$.

The measured resistance of the line from Boston to Springfield, including the relays in circuit, was found to be equal to 515970 of our units; hence the electrical energy per minute, exerted by the aurora upon the line while the needle stood at 78°, was $E=515970\times(\cdot 683)^2=241241$; and its equivalent mechanical value was $M=\cdot 0019\times 241241=46.173$ foot-lbs. per minute.

This wire is of iron, and is one hundred miles in length; it was originally of the wire known as No. 9, hence its volume could not exceed $\frac{\pi}{4}\times(\cdot 148)^2\times 5280\times 12\times 100=108925$ cubic inches, $=63\cdot 03$ cubic feet. Therefore the mechanical energy per cubic foot of the wire $=\frac{461\cdot 73}{63\cdot 03}=$ 7·32 foot-lbs. per minute.

If we suppose the auroral energy to be equally active at all points of space where its presence was evident, we shall find it to amount to

$5280^3 \times 7{\cdot}32 = 1077489008640$ foot-lbs. or more than 32000000, thirty-two millions) of horse-power per cubic mile of space. When we remember that the effects of this aurora, or magnetic storm, were felt in England as noticed by Mr. Airy, and probably upon the Atlantic cable which was then being laid, we can, in some degree, realize what mighty energies may be at play around us, and yet their effects be as harmless as the silvery moonbeams.

II. MINERALOGY AND GEOLOGY.

1. *Pachnolite, a new mineral.*—In searching for crystallized cryolite, KNOP has discovered an interesting mineral which occurs in druses and on the lines of cleavage of partially decomposed or weathered cryolite. The mineral is found in two varieties. In one case the crystals rest on the cryolite, and occur in right-angled parallelopipedons with three unequal cleavages parallel to the basal and lateral planes of the crystal. The other variety occurs in druses formed by the solution and removal of the cryolite. These druses are curiously divided by rows of crystals of the new mineral placed end to end, forming little comb-shaped partitions, the center of each partition being in the line of cleavage of the original cryolite. The crystals are lustrous, transparent and colorless, and from their resemblance to hoar-frost, Knop has named the new species *Pachnolite* from πάχνη, frost.

Heated gently in the closed tube, the mineral gives off neutral water, at a higher temperature the water has an acid reaction, heated rapidly it is decomposed with crackling and the formation of a white cloud which condenses on the walls of the tube. It is decomposed by sulphuric acid with evolution of fluohydric acid. Chemical composition :

Fe	Al	Na	Ca	$\dot{\text{H}}$		
50·79	13·14	12·16	17·25	9·60	=	102·94

from which Knop draws the formula $3(\frac{3}{5}\text{Ca}, \frac{2}{5}\text{Na},)\ \text{Fl} + \text{Al}_2\text{Fl}_3 + 2\dot{\text{H}} =$ Fl 51·12, Al 12·29, Na 12·38, Ca 16·14, $\dot{\text{H}}$ 8.07=100.

The crystalline form of pachnolite as determined by Knop and v. Rath is trimetric. The crystals occur in simple rhombic prisms sometimes with octahedral planes with pyramidal terminations, and occasionally the pyramidal planes have a stair-like form growing smaller towards the end of the crystal.—*Annalen der Chemie und Pharmacie*, vol. cxxvii, p. 61. [Dr. G. HAGEMANN, chemist to the Alkali Works at Natrona, Pennsylvania, has in a recent letter communicated to us the results of his investigations of this species, confirming the observations of Knop as to its crystalline form and chemical composition. Dr. Hagemann's analysis gives:

Fl	Al	Na	Ca	$\dot{\text{H}}$		
51·15	10·37	12·04	17·44	8·63	=	99·63

It is interesting in this connection to note that cryolite is now imported from Greenland by the cargo to Natrona for the purpose of manufacturing soda ash, alumina salts and other products mentioned in volume xxxv, p. 285.] G. J. B.

2. *On Chrysolite with Chromic Iron in Pennsylvania;* by Dr. F. A. GENTH. From a letter to Prof. Dana, dated Philadelphia, Dec. 10, 1865. —It is about one year ago, since I wrote Prof. Brush of a very interesting discovery which Prof. Booth made, of a large crystal of chrysolite from the great (or once great) chrome mine, called Wood's mine, in Lancaster Co., Pa. The occurrence is the more interesting to me, since, in a certain degree, it confirms my views as to the parent rock of the serpentine and talc of the chrome region. I may add that I have also received chrysolite, associated with hornblende and magnetic iron, from near Media, Delaware Co., Pa., at which locality occur the best crystals of chromic iron.

3. *Crystallized Gold in California.*—Prof. W. P. Blake states that a mass of gold which is for the most part a congeries of imperfect crystals, has been found 7 miles from Georgetown, El Dorado Co., California, which weighs 201 oz., and is valued at $4,000. The mass is now in New York city.

He also has a California crystal of an octahedral form, which if perfect would measure 2 inches on a side.—*In a letter to Prof. Dana.*

4. *On an Asphalt vein in Wood Co., Western Virginia;* by J. P. LESLEY. (Proc. Amer. Phil. Soc., ix, 183, 1863.)—This vein, situated about 20 miles (in an air line) south of Parkersburg, cuts vertically through rocks that are nearly horizontal and have a strike of S. 78° W., while the strike of the county is S. 35°–40° W. It is a vein of a solid bitumen-like substance rather than a coal bed. It resembles the glossiest, fattest caking coals; much of it breaks up into small prisms, and none consists of layers. In an assay made by Mr. B. S. Lyman of Philadelphia, in which the amount of hydrocarbon soluble in benzole was found to be about one-half of the whole, the volatile matter, according to the mean of two assays was 47·11, and of ash 1·73. The substance filling the vein is beyond question, Mr. Lesley observes, a product of the gradual oxydation of coal oil that once filled the open fissure.

5. *Descriptions of Fossils of the Marshall Group of Michigan, and its supposed equivalent in other States;* by Prof. A. WINCHELL.—Prof. Winchell's extensive investigations among the fossils of the sandstones lying between the Devonian Black Shale of the interior basin (equivalent of the Genesee shale of New York), including the beds called the Waverly sandstone in Ohio, and those of the rocks of which his Marshall Group in lower Michigan consists have led him to suggest, if not believe, that these beds are not equivalents, even in part, of the Chemung beds of New York, but rather of certain conglomerates in western New York which have been referred to the inferior Carboniferous. His former identifications of fossils with Chemung species are all abandoned, while an identity with four of the few species of the conglomerate alluded to (found only 4 miles north of Panama, Chautauque Co.) is proved. These four species are *Euomphalus depressus* Hall (Straparollus Ammon *White*), *Cypricardia contracta* Hall (Edmondia? bicarinata *Winchell*), *Edmondia æquimarginalis* Winchell, and *Allorisma Hannibalensis* Shumard. From the facts, he says, "it does not seem unreasonable to suspect a continuity between the more western beds and the supposed Carboniferous conglomerate," at least until observation shall have demonstrated that the Mar-

shall Group is in stratigraphical position really below that formation. The investigations in the more western States tend to confirm this view. The number of species that have been described from the rocks is about 379, 170 of which were first described by Prof. Winchell. The present paper contains descriptions of 94 species, 36 of them new.

6. *On a few of the Fossiliferous localities in Livingston and Genesee Counties, N. Y.;* by Henry A. Green.—(Communicated for this Journal.)—To reach one of the best localities of the Portage group, in this region, proceed about a mile up the ravine of Buck Run, from where it crosses the road a little south of the village of Mt. Morris. The spot may also be reached by going to the house of Mr. Sterling Case, upon whose land it lies, and proceeding along his private road to the ravine. Though much of the Portage group is destitute, or nearly so, of fossils, here is a considerable extent of the shale, at or near the bottom of the ravine, that is comparatively rich in organic remains. Nearly everywhere around this place patient labor will be rewarded with success, but some particular portions are much richer than others. By breaking up only a few cubic feet of the shale, I have procured large numbers of *Ungulina suborbicularis* and *Avicula speciosa.* I have also obtained, though less abundantly, the *Phragmostoma natator*, one or two species of *Retzia*, *Clymenia complanata*, *Orthoceras aciculum*, *Bellerophons*, *Goniatites*, and several other species of Mollusca.

A little farther up the ravine, I found, at one time, a portion of a fossil plant. The part obtained was nearly a yard long, from two to four inches in width and about half an inch thick. There is but little coaly matter about it, the larger part consisting of pyrites and shale.

At Gibsonville, a few miles west of our village, I have found quite a number of these plants. One of these I traced some six or seven feet. It was about four inches wide, and one-fourth of an inch thick, and was composed of coal.

Along the Cashaqua Creek there are good chances to work, but I have not had as good success as on Buck Run.

Of localities of the Hamilton group, the following are the most productive at present known to me.

The Geneseo localities do not seem to be as well known as some others, though now the most accessible of all, as they lie along or near the railroad. At the quarry near the depot, fragments of the *Phacops bufo* are quite abundant, but perfect specimens are not common. Here I obtained the most perfect *Cacabocrinus liratus* that I have seen. Have also found the same species at York. Of all the specimens I have seen, save this, only the lower half of the head is perfect, while the upper half, showing the arms, has been wanting. A large portion of this specimen is nearly perfect; it shows the forms and markings of the large plates of the lower half, and the smaller hexagonal plates of the upper half, also the bases of the ten arms, which are arranged in five sets.

About a mile south of Geneseo, the railroad crosses Fall Brook at Cuylerville Station. Passing up this creek nearly to the Falls, an abundance of fossils may be obtained; have found specimens of shells here that I have not noticed elsewhere in this region.

Here also is an outcrop of the fish-bearing, pyritiferous beds, though at present covered by a slide of earth, so that only loose slabs can be obtained. Fish remains are not so abundant here as at Moscow, but the bed is crowded with minute *Brachiopoda* and *Gasteropoda*, with some *Pentremites*, *Goniatites* and *Trilobites*.

The richest locality near Moscow is best reached by going north from the church nearly a mile, and turning down the first right hand road. Having crossed the stream just beyond the termination of this road, pass down it a few rods to where the shale is exposed in an abrupt bluff. Both above and below this, along the creek, fossils are very abundant and in fine preservation. Among them are *Atrypa reticularis*, *A. rugosa*, *A. zigzag*, *Phacops bufo*, *Homalonotus DeKayi*, *Nucleocrinus lucina*, and a Crinoid much resembling a *Comatula*. By following up, for a short distance, another branch of this stream, from a point one-eighth of a mile northwest of the village, the characteristic fossils of the Moscow shale may be obtained abundantly.

Intercalated between the beds of the Moscow shale, at this place, are lenticular masses of iron pyrites, from five to thirty feet in diameter, and from one to six inches in thickness. They contain fishbones and teeth in abundance, as well as numerous Brachiopoda, Gasteropoda and Cephalopoda, and occasionally Crinoidea.

Going north from Moscow about three miles, the road crosses Paterson's Creek. A few rods above this point the ravine begins, and along the bottom of this for some distance is a rich spot for the fossil seeker. The *Phacops bufo* and *Cacabocrinus glyptus* are among the choice things that I have found here.

The York locality is best worked near a saw-mill about one-half mile nearly west of the village. By breaking up the hard stratum that forms a slight fall in the stream, close by the mill, a rich harvest may be obtained. This rock holds the *Avicula flabella*, *Microdon bellistriatus* and a variety of rare Conchifers. At nearly all points about the mill, where the rock can be worked, it is productive. Also, at various points along the stream, for nearly two miles below the mill, there are good localities.

A very rich locality lies on the road from Pavilion to East Bethany, and is between one and two miles from the latter place, near the residence of Mr. Frank Peck. Here are found fine specimens of the *Atrypa fimbriata* and *A. hirsuta*, also a *Conocardium* and the *Dalmania calliteles*. To many of the corals found here are attached roots of the Crinoidea, species of *Aulopora*, and quite a number of Bryozoa. On one small bit of coral I have counted five parasitic species. The corals are quite plentiful here, especially *Heliophylli* and *Favosites*.

The Marcellus shale outcrops near Avon and LeRoy. At Littleville, a mile south of Avon, both the limestone and shale of this group are exposed.

A little farther north, along what is called the Little Coneseus, and a few rods above the Erie railroad, is another outcrop.

At LeRoy, just below the Main St. bridge, there is a good chance to work the shale. At each of these points the characteristic fossils of the Marcellus may be obtained.

The Corniferous limestone outcrops in numerous places in this region, but I will indicate only a few of the favorable ones for collecting.

Near Stafford and along the road toward Batavia, this limestone abounds.

The quarries at LeRoy are in the Corniferous. Going east from the village about a mile, on the road to Caledonia, then turning into the first left hand road and following it for about three-fourths of a mile, a point is reached where Corniferous fossils abound. From this locality, proceeding east and southeast, there is a range of rich localities. The corals are mostly silicified, and the rock may be removed by digesting in chlorhydric acid, leaving them in their original perfection.

Note.—Many of the fossils of the Hamilton shales are composed of carbonate of lime. When this is the case the shale may be removed, without injuring the fossil, by letting bits of caustic potash dissolve upon it. The work proceeds quite rapidly where the shale is free from impurities, but an admixture of lime retards, though it does not altogether stop it. Also when very cold the potash acts slowly.

Mt. Morris, Aug. 26, 1865.

7. *Chatham Islands; Peat fifty feet deep.*—In an article on the Chatham Islands, by H. H. TRAVERS, in the Proceedings of the Linnean Society, ix, 135, the author states the following among many other interesting facts.—The general surface of Chatham Island, except of that part which lies to the south of Petre Bay, is low and slightly undulating, with occasional hills. For example, on the tract to the north of the bay (to the left of the route from Wangaroa to Wari-kauri) there are three or four conical hills, attaining an elevation of 600 or 700 feet, and composed of basaltic and doleritic rocks, and some lower hills near the seacoast on the north side of the island. These hills are clothed with bush from top to bottom. The country to the eastward of the Great Lagoon is very low, scarcely rising in any part more than 50 feet above the sea-level. The peninsula to the south of Petre Bay is more hilly; the hills composed principally of basalts and tufas, and presenting, from Jenny Reef round to Cape Fournier, abrupt escarpments to the sea. The soil is peaty, and is often 50 feet deep. In several parts of the island this peat has been on fire for years, burning at a considerable depth below the surface, which, when sufficiently undermined, caves in, and is consumed. I have seen the loose ashes arising from these fires upwards of 30 feet deep. In one place I noticed, in the burning peat, at the depth of 6 or 7 feet from the surface of the ground, the trunks of trees of a growth evidently far exceeding any that are now to be found on the islands. I was, I am sorry to say, unable to obtain any specimens, in consequence of the great height of the wall of peat and the mass of hot ashes below. The surface-growth (exclusive of bush) consists principally of grasses and sedges, with patches of fern; but I have little doubt that large numbers of indigenous herbaceous plants have been destroyed, partly by the constant firing of the surface by the natives, and partly by the pigs, cattle, and horses which roam all over it. Nearly the whole country had, in fact, been burnt shortly before my arrival.

8. *Notice of some new Types of Organic Remains from the Coal Measures of Illinois;* by F. B. MEEK and A. H. WORTHEN. From the Proceedings of the Acad. Nat. Sci. Philad., March, 1865.—The fossils here described are from Morris, Grundy Co., Illinois, the same with that of the fossil insects described by Mr. Dana in volume xxxvi of this Journal. The species are the CRUSTACEANS, *Belinurus Danæ*, *Acanthotelson Stimp-*

sonii, and *A. inæqualis*, *Palæocaris typus*, *Anthracopalæmon gracilis:* the MYRIAPOD, *Anthracerpes typus ;* the INSECT, a Lepidopter, *Palæocampa anthrax.* The specimens are finely preserved. The new genus *Acanthotelson* is Tetradecapodan ; that of *Palæocaris* is of uncertain relations, it appearing to combine peculiarities of both the Decapod and Tetradecapod type; but the most important characters for settling the question are not preserved.

9. *Remarks on the Genus* TAXOCRINUS (Phillips) *McCoy*, 1844, *and its relations to* FORBESIOCRINUS Koninck and LeHon, 1854, with descriptions of a new species ; by F. B. MEEK and A. M. WORTHEN. From the Proceedings of the Acad. Sci. Philad., Aug. 1865.—The paper shows that the genus Forbesiocrinus is indentical essentially with the older genus Taxocrinus, or only a section of the latter. This paper is followed by another, by the same authors, containing descriptions of new Paleozoic Crinoids of Illinois and some of the adjoining States, and also by a note on the genus *Gilbertsocrinus* of Phillips.

10. *A Catalogue of the Palæozic Fossils of North America*, by B. F. SHUMARD, M.D. 16 pp. 8vo, from the Transactions of the Acad. Sci. of St. Louis, vol. ii, 1865.—This sheet contains the first pages of a catalogue which if completed with thoroughness will be of great service to American Paleontology. The author commences with the North American Echinoderms, gives a long list of works and memoirs on the subject, occupying 6½ pages, and then commences with the list of species and references. Only two genera are included in the part thus far received by us, viz : Acanthrocrinus and Actinocrinus.

11. *Geological Survey of Canada ;* PALÆOZOIC FOSSILS, vol. i, 426 pp. 8vo. By E. BILLINGS, F.G.S.—This work consists of descriptions of 446 new species of Lower and Middle Silurian Fossils with re-descriptions and in some instances additional details of about 50 others that were previously published. Sir W. E. Logan, in the preface, says "It has been prepared from time to time, according as the new forms were discovered, or as more perfect specimens of those already known were procured. The only systematic arrangement, therefore, that could be followed, was to group the descriptions together in a series of articles. The first portion, consisting of twenty-four pages, was issued in November, 1861,—the second, pages 25 to 56, in January, 1862,—the third, pages 57 to 168, in June, 1862,—the fourth, pages 169 to 344, in February, 1865, while the remainder, completing the volume, with last date herewith, (Oct. 1865). The first three have been noticed in this Journal under the title of "New Species of Lower Silurian Fossils." There are over 400 good wood engravings. The publishers are Dawson Brothers, Montreal, and Baillière, London, New York and Paris.

12. *Geological Survey of California.* GEOLOGY, volume I. *Report of Progress and Synopsis of the Field-work from* 1860 *to* 1864 *;* by J. D. WHITNEY, State Geologist. 498 pp. large 8vo, 1865. Published by authority of the Legislature of California.—The first volume of the Geology of California has just been issued, in the same elegant style with that of the Paleontology before announced. The work is full of interest both to the general reader and the scientific geologist. We propose to notice it at length in another number.

13. *Gold and Silver mines of Montana Territory.*—The amount of gold and silver for 1865 from the mines of Montana Territory, as stated on official authority, will be sixteen millions of dollars. The region was a wilderness in 1862.

III. BOTANY AND ZOOLOGY.

1. *On the Movements and Habits of Climbing Plants;* by CHARLES DARWIN. (Notice continued from the September number, p. 282.)—*Twiners* and *Leaf-climbers* having been considered, *Tendril-bearers*, which are the highest style of climbing plants, next demand our attention. But our analysis of this important part of Mr. Darwin's treatise must be disproportionably brief.

There are two kinds of movement exhibited by plants, which should be distinguished. 1st. Automatic, usually continued movements, not set in action by extraneous invitation. The gyratory movement of the small leaflets of *Desmodium gyrans* is an exalted instance of this. 2d. Movements in consequence of the contact or action of an extraneous body,—of which those of the leaves of the Sensitive Plant may be taken as the type. Twining stems, as has been seen, strikingly exhibit the first, and their coiling around a support is a consequence of it.

Tendrils for the most part execute both kinds of movement. They revolve, with some exceptions, like twining stems; and they are all more or less sensitive to contact,—usually more so than the petioles of leaf-climbers,—bending towards the impinging body so as to hook or clasp around it, if the size will allow. Different tendrils act differently in some respects, some revolving freely and sweeping wide circuits, some less evidently, and some, like those of Virginia Creeper, do not revolve at all, but turn from the light to the dark. But whether a tendril is the homologue of a leaf, or of a stem (or of a peduncle which is the same thing) appears to make no difference in its action. On the other hand their diversity of gifts in one and the same family, or even in species of the same genus, is very remarkable, as may be seen especially in the Bignonia Family, the Grape Family, &c. So, also, the tendrils are commonly aided in their endeavors by the revolving of the internodes of the stem, but sometimes not, even in plants of the same genus or family. Mr. Darwin takes up tendril-bearing plants by natural families, beginning with Bignoniaceæ, which order contains tendril-bearers, leaf-climbers, twiners, root-climbers, and various combinations of these diverse modes. We, however, will first consider the tendrils of the Gourd, and Passion flower families, regarding them as typical and simple representatives of tendril-climbers.

Passiflora gracilis, a delicate annual species, lately introduced into the gardens, of the easiest cultivation, one which differs from most of its relatives in the young internodes having the power of revolving, is said by Mr. Darwin to exceed all other climbing plants in the rapidity of its movements, and all tendril-bearers in the sensitiveness of its tendrils. In the latter respect it decidedly surpasses our *Echinocystis*; but it is nearly if not quite equalled by *Sicyos*, in which the coiling upon contact was first noticed as a visible movement. The revolving internodes, when in the best condition, make almost hourly revolutions, and the long, delicate, straight tendrils revolve nearly in the same manner and at the same rate. The sensitiveness of the tendril, when full-grown, is correspondingly great, a single light touch on the concave surface of the tip causing a considerable curvature. "A loop of soft thread weighing $\frac{1}{32}$nd of a grain, placed most gently on the tip, thrice plainly caused it to curve, as twice did a bent bit of thin platinum wire weighing $\frac{1}{50}$th of a grain; but this latter weight, when left suspended, did not suffice to cause permanent curvature." After touch with a twig, the tip begins to bend in from 25 to 39 seconds. After coiling into an open helix upon transient irritation, they soon straighten again, recovering their sensibility; but if left in contact, the action continues. We found it a pretty experiment, last summer, during the warmest days, to bring the upper part of an outstretched tendril by its inner or concave side against a twig or cord, and to see how promptly it would clasp it, revolving its free apex round and round it. A curious discrimination in the sensibility of such tendrils is mentioned by Mr. Darwin, as follows :—

"I repeated the experiment made on the *Echinocystis*, and placed several plants of this *Passiflora* so close together that the tendrils were repeatedly dragged over each other; but no curvature ensued. I likewise repeatedly flirted small drops of water from a brush on many tendrils, and syringed others so violently that the whole tendril was dashed about, but they never became curved. The impact from the drops of water on my hand was felt far more plainly than that from the loops of thread (weighing $\frac{1}{32}$nd of a grain) when allowed to fall upon it, and these loops, which caused the tendrils to become curved, had been placed most gently on them. Hence it is clear, either that the tendrils are habituated to the touch of other tendrils and to that of drops of rain, or that they are sensitive only to prolonged though excessively slight pressure. To show the difference in the kind of sensitiveness in different plants, and likewise to show the force of the syringe used, I may add that the lightest jet from it instantly caused the leaves of a *Mimosa* to close; whereas the loop of thread weighing $\frac{1}{32}$nd of a grain, when rolled into a ball and gently placed in the glands at the bases of the leaflets of the *Mimosa*, caused no action." (p. 90.)

Of Cucurbitaceous tendrils, the most active, after those of *Sicyos* (which Mr. Darwin has not observed), are those of *Echinocystis lobata*. The internodes and tendrils revolve in about an hour and three quarters, the former sweeping a circle or ellipse of two or three inches in diameter, the latter often one of 15 or 16 inches in diameter. Perhaps the most remarkable appearance of discrimination in tendrils is that which Mr. Darwin first noticed in this plant, but which may be seen in others,—and which he thus describes:—

"I repeatedly saw that the revolving tendril, though inclined during the greater part of its course at an angle of about 45° (in one case of only 37°) above the horizon, in one part of its course stiffened and straightened itself from tip to base, and became nearly or quite vertical. . . . The tendril forms a very acute angle with the extremity of the shoot, which projects above the point where the tendril arises; and the stiffening always occurred as the tendril approached and had to pass, in its revolving course, the point of difficulty,—that is, the projecting extremity of the shoot. Unless the tendril had the power of thus acting, it would strike against the extremity of the shoot, and be arrested by it. As soon as all these branches of the tendrils begun to stiffen themselves in this remarkable manner, as if by a process of turgescence, and to rise from an inclined into a vertical position, the revolving movement becomes more rapid; and as soon as the tendril has succeeded in passing the extremity of the shoot, its revolving motion, coinciding with that from gravity, often causes it to fall into its previous inclined position so quickly, that the end of the tendril could be distinctly seen travelling like the minute hand of a gigantic clock." (p. 75.)

Cucurbitaceous tendrils are mostly compound, in this case three-forked. When one of the lateral branches has firmly clasped any object, the middle branch continues to revolve. If a full-grown tendril fails to reach and lay hold of any object, it soon ceases to revolve, bends downwards, and coils up spirally from the apex. Indeed it often coils while still outstretched and revolving, the tendency to shorten (as we presume) on the inner side from the tip downward, which is usually brought into action by contact with an extraneous body, at length operating spontaneously. Uncaught tendrils when they thus coil up throw themselves of course into a simple helix or spire. One end being free, this is the simple and necessary consequence of the relative shortening of the concave side, sufficiently continued.

In a caught tendril, the relative shortening of one side, (through which the tip hooks round and fixes itself to the supporting object,) being propagated downwards, the whole now throws itself into a spiral form—with more or less promptitude according to the species—thus pulling the free portion of the tendril-bearing shoot nearer to the support, and within easier reach of the next tendril above. Both ends of the tendril being fixed, and the winding round an axis (real or imaginary) necessarily involving or *being* a twist, it is certain that the caught tendril cannot now coil into a simple spiral, but that the spire will be at least double, a coil near one end of the tendril in one direction requiring the other to twist in the opposite direction, unless indeed it undergoes torsion. So, as is familiarly known, there is at least one neutral point in a caught and coiled-up tendril, usually in the middle, the turns on one side of it running from right to left, on the other from left to right. That the coils, whether simple or double and reversed (as the case may be) are not determined by any peculiarity in the tendril, but merely by the relative shortening of one side, may be readily shown by a thread cut from a piece of india-rubber, of unequal tension of the two sides; this, when stretched and allowed to shorten while the two ends are held fast in the same plane, forms at once a pair of reverse coils, or three or four such coils, just as caught tendrils do.

Mr. Darwin explains the point by analogous practical illustrations. He shows, moreover, that an important service rendered by the coiling or spiral contraction "is that the tendrils are thus made highly elastic." In Virginia Creeper, where the ends of the compound tendrils are peculiarly attached, "the strain is thus equally distributed to the several attached branches of a branched tendril; and this must render the whole tendril far stronger, as branch after branch cannot separately break. It is this elasticity which saves both simple and branched tendrils from being torn away during stormy weather. I have more than once gone on purpose, during a gale, to watch a Bryony growing in an exposed hedge, with its tendrils attached to the surrounding bushes; and as the thick or thin branches were tossed to and fro by the wind, the attached tendrils, had they not been excessively elastic, would have been instantly torn off and the plant thrown prostrate. But as it was, the Bryony safely rode out the gale, like a ship with two anchors down and a long range of cable ahead, to serve as a spring as she surges to the storm."

Moreover, while unattached tendrils soon shrink up or wither and fall off, as we observe in the Grapevine, Virginia Creeper, &c., these same plants show how an attached tendril thickens and hardens, gaining wonderfully in strength and durability. In a Virginia Creeper, "one single lateral branchlet of a [dead] tendril, estimated to be at least ten years old, was still elastic and supported a weight of exactly two pounds. This tendril had five disk-bearing branches, of equal thickness and of apparently equal strength; so that this one tendril, after having been exposed during ten years to the weather, would have resisted a strain of ten pounds."

Our space will not allow even an abstract of Darwin's account of the admirable adaptations and curious behavior of various tendrils, even of some very common plants; as for instance of the familiar *Cobœa scandens*, in which (the stem and the petioles being motionless) the great compound tendril borne at the summit of the leaf executes large circular sweeps with remarkable rapidity, carrying round an elaborate flexible grapnel, consisting of its fine subdivisions, from 50 to 100 in number, which are very sensitive even to a slight touch, bending in a few minutes toward the touched side, so that they clasp twigs very promptly, and all tipped with minute, double or sometimes single, sharp hooks, which catch in little inequalities, and may prevent the tendril-branchlets from being dragged away by the rapid revolving movement before their irritability has time to act, while the still free ones proceed to arrange themselves, by various queer and complicated movements so as to secure the most advantageous hold; then contracting spirally so as to bring other portions up within reach of the support, until all are inextricably knotted and fastened, and finally growing stouter, rigid and strong, binding the plant firmly to its support.

We cannot omit all mention of *Bignonia capreolata*, a not uncommon climber of our Southern States, of which we especially wish to obtain fresh seeds or young plants, that we may ourselves observe the remarkable behavior of its tendrils which Mr. Darwin describes. These are said to turn from the light, as in many other cases; they will clasp smooth sticks, but soon lose their hold and straighten themselves again. A rough, fissured, or porous surface alone satisfies them; their young tips seek and crawl into dark holes and crevices, in the manner of roots; then they develop their hooked extremity, and, especially when they meet with any fibrous matter, the hook swells into irregular balls of cellular tissue, which first adhere to the fibres by a viscid cement, and then grow so as to envelop them. This tendril can do nothing with a smooth post, fails to attach itself to a brick wall, but is well adapted to climb trees with rough and mossy bark.

The Virginia Creeper also turns its tendrils from the light, and, although they will occasionally clasp a slender support, in the manner of its relative the Grapevine, they uniformly seek dark crevices, or especially broad flat surfaces, as a wall, a rock, or the trunk of a tree. Having brought their curved tips into contact with such a surface, these swell and form, in the course of a few days, the well-known disks or cushions by which they firmly adhere. Here is a tendril-climber, which emulates a root-climber, such as Ivy, in the facility with which it ascends smooth trunks, rocks, or walls.

A very short chapter is devoted to *Hook-climbers* and *Root-climbers.* The stems of the latter are said to "have usually no power of movement, not even from the light to the dark. But *Hoya carmosa*, which twines, also climbs by rootlets spreading over the face of a damp wall; and *Tecoma radicans* (our Trumpet Creeper) exhibits in its young shoots some vestiges of the revolving power with which its twining relatives are endowed."

In a dozen pages of *Concluding Remarks*, Mr. Darwin gives much interesting matter in the way of deduction and speculation, which it would be difficult to condense into an abstract.

Plants become climbers, he remarks, in order to reach the light, and expose a large surface of leaves to its action and that of the free air. Their advantage is, that they do this with wonderfully little expenditure of organized matter in comparison with trees, which have to support a heavy load of branches by a massive trunk. Of the different sorts of climbers, hook-climbers are the least efficient, at least in temperate countries, as they climb only in the midst of an entangled mass of vegetation. Next root-climbers, which are admirably adapted to ascend naked faces of rock; but when they climb trees they must keep much in the shade, and follow the trunk; for their rootlets can adhere only by long-continued and close contact with a steady surface. Thirdly, spiral-twiners, with leaf-climbers and tendril-bearers, which agree in their power of spontaneously revolving and of grasping objects which they reach, are the most numerous in kinds, and most perfect in mechanism; they can easily pass from branch to branch, and securely ramble over a wide and sun-lit surface.

After adducing some considerations in support of his opinion that both leaf-climbers and tendril-bearers "were primordially twiners, that is, are the descendants of plants having this power and habit," Mr. Darwin asks: "Why have nearly all the plants in so many aboriginally twining groups been converted into leaf-climbers or tendril-bearers? Of what advantage could this have been to them? Why did they not remain simple twiners? We can see several reasons. It might be an advantage to a plant to acquire a thicker stem, with short internodes, bearing many or large leaves; and such stems are ill fitted for twining. Any one who will look during windy weather at twining plants will see that they are easily blown from their support; not so with tendril-bearers or leaf-climbers, for they quickly and firmly grasp their support by a much more efficient kind of movement. In those plants which still twine, but at the same time possess tendrils or sensitive petioles, as some species of *Bignonia*, *Clematis*, and *Tropæolum*, we can readily observe how incomparably more securely they grasp an upright stick than do simple twiners. From possessing the power of movement on contact, a tendril can be made very long and thin; so that little organic matter is expended in their development, and yet a wide circle is swept. Tendril-bearers can, from their first growth, ascend along the outer branches of any neighboring bush, and thus always keep in the full light; twiners, on the contrary, are best fitted to ascend bare stems, and generally have to start in the shade. . . . .

"The object of all climbing plants is to reach the light and free air with as little expenditure of organic matter as possible; now, with spirally-ascending plants the stem is much longer than is absolutely necessary; for instance, I measured the stem of a kidney-bean which had ascended exactly two feet in height, and it was three feet in length. The stem of a pea, ascending by its tendrils would, on the other hand, have been but little longer than the height gained. That this saving of stem is really an advantage to climbing plants I infer from observing that those that still twine, but are aided by clasping petioles or tendrils, generally make more open spires than those made by simple twiners." (p. 110.)

The gradations between one organ and another, and their special endowments, and the great diversity of their movements, are illustrated at length; and the very large number of natural families which exhibit these endowments, in some of their members, is indicated; and it is noted that two or three genera alone have those powers in some of the largest and best defined natural orders, such as *Compositæ*, *Rubiacæ*, *Liliaceæ*, Ferns, &c.; from which he infers "that the capacity of acquiring the revolving power, on which most climbers depend, is inherent, though undeveloped, in almost every plant in the vegetable kingdom." (p. 117.)

Mr. Darwin somewhere throws out the remark that the larger number and the most perfectly organized climbing plants, as of the scandent animals, belong to one country, tropical America.

In abruptly closing these extracts and brief commentaries, we would add, that the Linnæan Society has issued a separate reprint of this charming treatise, thus opening it to a wider circle of readers. A. G.

2. *Catalogue of Plants found in Oneida County* [*New York*] *and vicinity;* by JOHN A. PAINE, Jr. From Report of the Regents of the University of the State of New York, presented March 22, 1865. pp. 140, 8vo. Date at the close, October, 1865.—This full catalogue, upon which much labor has been expended, embraces in fact the whole central part of the State of New York. The actual geographical limits are nowhere indicated, and are perhaps indefinite; but the range appears to extend east to Schenectady, north to the St. Lawrence and Lake Ontario, west to the Genesee River, and south to the tier of counties bordering on Pennsylvania; and in special instances even overpassing these limits. Eighty-one native plants (species and varieties) are enumerated at the close as being additions to the Flora and later catalogue of the plants of the State by Dr. Torrey. But a good many of these, and especially of the twenty-six Carices, are such as depend upon difference of views as to species, some of which have been settled during the many years that

have passed since the publication of the State Flora, and others are still in abeyance. *Dentaria heterophylla*, and *Diplopappus amygdalinus*, for instance, would probably be referred to other species. *Juniperus Sabina*, as the name of the northern prostrate Juniper, although indicated by Hooker, and referred to by Torrey, has waited for Dr. J. W. Robbins (who should be credited with it) to point out "the determining characteristic of the species." The real and specially interesting recent additions to the State Flora are such as these:

Nymphæa tuberosa, Paine, n. sp., the larger-leaved and slightly-scented white Water Lily of the Great Lakes and their tributaries, with the rootstock bearing copious lateral tubers, like "artichokes," and with a defective arillus. It is still to be seen whether the characters will hold out.

Potentilla paradoxa, Nutt., which Mr. Paine found on the shore of Lake Ontario.

Ribes rubrum, which Dr. Vasey is said to have found "on hills north of Salmon Falls,"—wherever that may be. But the general habitat: "swampy woods, low shaded flats of streams, hill-sides, and ravines; frequent," is surely quite wrong!

Solidago Houghtonii, Gray,—before known only from a single, unidentified station in northern Michigan, discovered last summer in an interesting swamp in West Bergen, Genesee County.

Pyrola secunda, var. *pumila:* a curious little form, which we have from Labrador, Lake Superior, and the Rocky Mountains, and which Chamisso indicated long ago on the N.W. Coast. Mr. Paine discovered it abundantly in the high cold bogs south of the Mohawk in which the most northerly sources of the Susquehanna originate.

Polemonium cæruleum,—the habitat in Addenda to Gray's Manual, is confirmed and extended by Mr. B. D. Gilbert.

Najas major, the interesting discovery of which, in Onondaga Lake, has already been recorded in this Journal. It has since been detected in Irondequoit Bay of Lake Ontario, by Mr. E. J. Pickett.

Platanthera rotundifolia: a narrow-leaved variety (*oblongifolia*) of this most rare northern species, was discovered by Mr. Paine along with the *Pyrola* above mentioned.

Cypripedium candidum, a western species, found in the Bergen swamp, with indications of the same farther south and east.

Cypripedium arietinum: found abundantly, with the *Pyrola*, &c.

Tofieldia glutinosa, and especially, *Carex vaginata*, in the West Bergen swamp. (*Carex argyrantha*, Tuckerman, should have been known to belong to the true *C. adusta*, Boott.)

Some of the above, and other plants detected by Mr. Paine in or near Oneida County,—the district of our own earliest botanizing,—fill us with admiration of his activity and sharpsightedness.

Twenty-five plants are enumerated as naturalized species not in the State Flora. But among them are Prickly Poppy, Horseradish, Musk Mallow, Thyme and the like; also *Reseda Luteola* and *Periploca Græca*, which were recorded long ago; *Artemisia biennis*, a very recent waif from the west; and *Rosa setigera*, the Michigan Rose, which we doubt;—the more so as, on turning to its place in the Catalogue (p. 26) we find it mentioned as if indigenous, and with stations which lead us to suppose that some other has been mistaken for this well-marked species.

For a *public document* the Catalogue is well printed, and, as a hasty essay by an unpracticed hand, it is creditable to its author, although there are many points which would not bear close criticism. A. G.

3. *Genera Plantarum*... auct. G. BENTHAM et J. D. HOOKER, Pars II, 1865.—We must now barely announce that the second part of this standard work is just published and has come to hand. It contains the *Leguminosæ*, *Rosaceæ*, *Saxifrageæ*, with the orders close to the latter, the *Halorageæ*, *Rhizophoreæ*, *Combretaceæ*, and *Myrtaceæ*. The recent illness of Dr. Hooker having delayed his revision of the *Melastomaceæ* for the press, this second part has been cut short of its intended dimensions; but the third part, which may be expected next summer, will complete the Polypetalous Orders and the first volume of a full thousand pages. A. G.

4. *On Morphology and Teleology, especially in the Limbs of Mammalia*, by BURT G. WILDER. (From the Memoirs of the Boston Society of Natural History.)—In this paper the author has brought to view more prominently than has hitherto been done, the remarkable relations existing between the anterior and posterior regions or poles of the Vertebrate body, both as exhibited in the structure of the bones and muscles of the limbs, and the more general relations found in the body itself and the internal organs. This idea usually expressed by "antero-posterior symmetry" was, perhaps, first distinctly enunciated, though in a very general way, by Oken, and has more recently been investigated by Prof. Wyman among others, to whose instruction and suggestions Mr. Wilder attributes many of the ideas so fully elaborated in the present memoir.

Although a large part of the work is devoted to an elaborate and instructive exposition of this peculiar symmetry as exemplified in the bones and muscles of the limbs, which necessarily involves much that is technical and complex in Vertebrate anatomy, there are many interesting and suggestive generalizations discussed in the introductory pages.

It is interesting to observe that the author finds in these investigations no support for the doctrine of serial development of species among animals, or gradual changes in structure through genealogical descent. After demonstrating the doctrine that man is *physically*, as well as mentally, the most highly organized animal,—in perfection of structure and harmonious arrangement of parts far surpassing what we observe in inferior animals, although excelled by some in special functions,—he proceeds to examine the more general relations existing among the four great types of animals, to which the more special principle forming the subject of the essay is subordinate.

In adopting here some views of Prof. Agassiz rather ambiguously and too briefly expressed in a verbal communication,[1] the author evidently labors under a great disadvantage, especially when attempting to present the "*laterality*" of Mollusca, and "*tergality*" of Articulata, relations which, if they exist, have never been distinctly demonstrated, and which other anatomists and zoologists have failed to discover. Certainly "laterality" has not been shown to characterize Mollusca, in the paper by Mr. Shaler[2] to which he refers, but only bilateral symmetry, which, as

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[1] Proceedings Boston Soc. Natural History, viii, 279.

[2] Proc. Bost. Soc. Nat. Hist., viii, 274.

Mr. Wilder justly remarks, is characteristic of *all* animals, even Radiata, as is also *cephality*, as Prof. Dana has fully enunciated in his several articles on cephalization. Mr. Shaler was, moreover, so far misled as to have entirely mistaken the real axial relations among *Brachiopoda* upon which his conclusions were based, as well shown by Mr. E. S. Morse,[3] although the observed *symmetry* still exists, and had been previously shown by others.

In this instance Mr. Shaler considered the valves of Brachiopoda as anterior and posterior, while others, as Owen and Hancock and most anatomists and conchologists, regarded them as dorsal and ventral, the only question being as to which valve was dorsal and which ventral. Either of these three views would obviously allow the same lateral symmetry, a plane dividing the animal in equal halves coinciding with both these axes. But if "laterality" be characteristic, and distinct from lateral symmetry, in Mollusca, it should be more clearly defined than any one has yet been able to do.[4]

The indefinite nature of these terms, as employed by Agassiz, will

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[3] Proc. Bost. Soc. Nat. Hist., ix, 57, see also Proceedings Essex Institute, iv, 162.

[4] The remarks of Prof. Agassiz referred to are as follows: "He thought bilateral symmetry should be distinguished from *laterality* which relates to the disposition of the organs on the sides of the body without reference to symmetry; in Mollusks this laterality is on the right and left sides; in Articulates the weight of the organs is on the dorsal and ventral surfaces, for which he would employ the term *tergality;* by *radiality* he would signify the radiated arrangement of the organs in Radiates, and by *cephality* the preponderance of the head and its contained organs in the Vertebrates." If, therefore, laterality expresses the arrangement of organs on the sides without reference to symmetry, it will be apparent that the organs of Articulates,—the legs, jaws, organs of senses, branchiæ, and the wings, spiracles and tracheæ of Insects,—are as definitely arranged upon the sides and with as perfect lateral symmetry as in any Mollusks. Moreover the central nervous ganglions are formed of two lateral parts, and are connected serially by two nervous threads, while the dorsal vessel and alimentary canal are in the median plane. On the contrary, *tergality* is best expressed, if at all, by an antagonism of some organs, which are themselves not homologous, such as the wings of Insects, as contrasted with the legs, various appendages found among Worms, and the dorsal vessel contrasted with the nervous ganglions; but here we find the anterior ganglion *above* the median plane, while the rest are below it, thus showing that such an antagonism of above and below does not exist among these animals, so much as among Mollusca where the heart, when present, is dorsal in respect to the alimentary canal, and the principal ganglion is ventral, while, in some, the valves of the shell themselves are dorsal and ventral. The position of the spiracles and tracheæ in Insects is also such as to refute the idea of "*tergality*" as applied, while they agree with that of laterality. But among Mollusca the "*laterality*" is even less marked than would at first appear if we regarded merely the ordinary bivalve shells. In Gasteropods, Tunicates, and Cephalopods it is certainly less marked than in Articulates, but even in Lamellibranchiates the folds of the mantle, with the valves of shell that they secrete, and the branchial folds, which rest upon the sides of the body, originate dorsally and extend downward upon the sides, while the hinge and its appendages show the importance of their *dorsal* relation to the shell. The organs of respiration do not favor the idea of laterality in many Gasteropods, while in all Mollusca there is as strong contrast or antagonism between above and below as in any Articulates. Thus the foot in the higher orders is neutral, the branchial usually dorsal (*Eolis*, *Doris*, &c., are good examples). The heart and main nervous mass, as before remarked, are as much *opposed* as in Articulates, but do not show any disposition to *laterality*. In fact, had the application of the terms used by Prof. Agassiz been reversed, the true relations would appear to us to have been better expressed.

appear from the following remarks: "We find that in the Mollusks not only are the organs arranged upon the two sides of the body, but the 'weight of organization,' as Prof. Agassiz expresses it, is thrown upon the sides, which even in common usage we recognize to have superior value over the front and hind ends, or the upper and lower edges; we examine and figure only the sides, and, except with the Cephalopoda, their natural position is such as to exhibit prominently one of the sides." Even were these views actually true to nature nothing could be more superficial than such characters. But in fact we place and examine various kinds of shells in very different positions,—the Brachiopoda dorsally or ventrally, the Gasteropods sometimes dorsally, sometimes anteriorly and posteriorly, sometimes laterally, according to their outward forms. The natural positions are, also, equally variable, the bivalve shells themselves more frequently being nearly vertical with the anterior pole downward, but at other times horizontal or oblique with the dorsal region upward, more rarely, as in Ostrea and Pecten, resting upon the sides. In Brachiopods the *ventral* valve appears to be uppermost, according to the homologies of Mr. Morse, while in Tunicates the sides are not more conspicuous than other parts, and the position usually vertical or oblique. Again; "We no more think of placing or viewing an insect on its side than a bivalve upon its upper or lower edge, which correspond to the tergal and ventral regions of the Articulate. This seems to confirm the idea that the single ring representing the Articulate unit is composed of an equal number of segments above and below a horizontal bisecting plane, and that the legs and wings when they exist are tergal and ventral repetitions of each other. But the internal anatomy is less satisfactory, at least as now understood, and I leave it to others more familiar with its details, to determine whether this type, whose sharply defined outlines so clearly illustrate the law, has at the same time the unsatisfactory internal arrangement; it is certain that in our present state of knowledge the laterality of the Mollusks is more apparent than either the tergality of Articulates or the cephality of Vertebrates." The importance of the cephalic character of Vertebrates no one can doubt, but the existence of the same principle in the other types in a marked degree, especially among insects and the higher Mollusca, should prevent the use of this term to express the Vertebrate type. Even the term "tergality" would be more appropriate for Vertebrates than for any other animals, for here we find the body consisting of two distinct arches, the dorsal containing the central nervous system, and the ventral, the organs of nutrition and reproduction, thus presenting a contrast between dorsal and ventral regions seen no where else among animals. The true explanation of these relations seems to be that all these various characters whether laterality, tergality, symmetry or cephality, are most fully exemplified in the Vertebrate structure, while they exist to greater or less extent among lower animals, whether Articulates or Mollusks, and only disappear or are gradually lost sight of in the lower Radiates, owing to the preponderance of the radiate character.

The principle of antero-posterior symmetry or "longitudinality," which the author more specially considers, seems to be characteristic of Vertebrates, and has not been observed among other animals. According to this law, the anterior and posterior poles of the Vertebrate body have organs and parts that are homologous and morphologically identical, although teleologically very different, while the corresponding parts on opposite *sides* are both morphologically and teleologically repetitions of each other. To follow the various arguments and illustrations of the author would carry us too far, but some of the conclusions are quite remarkable. The body is divided into four regions, the thorax and head, corresponding to the abdomen and pelvis. The center of the body morphologically is supposed to be between the thorax and abdomen, and in embryonic development the cerebro-spinal axis commences in that region, the anterior enlargement or brain being an "after-growth for teleological cause" without any posterior equivalent, but the medulla-oblongata is the part corresponding to the posterior enlargement of the spinal cord, behind the origin of the lumbar nerves. The opposite ends of the alimentary canal, with the adjacent cavities separated from them during embryological development, correspond respectively. Thus, some of the corresponding parts are as follows: "In the anterior region, enumerating from above, that is from the vertebral column downward, the *nose* or *anterior nares*, the *upper lip*, *the mouth*, the *tongue* and the *chin;* posteriorly the *anal opening*, the *perinæum*, the *vaginal opening*, the *penis* or *clitoris*, and the *pubes*." There are two principal diverticula of the alimentary canal, the *lungs* and the *urinary bladder*, the former open forward and the latter backward, and their outlets are between the pharynx or mouth and the tongue anteriorly, and the vaginal opening and the clitoris posteriorly. "The thyroid gland is in relation with the larynx much as the prostrate gland is with the neck of the bladder." The heart is considered only a more or less complicated enlargement and convolution of the great arterial trunk." "Pathology seems to indicate that the testes and the parotid glands are longitudinally homologous; for inflammation of the former is very prone to invade the latter by what is called metastasis." The anterior part corresponding to the uterus is not known. The most remarkable and evident illustrations of this law are however drawn from the limbs, the bones and muscles of which are fully examined from this point of view. The anterior limbs are shown to be appendages of the basal segment of the skull, thrown backward by growth in the higher Vertebrates but occupying their morphological position in Fishes and some young animals. But nothing short of a complete reproduction of his account of the structure of the limbs would do justice to the work, which every one interested in the subject should consult. A. E. V.

5. *Curious Facts in the History of Insects* including Spiders and Scorpions, a complete collection of the legends, superstitious beliefs, ominous signs connected with Insects, together with their uses in Medicine, Art, and as Food; and a summary of their remarkable injuries and appearances; by FRANK COWAN, 396 pp. 12mo. 1865, Philadelphia, (J. B. Lippincott & Co.)—This is an interesting book full of the wonders of the Insect world. It is unfortunate that fact and fable are not always easily distinguishable.

6. *The Myriapoda of North America*, by HORATIO C. WOOD, Jr., M.D., Prof. Botany, Auxiliary Medical Faculty of University of Pennsylvania.

112 pp. 4to, with 3 plates. Philadelphia, 1866. From the Transactions of the American Philosophical Society.—The author has here given a complete treatise, as far as facts have been collected, on the North American Myriapods, describing the genera and species in detail, with full synonymy, and illustrations both by means of wood-cuts and plates. He closes his memoir with a chapter on the natural arrangement of the Myriapoda.

7. *Synopsis of the Polyps and Corals of the North Pacific Exploring Expedition*, under Commodore C. Ringgold and Captain John Rodgers, U. S. N., from 1853 to 1856, collected by Dr. Wm. Stimpson, naturalist to the Expedition; with descriptions of some additional species for the west coast of North America; by A. E. VERRILL. Part II, Alcyonaria, with two plates.—This paper contains descriptions of 2 new species of Pennatulidæ, 4 of Pavonaridæ, 9 of the Gorgonia tribe, and 8 of the Alcyonium tribe, besides notices of other species.

V. ASTRONOMY.

1. *On the Physical History of Meteorites;*[1] by H. C. SORBY, F.R.S.—Though I am most willing to admit that much remains to be learned before we can look upon the following theory as anything more than provisional yet at all events it serves to unite a great number of facts, and is not opposed to any with which I am now acquainted. I shall describe the facts and discuss the objections to this and other theories in a communication to the Royal Society.

As shown in my paper in the "Proceedings of the Royal Society," (xiii, 333) there is good proof of the material of meteorites having been to some extent fused, and in the state of minute detached particles. I had also met with facts which seemed to show that some portions had condensed from a state of vapor; and expected that it would be requisite to adopt a modified nebular hypothesis, but hesitated until I had obtained more satisfactory evidence. The character of the constituent particles of meteorites and their general microscopical structure differ so much from what is seen in terrestrial volcanic rocks, that it appears to me extremely improbable that they were ever portions of the moon, or of a planet, which differed from a large meteorite in having been the seat of a more or less modified volcanic action. A most careful study of their microscopical structure leads me to conclude that their constituents were originally at such a high temperature that they were in a state of vapor, like that in which many now occur in the atmosphere of the sun, as proved by the black lines in the solar spectrum. On cooling, this vapor condensed into a sort of cometary cloud, formed of small crystals and minute drops of melted stony matter, which afterwarde became more or less devitrified and crystalline. This cloud was in a state of great commotion, and the particles moving with great velocity were often broken by collision. After collecting together to form larger masses, heat, generated by mutual impact, or that existing in other parts of space through which they moved, gave rise to a variable amount of metamorphism. In some

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[1] From a sheet "printed privately" and communicated to the Editors of this Journal.

few cases, when the whole mass was fused, all evidence of a previous history has been obliterated; and on solidification a structure has been produced quite similar to that of terrestrial volcanic rocks. Such metamorphosed or fused masses were sometimes more or less completely broken up by violent collision, and the fragments again collected together and solidified. Whilst these changes were taking place, various metallic compounds of iron were so introduced as to indicate that they still existed in free space in the state of vapor, and condensed amongst the previously formed particles of the meteorites. At all events the relative amount of the metallic constituents appears to have increased with the lapse of time, and they often crystallized under conditions differing entirely from those which occurred when mixed metallic and stony materials were metamorphosed, or solidified from a state of igneous fusion in so small masses that the force of gravitation was too weak to separate the constituents, although they differ so much in specific gravity. (Report of Brit. Assoc., 1864.) Possibly however some meteoric irons have been produced in this manner by the occurrence of such a separation. The hydro-carbons, with which some few meteorites are impregnated, may have condensed from a state of vapor at a relatively late period.

I therefore conclude provisionally that meteorites are records of the existence in planetary space of physical conditions more or less similar to those now confined to the immediate neighborhood of the sun, at a period indefinitely more remote than that of the occurrence of any of the facts revealed to us by the study of geology—at a period which might in fact be called *pre-terrestrial.*

Broomfield, Sheffield, July, 1865.

2. *On the Mineralogical Structure of Meteorites*;[1] by H. C. SORBY, F.R.S.—For some time past I have endeavored to apply to the study of meteorites the principles I have made use of in the investigation of terrestrial rocks, as described in my various papers, and especially in that on the microscopical structure of crystals (Quart. Journ. Geol. Soc., 1858, vol. xiv, p. 453). I therein showed that the presence in crystals of "fluid-, glass-, stone-, or gas-cavities" enables us to determine in a very satisfactory manner under what conditions the crystals were formed. There are also other methods of inquiry still requiring much investigation, and a number of experiments must be made which will occupy much time; yet, not wishing to postpone the publication of certain facts, I purpose now to give a short account of them, to be extended and completed on a subsequent occasion.[2]

In the first place it is important to remark that the olivine of meteorites contains most excellent "glass-cavities," similar to those in the olivine of lavas, thus proving that the material was at one time in a state of igneous fusion. The olivine also contains "gas-cavities," like those so common in volcanic minerals, thus indicating the presence of some gas or vapor (Aussun, Parnallee). To see these cavities distinctly, a carefully prepared thin section and a magnifying power of several hundreds are required. The vitreous substance found in the cavities is also met with

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[1] From the Proceedings of the Roy. Soc., June 16, 1864.

[2] The names given thus (Stannern) indicate what meteorites I more particularly refer to in proof of the various facts previously stated.

outside and among the crystals, in such a manner as to show that it is the uncrystalline residue of the material in which they were formed (Mezö-Madaras, Parnallee). It is of a claret or brownish color, and possesses the characteristic structure and optical properties of artificial glasses. Some isolated portions of meteorites have also a structure very similar to that of stony lavas, where the shape and mutual relations of the crystals to each other prove that they were formed *in situ*, on solidification. Possibly some entire meteorites should be considered to possess this peculiarity (Stannern, New Concord), but the evidence is by no means conclusive, and what crystallization has taken place *in situ* may have been a secondary result; whilst in others the constituent particles have all the characters of broken fragments (L'Aigle). This sometimes gives rise to a structure remarkably like that of consolidated volcanic ashes, so much, indeed, that I have specimens which, at first sight, might readily be mistaken for sections of meteorites. It would therefore appear that, after the material of the meteorites was melted, a considerable portion was broken up into small fragments, subsequently collected together, and more or less consolidated by mechanical and chemical actions, among which must be classed a segregation of iron, either in the metallic state in combination with other substances. Apparently this breaking up occurred in some cases when the melted matter had become crystalline, but in others the forms of the particles lead me to conclude that it was broken up into detached globules whilst still melted (Mezö-Madaras, Parnallee). This seems to have been the origin of some of the round grains met with in meteorites; for they occasionally still contain a considerable amount of glass, and the crystals which have been formed in it are arranged in groups, radiating from one or more points on the external surface, in such a manner as to indicate that they were developed after the fragments had acquired their present spheroidal shape (Aussun, &c.). In this they differ most characteristically from the general type of concretionary globules found in terrestrial rocks, in which they radiate from the center; the only case that I know at all analogous being that of certain oolitic grains in the Kelloways rock at Scarborough, which have undergone a secondary crystallization. These facts are all quite independent of the fused black crust.

Some of the minerals in meteorites, usually considered to be the same as those in volcanic rocks, have yet very characteristic differences in structure (Stannern), which I shall describe at greater length on a future occasion. I will then also give a full account of the microscopical structure of meteoric iron as compared with that produced by various artificial processes, showing that under certain conditions the latter may be obtained so as to resemble very closely some varieties of meteoric origin (Newstead, &c.).

There are thus certain peculiarities in physical structure which connect meteorites with volcanic rocks, and at the same time others in which they differ most characteristically,—facts which I think must be borne in mind, not only in forming a conclusion as to the origin of meteorites, but also in attempting to explain volcanic action in general. The discussion of such questions, however, should, I think, be deferred until a more complete account can be given of all the data on which these conclusions are founded.

VI. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the geological position of oil wells;* by J. P. LESLEY.—In the Proceedings of the American Philosophical Society, at page 189, of vol. x, Mr. Lesley observes that the recent facts he has collected from the valleys of the Sandy, in eastern Kentucky, confirm his view that the oil there comes from the base of the Coal Measures; that "the plants of the great Conglomerate have been converted into thick oil and reach the surface by horizontal drainage over the water-bearing Shales of the False or Lower Coal Measures." The next horizon of oil below this is far down in the Devonian. Mr. Lesley also states the fact that Dr. Newberry has announced that the flow of oil which took place years ago in southern Middle Kentucky came from the Lower Silurian limestones, the same horizon that affords oil in limited quantities near Chicago; and that he himself observed "petroleum trickling from Upper Silurian limestones at Cape Gaspé, Canada East, the surfaces of the limestone bed being almost covered with the vestiges of cocktail fucoids, coralloids, bivalves and trilobites."

2. *Scientific Exploring party in Russian America, connected with the Western Union Telegraph Company.*—[Through the liberality of the Northwest American Telegraph Company, a scientific corps under the direction of Mr. Kennicott accompanies the expedition. We cite the following statements respecting the corps and its operations from a letter received from Mr. W. H. DALL, of the corps, dated At sea, en route for Petropavlovsk, Bark Golden Gate, Oct. 11, 1865.] "Our party, which consists of Mr. Kennicott, Director; J. T. Rothrock, as Botanist; myself, in charge of the Department of marine invertebrates; H. M. Bannister, of the Smithsonian Institution, as Paleontologist; and Henry Elliott and Ferdinand Bischoff as general collectors, are employed by the Telegraph Company as explorers, &c., and the work which we do for natural history is entirely outside of this.

But by the kindness and liberality of Col. Chas. S. Bulkley, in general command, and Capt. C. M. Scammon, Chief of Marine (of the U. S. Rev. M.), both of whom are much interested in science and natural history, we are able to accomplish a great deal in the scientific way.

This year's actual collections are small, as we started late in the season and have paid flying visits everywhere, and our attention has been given mainly to mapping out next season's work, and placing men and outfits where they would be most useful.

The collections are mostly marine, and have been principally made by myself, as the other members of our party have been otherwise employed. They have been made on the surface of the north Pacific and Behring sea, and also by soundings in both; at Sitka, R. Am.; Ounga Island, south of Aliaska; Ounimak Pass, Aleutian Islands, Norton Sound; Behring Strait; Plover Bay, on the Asiatic side; and they will be continued at Petropavlovsk when we arrive there. We shall then leave for San Francisco. Our collections all pass into the hands of Prof. Baird, at the Smithsonian Institution, under certain restrictions.

One interesting result of this year's work was the examination of the lignite, or brown coal beds, at Ounga Island, and the collection of such a series of fossils as will doubtless determine their age.

Our party has been distributed as follows: Mr. Bischoff, with a good outfit, was left at Sitka in Aug. last, and will remain all winter and next spring. Mr. Bannister remains at St. Michaels, Norton Sound, where he will be joined in the early spring by Messrs. Kennicott and Rothrock, now absent in command of exploring parties, and by Mr. Elliott, and probably by Mr. Bischoff, later in the season. By thus concentrating, the natural history operations on the lower Youkon around Norton Sound are likely to prove successful."

3. *On Negro Instruments;* by A. INNES.—In your report of the proceedings of the British Association, in a paper read by Mr. J. Crawfurd, 'On the Physical and Mental Characteristics of the African Negro,' it is stated that "The Negro, also, had never shown ingenuity enough to invent letters, symbolic or phonetic." I beg leave to hand you a drawing of the "Elliembic," or African telegraph, an instrument which has been in existence for time immemorial to the oldest inhabitant in the Cameroons country, on the west coast of Africa. By the sounds produced on striking this instrument, the natives carry on conversation with great rapidity, and at several miles distance. I have one of the instruments now in my possession, which I brought home with me on my last visit to Africa in 1860. The sounds are made to produce a perfect and distinct language, as intelligible to the natives as that uttered by the human voice, and which I had the means of testing on several occasions. The instrument is in universal practice about the Cameroons, and up in the interior, in the Abo and Budi countries, a part of central Africa not yet visited by Europeans. In visiting this part of Africa in 1859, my coming was generally announced beforehand to the different villages by the "Elliembic." I questioned some of the oldest inhabitants as to the inventor; but none of them could tell me further than that they supposed "it must have been some of their great-grandfathers." This "Elliembic," therefore (which is a most ingenious invention), must have been in existence in Africa before telegraphs were dreamt of in England.—*Athenæum, Oct.* 14*th*, 1865.

4. *Malta cavern.*—The Mnaidva bone-cave, which Dr. Adams discovered in 1863, on the southwest coast of Malta, and which he named after the Phœnician mines close by, is to be further explored, the Geological Section having voted 30*l.* for the purpose. In 1864, Dr. Adams worked at it divers times, until the British Association sent a grant enabling him to clear out fifty-four feet of the cave, which was filled with red earth and stalagmite. Here he found sixty to eighty teeth, and numerous fragments of bones, of at least two species of elephant, one a mere pigmy, the other of larger size, but scarcely equal to the smallest Asiatic elephant; besides vast quantities of a gigantic rat, land tortoise, and swan—the last of colossal dimensions. It has been named *Cygnus Falconerii*, after the distinguished paleontologist, the late Dr. Falconer. Dr. Adams will continue his researches during the winter months.—*Reader*, *Oct.* 28*th*, 1865.

5. *Chicago Observatory.*—Mr. T. H. Safford, formerly assistant at the observatory of Harvard college, has been appointed Director of the observatory at Chicago.

6. *London International Horticultural Exhibition.*—Prof. Alphonse de Candolle of Geneva has accepted the Presidency of the Botanical Con-

gress to be held in London in May next, in connection with the great International Horticultural Exhibition, and will deliver an opening address on the mutual relationship of gardening and botany, and the practical results wrought by them. The Congress department has been placed under the care of Dr. Seemann, to whom all communications relating to it should be addressed.—*Reader*, Dec. 9th, 1865.

7. *National Academy of Science.*—The next session of the National Academy of Sciences will open at Washington on the 24th of January.

8. *Origin of lake-depressions.*—This subject receives some important illustrations, accompanied with criticisms upon the glacial theory of Prof. Ramsay, in an article by Prof. J. P. Lesley, in volume ix of the Proceedings of the American Philosophical Society, at page 190.

9. *The Proceedings of the recent meeting of the British Association at Birmingham.*—The best abstracts that have been published of the papers read at the recent meeting of the British Association are contained in the London weekly periodicals, The Reader, numbers 142 to 150 inclusive (Sept. 9 to Nov. 11), and the Athenæum, numbers 1976 to 1981 (Sept. 9, to Oct. 14).

10. *First Annual Catalogue of the Officers and Students, and Programme of the Course of Instruction, of the School of the Massachusetts Institute of Technology*, 1865–6. 40 pp. 8vo. Boston, 1865.—This first Annual Catalogue gives assurance that the Institute of Technology, established at Boston by the State of Massachusetts, under the direction of Prof. Wm. B. Rogers, is in full and successful operation. The course of instruction as here presented is excellent. The corps of Professors is one of great scientific strength, it consisting of WM. B. ROGERS, President, besides Professor in Physics and Geology; JOHN D. RUNKLE, Professor in Mathematics and Analytic Mechanics; FRANK H. STORER, in General and Industrial Chemistry; CHARLES W. ELIOT, in Analytical Chemistry and Metallurgy; WM. P. ATKINSON, in the English Language and Literature; JOHN B. HENCK, in Engineering; W. WATSON, in Descriptive Geometry and Mechanical Engineering; WM. R. WARE, in Architecture; JAMES D. HAGUE, in Mining Engineering; F. BÖCKER, in Modern Languages.

11. *Cabinet of Minerals for sale.*—Dr. F. A. Genth, of Philadelphia offers for sale his fine cabinet of rocks and minerals, rich in both foreign and American specimens. It also includes a collection of fossils.

OBITUARY.

Dr. J. L. RIDDELL.—A committee, consisting of Rufus Staples and James S. Knapp, appointed by the New Orleans Academy of Sciences, on the 16th day of October, 1865, for the purpose of drafting some resolutions expressive of the sense of that body on the death of Prof. J. L. Riddell, together with a sketch of his life, made a report, the larger part of which we here republish.

DR. JOHN LEONARD RIDDELL was born in Leyden, Mass., on the 20th day of February, 1807, and died in New Orleans on the 7th day of October, 1865. He was honorably descended from an ancient Scotch-Irish family. In the fall of the year 1807, he was taken by his parents to Preston, Chenango county, New York, where his boyhood was spent on his father's farm. He attended the Oxford Academy during portions of the years 1826 and 1827, and afterward the Rensselaer School of Troy, N. Y., where he obtained the degree of A.B., and subsequently of A.M.

For several years, commencing in 1830, he gave lectures on chemistry, botany and geology in various places in the United States and in Canada. In 1835 he was appointed Adjunct Professor of Chemistry, and Prof. of Botany in the Cincinnati Medical College, where he received the degree of M.D.

In 1836 he was appointed Prof. of Chemistry in the Medical College of Louisiana, at New Orleans; at present the Medical Department of the University of Louisiana, now under the patronage of the State, which chair he retained, and filled with great credit till his death. In 1838 he was appointed "Melter and Refiner" in the Branch Mint, an office he held till 1849.

His contributions to science have been of a varied nature. In 1835 at Cincinnati, O., he published a catalogue of plants, entitled "*A Synopsis of the Flora of the Western States*," including 1800 different species, the earliest work of any importance specially devoted to the *Botany of the West.* Subsequently he published a catalogue of the plants of Louisana comprising some 2300 species. In the Western States, in Louisiana and in Texas, he was the discoverer of numerous new species of plants. His name is indelibly impressed on the science in the *genus* "Riddellia," named from him. He prepared the materials for the publication of a work on the botany of the Southern part of the United States, and leaves a very large and well arranged Herbarium.

In 1845, he published a "*Monograph of the Dollar*," with fac-simile impressions of between five and six hundred varieties of American and Mexican dollars and half dollars, both genuine and counterfeit, with the assays of each.

In 1836 his thesis on "*Miasm and Contagion*" was published in Cincinnati, and republished in Boston, in which he advocated the theory that "organized and living corpuscles of various kinds" were the agents of communication in contagious diseases; and in this he was one of the earliest to adopt that theory which seems now to be so rapidly gaining adherents.

For many years preceding his death, Doctor Riddell had directed great energy and attention to microscopic observations, examining minutely the animalculæ and algæ found in the swamp waters in the vicinity of New Orleans, of many of which he made drawings. His researches in this department of science, as well as botany, are well known and appreciated on both sides of the Atlantic. He invented a *Binocular Microscope* which gave the student in microscopy an advantage never before enjoyed.

As a lecturer on chemistry in the University of Louisiana, he was remarkable for perspicuity of style and diction. He enjoyed the highest esteem of the students, among whom he was extremely popular. Unlike many men of learning, his attainments formed no barrier to a personal approach by the unlettered; nor did they prevent him from kindly and constantly aiding others, nor from giving that attention to business affairs in which he was eminently successful, and by which he accumulated and left to his family a large and productive property.

In the New Orleans Academy of Sciences, of which he was one of the founders, he acted most efficiently as President nearly all of the time from its formation. Among the varied subjects under discussion, his uncommonly retentive memory, his accurate and general information, and his happy faculty of imparting knowledge enabled him to cast light on almost any subject under consideration. Their thanks are especially due to him for the preservation of the domicile of the Academy from occupation by the military, and its property from pillage and waste during the perilous times of civil war.

VII. MISCELLANEOUS BIBLIOGRAPHY.

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2. *Smithsonian Report for* 1864.—The following are the contents of the Annual Report of the Smithsonian Institution, including its appendix for 1864.—Report of the Regents, including Report of the Secretary, Prof. Henry, etc., pages 1–114.—p. 125, Memoir of Delambre; Joseph Fourier.—p. 135, Essay on the Velocity of Light; M. Delaunay.—p. 166, Ozone and Antozone; Charles M. Wetherill, Ph.D., M.D.—178, Vegetation and the Atmosphere; J. Jamin.—p. 191, Extract of a Memoir on the Preservation of Copper and Iron in Salt Water; M. Becquerel.—p. 196, Preservation of Wood.—p. 206, Caoutchouc and Gutta Percha.—p. 221, The Products of the Combustion of Gun Cotton and Gunpowder under circumstances analogous to those which occur in practice; Lieut. von Karolyi.—p. 235, Description of Apparatus for testing the results of Perspiration and Respiration in the Physiological Institute at Munich; Prof. Max Pettenkofer.—p. 240, The Solar Eclipse of July 18, 1860; Dr. J. Lamont.—p. 261, Report on the Transactions of the Society of Physics and Natural History of Geneva, 1861; Rev. M. Duby, President.—p. 282, On the Crania Helvetica; Frederick Troyon.—p. 285, Experimental and Theoretical Researches on the Figures of Equilibrium of a liquid mass withdrawn from the action of Gravity, &c., Prof. J. Plateau.—p. 370, Artificial Shell-deposits in New Jersey; Charles Rau.—p. 375, The Intermixture of Races; George Gibbs.—p. 378, An account of the aboriginal inhabitants of the California Peninsula; Jacob Baegert.—p. 400, The first steps in the study of High Antiquity in Europe; A. Morlot.—p. 412, Scientific Expedition to Mexico. A Report addressed to the Emperor by the Minister of Public Instruction.—p. 416, A Journey to the Youcan, Russian America; W. W. Kirby.—p. 421, Exploration in Upper California in 1860 under the auspices of the Smithsonian Institution; John Feilner, U. S. A.—p. 431, Journal of an Exploration of Western Missouri in 1854, under the auspices of the Smithsonian Institution; P. R. Hoy, M.D.—p. 439, Tables of Weights and Measures.

3. *Aus Sahara und Atlas*, vier Briefe au J. Liebig von E. Desor. 72 pages 8vo, with several tables. Wiesbaden, 1865 (C. W. Kreidel).—The four letters here contained give an account of the interesting excur-

sion made by Mr. Desor in the region of the Sahara desert. We have already given some account of the explorations in volume xxxvii, at pages 146 and 445, 1864.

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Giornale di Scienze Naturali ed economiche publicato per cura del consiglio di Perfezionamento annesso al R. Istituto Tecnico di Palermo. Volume I, Fascic. i (96 pp.), ii (76 pp.), large 4to, with plates. 1865.

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Specimen of barometric curves as recorded by the Automatic registering and printing Barometer, at the Dudley Observatory, Albany, N.Y.

Lith. of Weed, Parsons & Co. Albany, N.Y.

THE

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[SECOND SERIES.]

ART. XVI.—*Notice of an Account of Geological Observations in China, Japan and Mongolia;* by RAPHAEL PUMPELLY.

[Read before the National Academy of Sciences,[1] Aug. 26th, 1865.]

IN the present brief notice, I propose to call attention to some of the principal conclusions to which I have been led by geological observations made during journeys in China and Mongolia. In a longer memoir I hope to give in detail the grounds on which these conclusions are based. The range of travel was as follows:

In the summer of 1863, from *Shanghai* to *Hunan* and the boundary between *Hupeh* and *Sz'chuen*.

In the autumn and winter of 1863 and 1864 and during the following spring, from *Peking* through the mountains of western *Chihli;* and from *Peking* to beyond the Great Wall of China and westward on the plateau, following its southern edge to about the 112th meridian, E. of Greenwich, returning by a route south of the Great Wall.

In the winter of 1864 and 1865, from *Peking* across the plateau of Central Asia, via *Kalgan* and *Urga*, and *Kiachta* in Siberia.

The almost total absence of previous observations of a geological character, through this wide field, the comparatively small amount of surface seen in the above journeys, and the great difficulties that a single observer has to contend with, owing to the jealousy of the inhabitants in the center of China, and the extreme cold of a winter journey over the table land, restricted my range of observation, and permit me to give in the paper I am

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[1] The work to which this brief notice calls attention, and which the National Academy has kindly volunteered to publish in its memoirs, contains also an itinerary of geological observations in Japan, and will be accompanied by a considerable number of maps, sections and illustrations.

preparing only a general and necessarily very incomplete idea of the geology of that interesting country. The data at my service are: my own observations, the extremely limited number of those of other foreigners, and the information obtained from Chinese works on the geography of the empire, chiefly bearing on its mineral productions and scattered through an immense range of literature.

The chief results arrived at are as follows:

I. There is reason for believing that there exists throughout China, an immense development of Devonian limestone, which rises to the surface in all the important ridges, and attains in places a thickness of over 10,000 feet.

II. Wherever the formations beneath this limestone were seen, they were found to be, either granitic rocks, or metamorphic schists, non-conformably stratified as regards the limestone.

III. Overlying the limestone, there exists in almost every part of China, a great coal-bearing formation of sandstones, shales, conglomerates, etc., as a rule in nearly, if not quite, conformable stratification as regards its limestone floor. The fossil plants obtained from this formation in widely separated localities, in the province of *Chihli* and on the *Yangtse Kiang* in western *Hupeh*, are being examined by Dr. J. S. Newberry, who considers them to be decidedly supra-carboniferous. The absence of Carboniferous forms and the presence of Cycads closely resembling Triassic species, make it probable that the coal-fields of China, which vie with our own in extent, are referable to the Triassic period.

IV. Although from the limited range of actual observation, it would be assuming too much to assert that there is a total absence of all formations younger than the Chinese Coal-measures, still I failed to find any traces of them, and I feel justified in doubting the existence of marine Jurassic, Cretaceous or Tertiary deposits to any important extent, within the limits of the Eighteen Provinces, or China Proper, unless they may be represented on the frontiers of Assam, Burmah or Cochin China, or on the islands of Formosa or Hainan.

V. Excluding the N. S. ranges of mountains that form the eastern edge of the Thibetan highland, only two systems of elevations occur in China, of sufficient importance to have left a marked impress on the surface. These are the N.E., S.W. and the E.W. systems. The N.E. system of trends, in all eastern Asia, east of the 110th meridian, determines the outline of that part of the continent, and they, as well as nearly all the more important features of this region, can be represented by lines drawn parallel to a line running N. 47° E., and coinciding with the middle course of the *Yangtse Kiang* and the lower course of the *Amur*, with the longer axes of the Gulfs of *Penjinsk* and of *Pechele*, and with that of the depression occupied by the delta plain of the *Hwang Ho*.

The E.W. system exists in western China in the *Min* mountains and in the *Nan ling* range.

While the N.E. system has determined the eastern outlines of the continent, and much of its inland configuration, to the E. W. system is due the *general* course from west to east of the three principal rivers, the *Hwang Ho*, the *Yangtse Kiang* and the *Si Ho* of the south.

The disturbance of the N.E. system began after the deposition of the great Devonian limestone formation. It appears to have been acting slightly, during the forming of the coal-bearing beds, but its chief operation was after these had been deposited.

There is a striking analogy between this system and the Appalachians, both having the same trend, and, within certain limits, contemporaneous origin, and both folding immense areas of coal-bearing strata, and determining the eastern outlines of their respective continents.

I have taken the liberty of applying to this widely extended upheaval, the name of the SINIAN[1] system.

The E.W. system appears to be younger than the Sinian. It has raised the limestone and overlying rocks in the *Min* mountains and in the *Nan ling* range, and M. de Semenow found Carboniferous limestone forming synclinal folds in the longitudinal valleys of the *Tien shan.*

VI. Evidences of recent oscillations, extending over a great area, are visible in terraces on the coast of *Shantung*, along the whole course of the *Yangtse Kiang* from the sea to western *Sz'chuen*, and on the western skirt of the delta plain, as well as throughout the islands of Japan.

VII. The great plain of north-eastern China is a delta deposit, mainly of the *Hwang Ho*, stretching over nearly eight degrees of latitude and yearly increasing in extent. Within the limits of this delta the *Hwang Ho* varies its course every few centuries, emptying into the sea, alternately to the north and to the south of the mountainous peninsula of *Shantung.*

VIII. The great table land that lies between China and Siberia is made up, where my route crossed it, of basins of undisturbed strata of sandstone, probably younger Tertiary, containing, in places, beds of gypsum. These basins are separated by low ridges, often of granitic rocks, but more generally, of highly inclined and folded strata of schists, sandstones and limestones, etc., all highly metamorphosed. The general trend of these ridges is between E. and N.E.

In the south the plateau rises gently, terminating in a precipitous wall facing the S.S.E. Where I travelled along this southern edge, between the 112th and 115th meridians (E. of Green-

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[1] From *Sinim*, the name under which the earliest mention of China is made; Isaiah, xlix, 12.

wich), it is formed by an immense development of lava flows, in places more than 1,500 feet thick. Wherever the rocks underlying this volcanic formation were observed, they were invariably found to be granitic, with metamorphic schists, chiefly gneiss, granulite and hornblendic varieties.

The abrupt termination of the plateau is owing to a great dislocation which marks, approximatively, the coast line of a former ocean to the north, in which the more recent deposits of the plateau originated, and along whose southern shore there existed an extensive region of volcanic activity.

This high escarpment seems to be the *Inshan*, and the fact that it is volcanic goes to prove the justness of Humboldt's belief, that the *Inshan* forms the continuation of the *Tienshan*.

While the plateau is terminated on the south by this escarpment, it is limited on the east by parallel ridges, and descends by successive terraces, to the Manchurian lowlands.

By the elevation of the plateau, north of this line of fracture, a great basin was formed between the escarpment and the range of mountains nearly marked, on the maps, by the Great Wall. This area became the seat of a series of lakes extending several hundred miles, from W.S.W. to E.N.E., and which have left a deposit of loam often visible in terraces several hundred feet thick. These lakes seem to have covered the whole land of the *Ortos*, within the great northern bend of the *Hwang Ho*, and the valley system of the *San Kang* and *Yang* rivers. The fresh-water character of the loam is proved by the presence of fresh-water shells.

The circumstances seem to warrant the supposition of a connected chain of lakes, stretching from the 106th to the 116th meridian, which received the waters of the *Hwang Ho*, before the formation of, or during a long continued obstruction of, the deep channel in which that river now flows between *Shansi* and *Shensi*. The main outlet seems to have been the present gorge, by which the *Yang Ho* traverses the mountains west of *Peking*, to join the *Pei Ho* of the delta plain.

The lower *Pei Ho* has, within historical times, more than once formed the mouth of the *Hwang Ho*.

Thus the *Hwang Ho* appears to present a most remarkable instance of one of the great rivers of the earth, not only shifting its lower course over an area of several degrees of latitude on its delta-plain, but also reaching the sea at the same point, at different times, after following two widely separated routes through a highly mountainous country.

IX. Among the more practical results obtained, I may mention the determination, from personal observation and from native sources, of a large number of extensive coal-basins, and of localities producing other useful minerals, all of which I have tabulated and represented, so far as is practicable, on a map.

These are so widely distributed throughout the empire, as to warrant the belief that China stands second to not even the most favored countries, as regards the quantity and quality of its coal and the long list of its other mineral resources.

Such great gifts of nature, combined as they are, with an unsurpassed variety of favorable circumstances, both climatal and structural, cannot long lie idle; they are the elements of the civilization of the present age, and in the natural course of events, the country possessing them cannot avoid being drawn into the stream of industrial and intellectual progress. They seem to predetermine a future history for that distant people; for, far from witnessing the often asserted signs of decay in the Chinese race, I am, and I think every careful observer must be, rather astonished at the evidences of a most remarkable vitality.

ART. XVII.—*The present annual effect of the secular change of the Magnetic Declination in the Eastern part of the United States, accompanied by a Chart;* by CHARLES A. SCHOTT, Assistant U. S. Coast Survey.

[Published in this Journal by permission of the Treasury Department, and communicated by Prof. A. D. BACHE, Superintendent U. S. Coast Survey.]

IN a preceding number of this Journal (vol. xxix, May, 1860), I have given a special discussion of the secular variation to which the magnetic declination in the eastern portion of the United States appears to be subject: in the present communication will be found some additional material, since collected, with a chart of isomagnetic curves of the *annual change* of the declination. As a first attempt, this chart can claim but very moderate accuracy; it has been supposed, however, that enough information had accumulated to attempt its construction.

The curves unite places of equal annual change and by their distribution furnish us with ready means to refer any observed magnetic declination (within their limits) taken within the past decade, to the present value or to an epoch a few years in advance. These lines themselves change in the course of time, as is sufficiently plain from the discussion above referred to, but they may be taken to answer for about a decade either way from date, without passing beyond the limit of uncertainty to which they are subject themselves. The year 1860 may be taken for their average epoch.

The curves marked thus: II, III, IV, V, indicate the localities where the *annual* increase of west declination amounted, on the average, to as many minutes, between the years 1850 and 1860.

The change at Eastport, Me., +1′·6 appears singularly small, but monthly observations, continued between 1860 and 1864, and a verification of last summer, will not admit of any other value. For the greater part of our Atlantic coast the annual change is confined between +2′ and +3′, less on the southern coast, the careful observations at Key West between 1860 and 1865 give the comparatively large value +2′·9. Proceeding westward, on the Gulf coast the annual change becomes less, and at the Mississippi delta it is but a fraction of a minute. The Coast Survey report of 1861, pp. 252 and 256, contains the numerical quantities for our southern coast.

If we start from the extreme northeast, in a southwesterly direction, we shall find the annual change as follows: along the St. Lawrence river between the Saguenay river and Quebec +6′; between Quebec and Montreal about +5′; between Montreal and Kingston about +4′; at Portland, Me. +3′·2 (from the most recent observations); along Lake Ontario +4′; at Toronto +3′·1 (from a table of absolute value published by G. T. Kingston, director of the observatory); at Buffalo +3′·6; at Dunkirk +4′·3; at Lake St. Clair +2′·9. The average value for Pennsylvania is about +2′·7 (see record and results of a magnetic survey of Pennsylvania, etc. etc., by A. D. Bache, LL.D., Smithsonian Contributions to Knowledge, Oct. 1863). At Parkersburg, Western Va. +3′·2; at Cairo, Ill. +2′·0, apparently a reliable value; at Florence, Ala. +2′·3 a very reliable value; the value +0′·8 for Chicago, Ill. seems too small, though it is certain that the secular change must pass through zero and increase the eastern declinations along our Pacific coast.

Taking a glance at the West Indies and Central American regions, we find at Havana, Cuba, and in Jamaica the *easterly* declination still on the *decrease*, and the dividing region between stations of decreasing and increasing easterly declination, appears to lie somewhere between Panama and Vera Cruz. At the city of Mexico the east declination *increases* about 1′ a year, and at San Blas, Mexico, about 3′; for California, Oregon and Washington, the value formerly assumed by me (in the Coast Survey reports for 1856 and 1859) appears now too small though we possess as yet no precise information. According to Col. Ransom's paper (vol. ii, of the Proceedings of the California Academy of Natural Sciences, 1858–62, San Francisco, 1863) the annual increase of easterly declination for the epoch 1855 is between 2½′ and 4′, though 7′ is said to have been observed in Alameda Co. I feel inclined to assume now an annual increase of 2¾′ along our western coast, 3′ may be taken under the forty-ninth parallel and west of the Rocky Mountains. Higher north, at Sitka, Russian America, the east declination increases about 4′·7 per annum.

It is in contemplation to have special observations made on the Texan and Western Coast for the purpose of a precise determination of the annual change in those localities.

ART. XVIII.—*Observations of Tides at Tahiti, made for the U. S. Coast Survey, under the direction of Captain* JOHN RODGERS, U. S. N. Communicated by Prof. A. D. BACHE, Supt. U. S. Coast Survey.

THE tides at Tahiti have long been known to exhibit the peculiarity of occurring nearly at the same hour of every day, indicating an almost total elimination of the lunar tide.

As far as we know, the tides of no other part of the globe present this extraordinary feature. No explanation fully satisfactory has yet been proposed for this phenomenon.

From their bearing on the laws regulating the tides on the North American coast of the Pacific Ocean, accurate tidal observations in central parts of that ocean are a great desideratum, and advantage was therefore taken by the Superintendent of the Coast Survey, of the surveying expedition under the command of Captain John Rodgers, U. S. N., by furnishing him with one of Saxton's self-registering tide-gauges, with the request to set it up at some suitable point.

The town of Papeete, on the island of Tahiti, was selected by Captain Rodgers, and the tide-gauge left there under the charge of an intelligent French soldier. The observations began on the 27th of April, 1858, but up to June 2d were so frequently interrupted as to be of little use. After that date, they are nearly complete to October 12th, subsequent to which time no observations have been received.

On the accompanying diagram the mean local time of each high-water has been plotted in such a manner that the abscissæ represent the days of the month, the ordinates the hours of the day. An inspection of the diagram will show that during part of the month of June the tide appears to have followed the general rule, occurring later every day, so that there was a high-water successively at all the hours of the twenty-four. In July, however, the case was quite different. The high-waters occurred at a later hour on successive days, but only until they had reached three or four hours, and, in one case, five, after noon or midnight, when they came back abruptly to the neighborhood of 12, to follow again a similar cycle. This type they preserved to October 12th, when the observations ceased, only the range and the abruptness of the return to an earlier hour becoming lessened.

It will also be remarked that the midnight tides diverge less from that hour than the midday tides from noon. The times of low-water have, as may be expected, similar relations to 6 A. M. and 6 P. M.

TIDAL OBSERVATIONS AT PAPEETE ON THE ISLAND OF TAHITI

Taking the mean of all the observations we find 59 minutes past noon, and 53 minutes past midnight, for the average time of high-water, and 45 minutes past six for the average time of low-water, both morning and night.

The smaller diagram shows the variations from that mean, arranged according to the moon's transit. The curve exhibited might be called the half-monthly inequality in the soli-tidal interval, in analogy to the curve of half-monthly inequality of the luni-tidal interval of ordinary tides.

With regard to the heights, the statements received are not quite precise as to the scale used in the self-registering tide-gauge, and some uncertainty arises from the zero-point having been repeatedly altered, owing to the necessity of using the same paper on the gauge several times. On the best supposition that can be made we find the mean rise and fall to be 0·87 ft. The observations made at the same port, for a few days, by Capt. Sir Edward Belcher, R. N., in 1840 (Phil. Trans., 1843) gave a mean rise and fall of only 0·56 ft. The diurnal inequality is well marked, and the half-monthly inequality regular and normal.

If we examine the variations of the intervals near the time of the summer solstice, we shall find that on the 3d of June or a little after, when the moon's upper transit comes at noon, the intervals for midday tides have their mean value. Then the interval increases rapidly every day as the moon's transits come later, until they come near the middle of the afternoon, when there is a sudden change of 6^h or 8^h in the course of 2 or 3 days, during which time, the tides are so small that their times and intervals cannot be well determined. The high-waters then seem to pass under the influence of the moon's inferior transits, and the intervals are reduced to their minimum values, or become negative. The intervals then increase rapidly again for a considerable part of half a lunation, until they pass again under the action of, and finally under the control of, the moon's superior transits. The same law will be observed to prevail throughout the period of observation, but the inequality rapidly decreases in amount as we depart from the solstice. Similar observations apply *mutatis mutandis* to the midnight tides.

The range of the tides seems to be considerably less near the solstice, than they are near the equinox.

There seem to have been some notable changes in the mean level of the ocean in the month of July.

Hopes are entertained of obtaining more observations, and a supply of paper was forwarded to the U. S. Consul some years ago, but no answer has ever been received. It has been thought advisable therefore to publish the results as far as they have been obtained.

ART. XIX.—*On Prairies*; by A. FENDLER.[1]

IN my botanical rambles I have seen Prairies, Llanos and Savannahs of different magnitudes and in various stages of progress; and, as I am assured that my suggestions on this subject, although they may not fully coincide with your views, would be received in a kind spirit, I beg to make the following remarks.

The prevalence of moisture, although generally is not always connected directly with a prevalence of forest. For four years I lived on the range of mountains that stretches along the northern coast of Venezuela in lat. 10° N., at an elevation of 6,500 feet above the sea, in the midst of a vast forest. The northern slope of this chain of mountains, from its very crest (7,000–8,000 ft.) down to the margin of the sea, is covered by an immense primeval forest, except in a very few insignificant spots, near some of the seaports, where man has interfered with it. In this mountainous region, from the middle of April to the first of January, hardly a day passes without rain. It is a region enveloped in mist and clouds during most of this time, alternately drizzling, dripping and pouring down, where the temperature rarely ever rises as high as 70° or falls as low as 38°. It is a true "Fern-region," where tree-ferns may be found from 30 to 40 feet high. It is certainly one of the most rainy, moist and humid regions outside of the great equatorial rain-belt. Although the northern or sea-side of this mountain-range is in its whole length covered by forest, savannahs stretch in many places from the very crest down the opposite or southern side, which is constantly exposed to southern or southeastern winds, driving the clouds and mist against it and up along its surface away over the crest. In some localities of the windward side forests alternate with savannahs, but in other localities on the same side, and exposed to the same wet weather, large tracts are entirely bare of forest. The forests, however, do not gain on the savannahs, but from time to time the savannahs gain on the forests by a very simple agent, namely, that of *fire*.

Fire I consider by far the most powerful and the principal agency that gave prairies and savannahs their existence, extending them in the course of time and still busy in extending them. In the prairies of Illinois, Missouri and Texas as well as on the great plains between Missouri and the Rocky mountains, on the llanos of Venezuela and the high savannahs of the mountainous district of the same country, I have seen the same forest-destroyer at work. In the region last named I had the rare opportunity of observing not only the gradual extension of the savannahs,

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[1] From a letter to Professor Dana, dated Cambridge, Mass., Dec. 12, 1865.

but also the beginning and the different stages of the conversion of an almost impenetrable primeval forest into a savannah.

I cite the following facts, observed by myself at Colonia Tovar in Venezuela, from an account in the Smithsonian Report for 1857, pages 186–188.

> "On the 5th of January I made a botanical excursion to one of the highest mountains of this region, about twelve miles to the east of the colony. The mountain, according to my estimation, may be about 7,800 feet above the level of the sea, and is a kind of central point or knot, from which several rivers, flowing in different directions, take their origin. This mountain is covered by a dense forest, with the exception of a level spot of about half a mile in length and a quarter of a mile in width, which forms a kind of shallow basin, only sparingly covered by a thin coat of short grass and other small plants. * * *
>
> In this excursion I had also an opportunity to form some idea of the vast extent of destruction which was carried into the mountain forest last February by a lucifer match and a thoughtless boy. Over whole tracts of this primeval forest the trees lie dead, one over the other, as if uprooted by a whirlwind, scarcely showing any marks of fire on their trunks. I was struck more than ever with the easy manner in which fire can destroy these dense and humid forests, which, by their shade, preserve a cool and moist atmosphere, and thereby cause the vapors of the adjacent strata of air to condense into clouds, that rest upon them, with little intermission, during nine months in the year. In these high regions the temperature is so low and equable that the vegetable matter which is gathered on the ground between the trees is decomposed very incompletely and very slowly. It forms a stratum of loose half-decomposed matter, in some places two to three feet thick, which, in the rainy season, like an immense layer of sponge filled with water, feeds and supplies the rivulets and rivers *gradually*. In the midst of the dry season this layer becomes sometimes dry enough to burn, when kindled, with but little flame, and more like tinder, spreading in all directions.
>
> In this way the fire extends until met by a river or a road, or some other obstacle. The subsoil which underlies the spongy stratum on these mountains is also very shallow and resting on hard rocks. The roots of the trees, therefore, do not go down very deep, but extend more in a horizontal direction. When the spongy layer, with the smaller roots, are burnt, the trees lose their hold entirely and fall, one over the other, in all directions. They die less from being burnt than from being uprooted. Many different kinds of tall reeds soon take the place of the trees. In a few years these reeds exclude everything else. The fertile mould that may perhaps have escaped destruction by fire is by and by carried down the declivities by the frequent rains. The region, no longer shaded by high trees, becomes dry. Subsequent conflagrations of adjacent savannahs, which are intentionally set on fire to procure a new growth of young grass, take hold of the reeds of the ruined forest, until, by the repeated attacks of these fires, the roots of the reeds can stand it no longer, and the smaller grasses, interspersed with a few other plants, take their places.

On the road from the colony to Caracas we pass through a region in which this process is going on; the reeds giving gradually way to the smaller grasses. Here the great number of half-burnt yet standing trunks of the wax palm tell plainly enough that there existed not long ago a dense and humid forest, in which they luxuriated in all their beauty, for these palms are never found, in their natural state, growing in any other but humid forests. Here they stand isolated in the midst of reeds. Most of them have died already, but many linger yet in a dying condition, until their last green leaf has turned brown, and then they stand like tall and slender pillars, the mournful remnants of a once stately forest."

The contrast with regard to forests in the above mentioned two mountain slopes (the northern and southern) is easily accounted for. The strong and ever restless southern and south-eastern breezes sweep only the southern side of the mountains in their course up to the crest. Leaving the latter, they go on horizontally through the aërial ocean and never touch the surface of the northern slope, where calms prevail. The fire being fanned by the southern current, ascends the windward side of the mountain, but on reaching the crest is abandoned by the breeze; it can make no further progress and dies out.

I may also remark, that no instance ever came to my knowledge in which a high prairie (savannah) once *firmly established* was encroached on by the extension of a forest, no matter how humid the region may have been. But as long as the loose mould in a partially burnt forest has not been destroyed by fire or swept down by rain, so long is there a chance for the recovery of that forest in a moist region, if no intruding weeds are in the neighborhood, and further attacks of fire excluded.

Although the prevalence of moisture and forest, and that of dryness and prairie generally go together, we are not warranted to conclude that a prairie is the effect of dryness alone, for it can be shown in many instances that dryness of a region is the effect of prairies. The sun, heating the surface of the earth, thereby raising heated columns of air, disperses clouds and fogs, as may often be seen at Colonia Tovar with clouds moving across the cultivated valley, which lies between two nearly parallel mountain-ridges heavily timbered. The clouds as they come moving on from the southern range vanish as soon as they reach the cleared and cultivated area, and form again by condensation on drawing near the opposite or northern range.

New-made land offers a good chance for the establishment of a forest. If we believe in geology we cannot but admit that, at one time or other, far back in the history of our planet, either anterior to, or cotemporaneous with, the great Carboniferous era, a humid, rainy, cloudy climate of a more equable temperature, and resembling in many respects that of the equatorial low regions of South America, prevailed all over the continent up to high latitudes. Here, then, all the conditions for the existence of a vast continuous forest all over the land are given, and we are entitled to infer that at that period one immense mass of forest spread not only over all the land above water, but also through swamps and other shallow overflowed places. All the grassy plains, prairies and high savannahs must have originated since. Suppose the climate to have changed gradually in later periods, the ground elevated in some places, clouds dispersed and the atmosphere become drier. In this case a majority of the trees will, no doubt, die off gradually; but as long as the ground underneath is shaded, and covered by vegetable mould of a loose texture, resulting from the accumulation of decayed leaves, tree-seeds will germinate, new varieties and new species, better adapted to the new order of things, will in their struggle for existence make their appearance, and still there will be a forest although in a different garment.

Grass cannot well succeed in dense shady forests. In the extensive prairies of western Texas I have seen isolated clumps of timber like little oases in a desert, some not more than 200 feet in diameter, effectually resisting not only the encroaching attacks of the prairie-grass, but even those of the prairie-fires, and this in a pretty dry region subject to long continued droughts. Their margins are so dense with underbrush that in most cases not even a large sized dog could penetrate them.

Let the climate of a mountain region have only drought of two or three months' duration, no matter how moist, damp and wet it may be the remaining nine or ten months, and it will be no difficult task to convert by fire the forest covered slopes into savannahs. In a drier climate, of course, this conversion of forest into prairie by the agency of fire can be accomplished much faster.

On the other, hand in regions perpetually moist and wet the forests are safe enough against all encroachments from prairies, because fire can do no mischief here. But also in comparatively *dry* climates the forest will be safe against the intrusion of prairies, if the trees stand on a deep fertile soil, where their roots may go down deep and support the tree from falling, and where the trees have a tendency to sprout from their roots; for it would take many repeated firings of the undergrowth to lay that ground open to the baking influence of the sun.

Again, at Santa Fe, New Mexico, the atmosphere is so exceedingly dry that, with the exception of the sides of a deep, narrow mountain-valley, through which a creek flows, I have never seen *dew*. The dry, gravelly soil is for the greater part covered with forests of Coniferæ, not only on the higher mountains, but also on the low hills. The sterile soil is so dry during summer and autumn, that the thin grass, although sprouting and growing during spring, has no power of spreading. In winter the ground is generally covered with a considerable layer of snow.

That on sloping land, elevated ridges, mountains, etc., the forest can be changed into prairies or savannahs more readily than in other situations having the same degree of humidity, is easily accounted for. The thin layer of soil in such localities rests mostly on layers of rocks; the tap-roots of trees cannot penetrate to any considerable depth, and the tree is rather loosely fixed to the ground. Fire can easily undermine it, so that it may be prostrated not only by moderate breezes, but by its own weight. When fallen, its shade no longer protects the binding rootlets of thousands of cryptogamic and other plants delighting in shade; they wither and die. The fertile layer of mould is now open to the attacks of sun and rain. By degrees it is washed down the declivities, leaving the more tenacious clay behind, on which reeds and grass spread and with their creeping roots form a dense matting in which no tree-seeds can germinate.

All the moist and forest-covered places and valleys on the lower parts of Tahiti and elsewhere, cited as exceptions, are those by which, on account of their moist surface, the progress of fire that once destroyed the forests on the drier slopes and convex localities, was arrested.

ART. XX.—*A new method of Meteorological comparison, with three illustrative Tables;*[1] by PLINY EARLE CHASE, M.A., S.P.A.S.

[Concluded from p. 95.]

IN the regions of variable winds, it can hardly be supposed that the correspondence between changes of wind and of declination should be so marked as in the torrid zone. I find, however, upon tabulating about two thousand of the Toronto Observations, that there are some indications of a similar character to those in the St. Helena Table; but they are, comparatively, so slight, that another form of comparison has given results which are more satisfactory to my own mind.[2]

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[1] From the Proceedings of the American Philosophical Society, vol. x, pp. 161–166.

[2] M. Kaemtz (Meteorology, Walker's translation, p. 451) states that "the dip depends, like the height of the barometer, on the direction of the wind and on temperature." This is the earliest intimation I have yet discovered, which can be possibly construed as either *implying* or tending to demonstrate a direct correlation between weight and magnetism. The resemblance between the curves of wind-force and magnetic vertical force, would naturally lead one to look to the dip rather than to the declination, for the most striking evidence of the magnetic effects of direction of the wind.

According to my several hypotheses, the magnetic impulses are transmitted with a velocity analogous to that of light, and the position of the needle at any moment is dependent upon the combined action of local and cosmical forces, the former producing continual agitations of short period, and the latter largely preponderating in the daily means. On the other hand, the barometric and other atmospheric changes, in consequence of greater inertia, are more obedient to cumulative influences that have a limited local origin, and less affected by sudden violent disturbances. It seems reasonable, therefore, to suppose that the oscillations about the mean magnetic values should differ, in duration and in other respects, from those about the thermal and barometric means. If their mutual relations are much obscured in consequence of this difference, any lingering evidences of inter-dependence that we may find may be entitled to great weight.

Taking Toronto as a typical station of average, and St. Helena as one of minimum accidental magnetic disturbance, I first deduced from three years' observations at each place (1843, '44, '45 at Toronto; 1843, '45, '46 at St. Helena; the observations of 1844 being comparatively incomplete), the average duration of the fluctuations of each element. I found the following mean lengths of an oscillation, measuring from the maximum of one wave to the maximum of the succeeding wave (B representing the barometer; T, thermometer; H, horizontal force; V, vertical force; D, declination).

	B.	T.	H.	V.	D.
Toronto, . .	3·98 days.	3·93 days.	4·54 days.	4·31 days.	3·10 days.
St. Helena,	4·38 "	3·67 "	3·32 "	4·46 "	3·35 "

The mean wave-periods, taking the duration of the alternate variations above and below the monthly means, were as follows:

	B.	T.	H.	V.	D.
Toronto, . .	2·91 days.	3·70 days.	4·55 days.	4·78 days.	2·32 days.
St. Helena,	3·76 "	3·86 "	4·34 "	5·51 "	3·27 "

By marking with the signs + and − the excess or deficiency of each daily mean, the monthly mean being assumed as the standard of comparison, I obtained the data for Tables I and II. The columns headed C contain the number of observations that present a correspondence (excess in one element accompanying excess in the other, and *vice versâ*), and those headed O give the number of instances in which there was an opposition of signs between the daily means indicated by the heading of each double column.

TABLE I.

Correlations of Temperature, Gravity, and Magnetism, in the Daily Means at Toronto.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		B. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.
Jan.	9	17	20	1	16	8	2	22	14	8	2	20	9	15	11	13
	5	22	..	..	18	9	6	21	..	..	..	..	14	13	10	17
	11	16	18	9	15	12	8	19	14	13	8	19	9	18	15	12
Feb.	11	13	8	13	11	11	13	8	14	10	2	22	14	10	11	13
	9	16	16	2	20	5	10	15	15	3	6	12	16	9	14	11
	6	18	20	4	16	8	6	18	18	6	2	22	15	8	4	19
March.	10	17	13	14	6	21	17	10	16	11	9	18	13	12	9	16
	12	14	18	8	10	16	10	16	12	14	4	22	16	10	10	16
	16	10	20	5	9	16	6	19	8	17	5	20	13	11	12	12
April.	9	15	4	20	10	14	18	6	18	6	4	20	19	5	11	13
	8	17	16	9	13	12	12	13	13	12	5	20	14	11	11	14
	14	12	26	0	12	14	2	24	12	14	2	24	14	12	6	20
May.	8	19	5	22	10	17	15	12	18	9	5	22	11	16	12	15
	7	20	19	7	16	10	6	20	16	11	6	21	17	10	9	18
	7	20	23	4	15	12	7	20	18	9	6	21	13	14	14	13
June.	11	15	4	22	13	13	20	6	13	13	2	24	12	14	13	13
	8	17	17	8	20	5	7	18	16	9	1	24	14	11	15	10
	6	19	14	10	20	5	5	20	16	8	9	15	11	14	14	11
July.	8	19	8	18	10	17	15	12	21	6	6	21	13	14	12	15
	9	18	14	13	17	10	5	22	10	17	10	17	19	8	11	16
	10	17	22	5	13	14	6	21	14	13	5	22	19	8	12	15
August.	11	16	14	13	17	10	11	16	20	7	6	21	16	11	8	19
	15	12	21	6	14	13	8	19	10	17	10	17	10	17	10	17
	8	18	8	18	18	8	6	20	8	18	22	4	16	10	12	14
Sept.	9	17	22	4	13	13	4	22	15	11	2	24	16	10	11	15
	9	16	22	3	17	8	3	22	18	7	2	23	12	13	12	13
	8	18	22	4	16	10	6	20	18	8	4	22	12	14	12	14
Oct.	8	18	7	4	15	9	3	21	6	6	3	9	13	13	12	14
	7	20	18	9	13	14	9	18	18	9	4	23	15	12	11	16
	4	23	23	4	20	7	7	20	18	9	5	22	17	10	10	17
Nov.	7	19	..	..	15	11	8	18	..	..	..	..	16	10	11	15
	13	13	18	8	18	8	7	19	15	11	6	20	15	11	8	18
	6	19	22	3	19	6	2	23	18	7	3	22	12	13	9	16
Dec.	12	13	..	..	18	7	9	16	..	..	..	..	15	10	10	15
	10	15	20	5	14	11	3	22	11	14	4	21	13	11	7	18
	9	17	22	4	16	10	5	21	16	10	1	25	13	13	8	18
1843.	113	198	105	131	154	151	135	169	155	87	41	201	167	140	131	176
1844.	112	200	199	78	190	121	86	225	154	124	58	220	175	136	128	184
1845.	105	207	240	70	189	122	66	245	178	132	72	238	164	145	128	181
Total,	330	605	544	279	533	394	287	639	487	343	171	659	506	421	387	541

TABLE II.

Correlations of Temperature, Gravity, and Magnetism, in the Daily Means at St. Helena.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		B. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.
Jan.	11	15	14	8	14	12	7	19	15	7	6	16	12	13	14	11
	17	10	14	12	11	16	10	17	13	14	11	16	13	14	11	16
	7	19	8	19	23	4	5	22	9	18	15	11	17	10	12	14
Feb.	13	11	15	8	12	12	9	15	8	15	5	18	12	12	13	11
	16	8	11	11	16	8	15	9	13	9	13	9	16	8	16	8
	10	14	12	12	12	12	4	20	8	16	8	16	9	15	11	13
March.	12	15	10	17	15	12	7	20	9	18	18	9	15	12	14	13
	11	14	15	10	8	17	16	9	14	11	16	9	13	12	15	10
	12	14	17	9	10	16	6	20	11	15	15	11	13	13	13	13
April.	21	4	4	20	10	15	10	15	19	5	19	5	13	12	15	10
	16	10	18	7	14	11	17	8	13	13	17	9	15	11	13	13
	9	16	3	16	12	13	12	13	8	11	15	4	10	15	10	15
May.	10	17	5	21	15	12	8	19	7	19	19	7	19	8	12	15
	10	17	6	20	20	7	5	22	7	19	19	7	12	15	17	10
	10	16	6	18	14	11	6	19	7	18	22	3	13	13	9	17
June.	10	16	5	20	21	5	11	15	10	15	19	6	15	11	15	11
	14	11	4	21	13	12	4	21	12	13	19	6	11	14	8	17
	12	14	8	15	18	8	8	18	10	13	10	13	15	11	19	7
July.	9	17	5	19	16	9	9	16	7	18	16	9	13	13	14	12
	12	15	14	13	14	13	9	18	13	14	18	9	14	13	17	10
	10	17	7	20	19	8	6	21	13	14	22	5	14	13	11	16
August.	5	22	3	23	20	7	6	21	7	19	20	6	16	11	10	17
	18	8	13	13	11	15	7	19	12	14	18	8	16	10	12	14
	8	18	14	11	17	9	11	15	7	18	17	8	12	13	15	10
Sept.	12	14	10	14	10	16	6	20	14	10	16	8	20	6	16	10
	15	11	11	15	9	17	8	18	14	12	19	7	12	14	7	19
	14	12	11	15	6	20	13	13	6	20	16	10	10	15	14	11
Oct.	16	10	18	6	10	16	6	20	11	13	4	20	18	8	14	12
	12	15	9	17	18	9	9	18	11	15	16	10	12	15	15	12
	11	16	9	18	16	11	12	15	16	11	20	7	16	10	12	24
Nov.	10	16	10	12	16	10	4	22	7	15	13	9	13	13	11	15
	12	13	7	18	14	11	9	16	10	15	15	10	15	10	12	13
	14	11	11	15	15	10	12	13	13	12	14	11	13	12	16	10
Dec.	9	16	17	8	18	7	8	17	12	13	8	17	16	8	11	13
	18	8	12	14	13	13	13	13	15	11	13	13	14	12	12	14
	14	11	15	10	7	18	6	19	7	18	12	13	7	17	8	16
1843.	138	173	116	176	177	133	91	219	126	167	163	130	182	127	159	150
1845.	171	140	134	171	161	149	122	188	147	160	194	113	163	148	155	156
1846.	131	178	121	178	169	140	101	207	115	184	186	112	149	157	150	156
Total,	440	491	371	525	507	422	314	614	388	511	543	355	494	432	464	462

Tabulating similarly the magnetic observations for one or two days prior and subsequent to the several thermometric and barometric fluctuations, I find indications of a continued action, which is paralleled by the ocean swell that remains after the subsidence of the winds by which the waves were originally excited.

In order to ascertain whether the correspondence, which is thus shown to exist between the daily means of the different elements, can also be traced in the hourly means, I noted the character of the undulations for several entire weeks, selecting observations at different seasons, in such a manner as I thought would give a pretty correct approximation to the average of each of three years. Considering the increasing waves as positive and the decreasing as negative, I obtained the data which are summarily detailed in Table III.

TABLE III.

Correlations of Temperature, Gravity, and Magnetism, in the Hourly Means at Toronto and St. Helena.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		B. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O
TORONTO.																
1st year.	197	242	208	188	212	232	227	232	201	176	162	229	225	211	195	260
2d "	202	234	170	202	246	217	197	234	188	173	165	192	225	217	189	238
3d "	191	232	171	128	218	211	192	259	155	125	120	172	230	202	200	248
Total,	590	708	549	518	676	660	616	725	544	474	447	593	680	630	584	746
ST. HELENA.																
1st year.	198	227	125	179	231	200	217	187	129	183	172	131	225	205	198	204
2d "	199	232	121	203	247	189	250	164	138	196	173	145	248	174	189	211
3d "	190	203	143	182	244	194	249	159	142	194	187	126	220	199	181	210
Total,	587	662	389	564	722	583	716	510	409	573	532	402	693	578	568	625

This triple comparison exhibits, in a very conclusive and satisfactory manner, a connection between temperature, gravity, and magnetic force, which, taken in conjunction with my previously adduced evidences of rotation-tides, appears sufficient to adequately explain all of the well-established normal meteorological fluctuations, and to give a clearer insight into the true meaning and value of the various partial relations which have been previously ascertained or surmised.

It is interesting, especially if we incline to adopt the common hypothesis that the barometric fluctuations are all owing, mainly, if not exclusively, to thermal disturbances, to observe that the magnetic force is more directly and powerfully affected by variations of temperature than the barometric pressure; and that at St. Helena the relation of the barometric to the thermometric movements is less marked than those of either the horizontal or vertical force to the fluctuations of gravity and of temperature. The relative preponderance of the rotation tide over the temperature tide at St. Helena (as shown by the barometer), is an additional evidence of the eligibility of that station for observing the correspondence between the fluctuations of magnetic force and the disturbances of gravitation.

In comparing the St. Helena and Toronto totals, five of the columns exhibit an opposition of relations, such as might have been anticipated, because the laws of equilibrium require that a disturbed "line of force" in one portion of the globe should be counterbalanced by an opposite line in another portion.

The analogies that have been pointed out by Sir David Brewster and Sir John Herschel between the curves of terrestrial magnetism and those of the polarization of skylight, are a natural consequence of the mechanical laws which we have been considering. The special maximum which Herschel finds it so difficult to account for (Meteorology, p. 230) may be explained by the centripetal reaction against the centrifugal thermal and other solar disturbances, which is a maximum at 90° from the sun.

ART. XXI.—*On Cephalization; No. IV: Explanations drawn out by the Statements of an Objector;* by JAMES D. DANA.[1]

IN a paper published in the third volume of the Proceedings of the Entomological Society of Philadelphia, Mr. B. D. Walsh discusses the subject of the classification of Insects as based on the principle of cephalization, and criticises, not my views, but his own misconceptions of them.[2] As others may have fallen into similar errors, notwithstanding the long explanations which have been presented, I briefly notice here some of the points in his paper.

1. Our objector says (p. 238) that "as originally propounded by him [Mr. Dana] in Crustacea, cephalization consists in 'the transfer of the anterior members of the thorax to the cephalic series' (Sill. Jour., vol. xxxv, p. 66), or in other words in *legs* being converted into *head-organs*."

In the first place, our expositor, while claiming to cite what was "originally propounded" by me, had not seen my *original* memoir published in 1852[3] in the Report on Crustacea, and in 1856 in this Journal, and refers to no paper earlier than that of 1863.

In the second place, he finds in the paper which he does cite what neither that paper, nor any other that I have written, contains. I have nowhere said that cephalization *consists* in such a

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[1] For number I, of this series, see this Journal, xxxvi, 321, Nov. 1863; number II, xxxvii, 10, Jan. 1864; number III, xxxvii, 157, March, 1864.

[2] On certain Entomological speculations of the New England School of Naturalists, by B. D. WALSH, M.A., Proc. Entomolog. Soc., iii, 207. The writers of the "New England School" here particularly criticised are Prof. Agassiz and Prof. Dana; and incidentally, A. S. Packard, Jr., some passages of a paper of his having been cited by the latter.

[3] Not 1855, as stated in this Journal, xxxvi, 321.

transfer of members. The statement would be wholly at variance with the very idea of cephalization. What I have asserted is this: that variation in grade of cephalization is *manifested* in the structure by the transfer referred to, and by this as only *one among many methods.*

I have argued that since animals have a head as their grand characteristic feature, and a cephalic nervous mass as the fundamental element of the head and the prime center of force in the organism, exaltation and concentration anteriorly of the life-forces mark a high grade of cephalization; and relaxation or decentralization, and an enfeebling of the same, with a consequent spreading posteriorly or away from the cephalic extremity, indicate a low grade of cephalization. I have also said that these conditions of the life-forces of the individual, that is, of the organizing and working forces, should necessarily be apparent, and are in fact apparent, in the structure of the organism, the resultant of the forces. I have shown that concentration anteriorly, with exaltation of the cephalic extremity, is manifested not merely in the transfer of members to the cephalic series (thereby enlarging the sphere of the head), but also in the form and structure of the head,—in the form and condition of the organs of the senses—of the organs of the mouth—of the successive pairs of legs—of the abdomen—of the abdominal appendages; and in my later memoirs I have still more widely extended the list of characteristics that indicate grade of cephalization.

The laws of cephalization act conjointly with another principle in animal life:—that of the *oppositeness subsisting between the cephalic or anterior and the posterior extremities of the animal structure*, which is a kind of antero-posterior or fore-and-aft polarity. This oppositeness or polarity is *up-and-down* in the plant, and *fore-and-aft* in the animal. The fore-and-aft becomes strictly up-and-down *in position* in one animal alone—Man; and this by elevating heavenward the cephalic extremity, not by a change of the axis of symmetry to that of the plant. (See this Jour., xxxvi, 351.)

In view of the total misapprehension of this subject by our entomological critic, I may be excused for citing additional explanations from an article written for a popular magazine, even if they are essentially a repetition of what is contained in my former papers.

"As the head is the seat of power in an animal, it is natural that among species rank should be marked by means of variations in the structure of the head; and not only by variations in its structure, but also in the extent to which the rest of the body directly contributes, by its members, to the uses or purposes of the head. *Cephalization* is, then, simply domination of the head—cephalic domination—in an animal, as manifested in the structure; and any *degree* of it depends on the grade of power of the cephalic center, and the degree of subordination to it in the structure. The following are some of the ways or methods in which it is manifested.

(1.) With *superior* cephalization, that is, as species rise in grade or rank, more and more of the anterior part of the body, or of its members, renders service to the head; with *inferior*, less and less.

(2.) With *superior* cephalization, the structure of the head, or of the anterior portion of the body, becomes more and more compacted, perfected, and condensed or abbreviated; with *inferior*, the same portion becomes more and more lax in its parts or loosely put together, and imperfect in the parts or members themselves; and, at the same time, the whole is more and more elongated, and spaced out or enlarged.

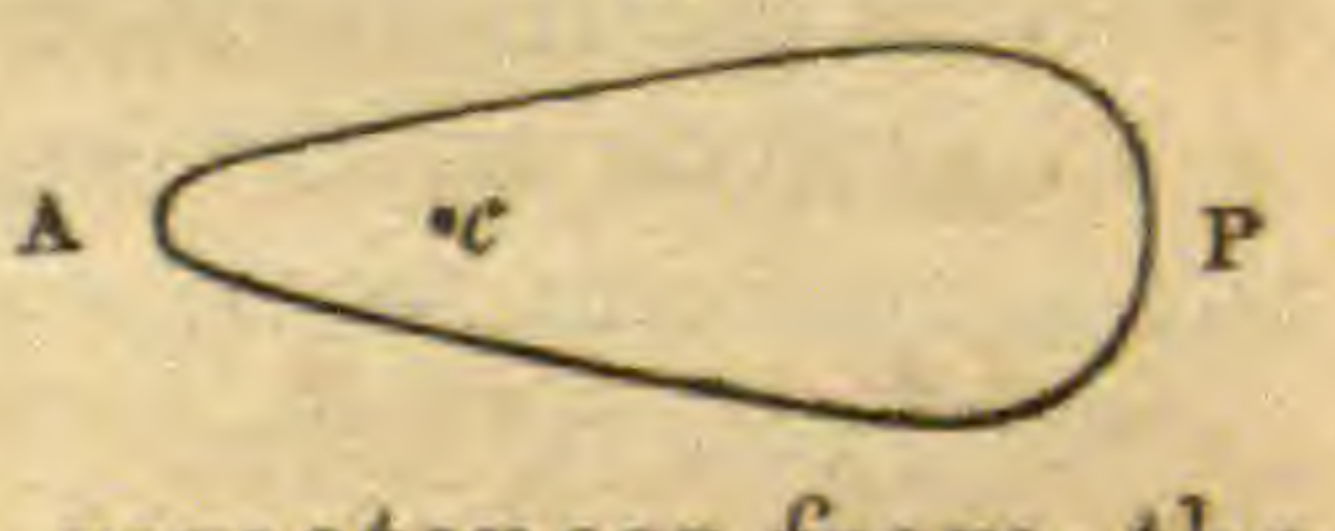
(3.) With *superior* cephalization, the posterior portion of the body becomes more and more compacted, or firmly put together and abbreviated; that is, as concentration goes on *anteriorly*, there is abbreviation *posteriorly*. Even the tail shows grade; for great length, or size, or functional importance is actually a mark of inferior grade, other things being equal.

(4.) With *inferior* cephalization, there is not only a less and less concentrated or compacted and perfected state of the whole structure, before and behind, but, in its lower stages, the degradation of the structure extends to an absence of essential parts, as *teeth*, *members*, *senses*; and often, also, to a gross enlargement of the body beyond the size which the system of life within can properly wield, and in this case the body is stupid and sluggish."

The question as to the condition of the life-forces thus passes from the sphere of speculation to one of direct observation. A *Lion*, for example, exhibits to the eye the high degree of cephalization of its structure by its strength anteriorly, or that of its head and fore-limbs, and the correlate form and structure of these and other parts of the body; and a *Whale* manifests its low degree by its degraded head and senses, its feeble limbs partly obsolete, and the immense size and strength of the tail; and this is so obvious, that the muscular or motorial force of the two might be sufficiently well represented by the annexed figures: figure 1 corresponding to that of the Lion, and 2, to that of the Right Whale, A being the anterior or cephalic extremity and P the posterior or caudal extremity. The figures give a faint idea of what is meant by *cephalization* and *decephalization*. If the sensorial forces of the Lion were taken into consideration, the contrast between the two would be still greater. *c* is the position of the prime systemic center; its remoteness from the front margin in the Right Whale, (figure 2) is one of the marks of the extreme decephalization of the structure. (See on Cephalization, No. III.) The arrangement of the muscular force in different Herbivores might be represented by figures intermediate between 1 and 2.

1.

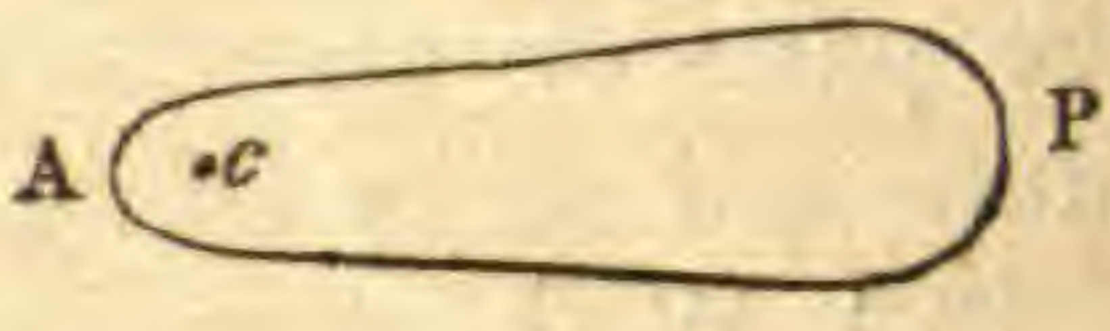
2.



The following figures serve in a similar rude way to illustrate the condition of the force in the three subdivisions of Decapod Crustaceans; figure 3, in the Crab, which has the abdomen (the part so large in the lobster) almost wanting and very feeble, and the systemic center (*c*) very close to the front margin; fig. 4, in the Shrimp which has the body prolonged before and behind, but especially in the latter direction, the posterior portion or abdomen being of great size and powerful as an organ of motion; fig. 5, in certain species of the Squilla group, in which the cephalothorax is weak, its appendages feeble, the abdomen 2 or 3 times as long as the anterior part of the body and relatively to the cephalothorax far more powerful than in the Lobster or Shrimp. Other classes of animals afford similar illustrations.

3.

4.



5.

There are probably no characters connected with the structure, growth and habits of an animal that have not something to reveal with reference to grade, under this principle of cephalization. To read the truth, especially among the lower subdivisions of a class, the families, genera, species, may often require profound study, and even a higher stage of science than the world has now attained to. But the necessity of profound study, when knowledge below the surface is sought for, is not peculiar to this department of nature.

I repeat, then—cephalization does not "consist in a transfer of members" one way or another, but is *manifested* by the whole animal structure within and without.

2. Our objector says that this character of cephalization "really appears to be of high systematic value in Crustacea"; but, as the neuration of the wings is a good characteristic in one group of Insects and not in an another, so it is not necessarily good in other animals.

This comparison of the principle of cephalization, the origin of a host of characteristics, with the single superficial one *from the neuration of the wings*, is in accordance with the misquotation making cephalization to consist in a transfer of members, &c.

The laws of cephalization pertain to the elemental forces of the organism, or the fundamental nature of animal life, as much as the laws of attraction to the fundamental nature of a molecule; and, therefore, if true of one branch of the Animal Kingdom, they must be true of all. Yet the exhibition of these laws in the structure will be widely different, as the structures themselves are various in character. They cannot be precisely the same in footless Worms as in Crustaceans; or in Crustaceans as in Insects; or in Insects as in Mammals; although the grand fundamental principle at the basis of the organism is the same in each.

3. Our objector observes again, with like misconception of the subject, that as "the conversion of the front wings into elytra amounts to a decephalization," "instead of classing Hemiptera as inferior to Coleoptera and Orthoptera to Hemiptera, we ought to adopt exactly the opposite arrangement. For Coleoptera have the front wings entirely elytriform, Hemiptera (Heteroptera) only about one-half elytriform, and Orthoptera scarcely or but slightly elytriform. Those groups, therefore, according to Dana's own principle ought to stand, 1, Orthoptera, 2, Hemiptera, 3, Coleoptera, instead of the reverse."

Thus, Mr. Walsh sets up his man of straw, and combats it with great success.

"Dana's own principle," above announced and demolished, is not to be found in any of Dana's own writings. The fact of the fore-wings being coriaceous wholly, in part, or not at all, has no bearing whatever on the question; this is a mere external characteristic, of no dynamical value, like most of the characteristics appealed to by ordinary systematists. I expressly state that the true distinction depends on the *posterior* wings being the main flying-wings; I say, further, that the fore-wings may be used for flying, and still, if the hinder wings are the more powerful, the insects are *metasthenic*, and have the characteristic of the inferior or Coleopteroid division.

The segment of the body bearing the stronger flying organs in these metasthenic species (Coleoptera, Hemiptera, Orthoptera) is one *posterior* to the same in the higher prosthenic species (Hymenopters, &c.); and the fact that the force is consequently, more posterior among the body segments, and among the nervous ganglions, is hence one of direct observation, and not a hypothetical inference. The terms *prosthenic* and *metasthenic* bear the profounder meaning of cephalization in their composition.

There being two sthenic characters of acknowledged value based on the limbs, one on the *wings*, and the other on the *legs*, it is asked, why the former should be made to have the precedence in classification. Simply because they have the precedence *in fact*. The species of the grand division of Coleopters are *throughout metasthenic as regards the wings;* that is, the posterior wings are the only flying wings or, at least, the stronger, in all the species; and this is true also, of the Hemipters and Orthopters: while they are not all metasthenic as regards the legs; for under these groups there are subordinate divisions which include among the species both those that are *prosthenic* and those that are *metasthenic as regards the legs.* The latter distinction is, therefore, as a matter of fact, of limited importance or comprehensiveness compared with the former. But this point is sufficiently illustrated in my article on the classification of Insects and requires no additional explanation here.

4. Our objector says that the position of the wings in the Dipters is half a segment nearer the head than that of the anterior pair in the Hymenopters, and that *therefore the Dipters ought to stand first in the system*. But he errs from failing to note that the wings in Dipters do not pertain to a *more anterior segment*, or nervous ganglion (center of force), than the fore-wings in Hymenopters, but, on the contrary, to the very same; whence, there is no parallelism between this difference and that separating the Hymenopters and Coleopters. The difference of position alluded to has, consequently, little or no dynamical value, and little or no weight in a classification based on cephalization.

5. Our objector applies his mistaken definition of cephalization further, and argues as follows:

> "If we apply the principle of Cephalization in its original signification to Insects, we shall find that there are certain families and genera, e. g. in Orthoptera *Mantidæ*, in Neuroptera *Mantispa*, in Heteroptera *Myodocha*, *Phymata*, *Macrocephalus*, *Syrtis*, *Reduviidæ* and *Nepidæ*, and in Diptera *Hemerodromia*, which have what are commonly known as raptorial front legs; in other words the front legs are used, not as *legs* but as *arms* to catch their prey with. In other species, e. g. the dipterous *Calobata antennæpes* Say, which takes its name from that peculiarity, and in many Nemocerous Diptera, the front legs are not used at all for locomotive purposes, but are elevated in the air and vibrated after the fashion of antennæ. Here therefore it is strictly true that "the anterior members of the thorax are transferred to the cephalic series;" and if, as Prof. Dana maintains, the cephalization of the anterior pair of limbs in Man, or in other words the conversion of his front limbs into arms, "places Man apart from the whole series of Mammals" (Sill. Journ., vol. xxxv, p. 68), then by parity of reasoning, if the principle of cephalization is universally applicable, all the above-mentioned families and genera of Insects ought to be placed in a group by themselves."

The prehensile or raptorial modification of the anterior limbs and the transfer of members to the cephalic series are here mixed up, although both characteristics are the subject of extended explanations in my paper; and hence our objector's remarkable result.

I have stated that there were but three examples of the *transfer of members to the cephalic series* in the whole animal kingdom—the Entromostracans or degradational Crustaceans excluded, in which the examples are not well-defined. One is that from Tetradecapods to Decapods, the *four anterior* of the *fourteen* feet in the former being mouth-organs in the latter; the *second* is that from Spiders to Insects (or Octapods to Hexapods), the two anterior feet in the former being mouth-organs in the latter. One of these cases occurs between the two higher divisions of *aereal* Articulates or Insecteans; and the other two between the two higher divisions of the foot-bearing *aquatic* Articulates or *Crustaceans.*

The *third* case is that from Quadrupeds to Man, the *two* anterior feet in the former being in man taken completely out of the locomotive series and given up to the cephalic series, to which series, moreover, they *structurally* belong.

Now there are numerous Tetradecapods with *prehensile* fore-legs, but they are no less Tetradecapods in type of structure and all their relations. These prehensile legs aid in capturing food; but they are no more part of the cephalic series than are the prehensile fore-feet of a squirrel. There are Decapods with prehensile fore-legs, which are none the less Decapods; and there are also inferior macrural species (certain shrimp-like kinds) which have the four outer mouth-organs foot-like in size and function, so that they have as many feet as the Tetradecapods; and yet they are Decapods in type of structure, and show no true approximation to the Tetradecapod type.

Among Quadrupeds, the fore-feet of the Carnivores are prehensile, and those of the Squirrels and Monkeys quite perfectly so; and yet these limbs are part of the locomotive series. Man stands alone among Mammals in having the fore-limbs, not only prehensile, but out of the inferior series, the posterior pair being the sole locomotive organs.

The question of the exact parallelism of this last of the three cases with the preceding two admits of arguments on both sides. But whichever way decided, it does not affect in the slightest degree our deductions under the principle of cephalization. It touches only one single argument on the question whether Man constitutes by himself a separate Order among Mammals, and this, in our view, not seriously. All must admit, whatever his views of the question, that this ennobling of the fore-limbs is one mark of that preëminence of cephalization which belongs to Man.

6. The necessity of an exact balancing of all characteristics bearing on grade, in order to arrive at correct results, is too obvious for an argument. If the inferior criterion is in any case made the superior one, only absurdities are reached. Our objector affords examples of this kind of error. Observing that narrow limits of variation, and a less tendency to run into bizarre forms, are set down as generally characteristic of a superior group, and as part of the evidence of the superiority of

the Hymenopters, he remarks that the Fleas are far more uniform in shape and size than the Hymenopters, and therefore, according to the criterion mentioned, ought to be placed *first* among the Apipens; apparently unaware that in this bit of logic the criterion referred to is made *superior* to all others, or the most decisive of grade, and not perceiving, therefore, that the *reductio ad absurdum*, intended for the principle criticised, attaches to the critic himself. Again, by a similar misuse of the criterion connected with prehensile anterior limbs, and additional misunderstandings already alluded to, he arrives at other absurdities. In the same way he might assume that, because great length of antennæ is one of the marks of low grade,—the Macrurans (Lobsters, Shrimps, &c.,) showing by this character, as I have stated, their inferiority to Brachyurans (Crabs),—therefore Insects ought to be arranged according to length of antennæ; which would of course make very heterogeneous assemblages. Or he might next make abdomens or tails the grand criterion, (this characteristic being also set down as a mark of grade), with a like result. By thus assuming successively that each criterion is superior in value to the others, all may be run into the ground; a feat of no great prowess in logic or science.

While long antennæ and long abdomens are among the marks of that decentralization or decephalization which distinguishes the Macrurans from the Crabs, some of the higher Macrurans have, relatively to size of body, longer antennæ than the lower; and there are hundreds of Tetradecapods and Entomostracans, still inferior species, that have relatively to length of body, far shorter antennæ, and shorter abdomens too, than the Macrurans. There are, in all such cases, characters to be considered of higher value before we come down to that level where length of antennæ, or of abdomen, is decisive as a mark of grade.

7. As Nature is yet an unfathomed deep, our systems must have their imperfections and uncertainties, and we our difficulties in applying principles that have been ascertained. Examples of such difficulties from the subject of cephalization have been alluded to in the preceding remarks; and here is another.

Large size in species, as all know, is sometimes a mark of superior grade. The fact is pressed upon our attention by familiar facts, as well as by the general relations in mean size of high and low types among animals. Vertebrates are larger than Insects or Worms, Insects than Infusoria, Beasts than Birds, etc.

But, again, large size is sometimes, also, accordant with, and a mark of, inferior grade. Man is smaller than his inferior the Lion; the Lion is smaller than its inferior the Hippopotamus; the Hippopotamus than its inferior the Whale; the Crab than its inferior the Lobster; the Echinus than its inferior a large

Medusa; and so on. Now it may be urged, against the system of classification proposed, that size sometimes means one thing, and sometimes the reverse, and there is here manifest indefiniteness and a chance for indefinite assumptions. Or, the charge may be made with more point, and much less truth, as follows: "Because great size is correlated with superiority in *Crustacea*, you [Mr. Dana] infer that it is so correlated everywhere throughout the Animal Kingdom; and when, as nobody can fail soon to do, you meet with examples where facts contradict your theory, you get over the difficulty by assuming gratuitously that size is there due only to what you call 'vegetative enlargement.' As I cannot find that you have anywhere laid down any definite rules by which this vegetative enlargement is to be distinguished from the normal enlargement, the distinction appears to be an empirical one."[4]

Now great size is not correlated with superiority in Crustacea *any more* than in the rest of the Animal Kingdom, and this I particularly illustrate in my first paper on the subject; for I there discuss at length the relations of rank to mean size, and of rank to size from overgrowth or vegetative enlargement. The facts in nature are always obscure of interpretation until thoroughly and properly studied; and if the relation of size to rank is among the things not understood, it is among the things to be investigated. I have endeavered to give some criteria for deciding on this point. Towards this end I have presented the consideration that where a structure is so large for the species that the animal is sluggish in its movements, or stupid in its senses, there is evidence in this that size is a mark of degradation. But I have shown, further, that where size is a mark of low grade, the low grade is also manifested in a multitude of other characters, so that we are not left to this one distinction alone. In fact, wherever size has been mentioned as one of the characteristics of an inferior group, I have rested mainly upon the others for proving the inferiority of the group.

Moreover, I have given illustrations explaining why size should be a mark of high grade, and also why in other cases a mark of low grade. I may add one or two comparisons in elucidation of this point. We all know that if a steam-engine of the size and strength for 100 horse-power has a working-force of 100 horse-power, it is an engine of respectable grade. But if, while thus large in its cylinder, beam, and other parts, it were furnished with the means of generating a force-system, as we may call it, of 1 horse-power, it would be a very feeble and worthless piece of machinery. Suppose, for closer parallelism with animal life, the engine to reach its size by a method of growth; and that

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[4] From a recent letter of a critic.

its force-system attained thus a 1-horse capability when the engine had attained the size of a 100 horse-power, and poor construction with that. What would it be but a small thing vastly overgrown. In an animal there are the *sensorial* and *motorial* systems of force, which have their prime center in the cephalic nervous mass; and there is also the *vegetal*, or the power of growth or vegetative enlargement, which requires, as vegetation shows, no such nervous center, although in animals it is mostly under nervous control. If then this central control is weak, vegetative increase may make a vast structure, as unwieldy for the power within as the 100 horse-power engine with a 1-horse force-system; and it should in such a case manifest the feebleness of the force-system in an analogous manner, that is, by sluggish movements, or by stupid senses, and have corresponding structural deficiencies: as is true of a huge Medusa among Radiates, a Horse-shoe (Limulus) among Crustaceans; a Sloth and its kin among Mammals, etc., etc.

8. Mr. Walsh objects to the wide separation of the Hemipters (or Heteropters) and Homopters; and in this he is sustained by many facts and good authority. As respects this, and other like points in the classification, it is necessary to distinguish between direct inferences from the principle of cephalization, and conclusions from all the various considerations bearing on classification. By that principle, we prove that Hemipters are inferior to Homopters, since they are *metasthenic* in the wings, while the latter are *prosthenic:* but it does not also follow from it that the two groups should be so widely separated, for they may still be superior and inferior subdivisions of the same group. *Cephalization distinguishes grade among groups; but it is subordinate to type of structure in fixing the limits of natural groups.* Toward this latter object it affords aid through the many new criteria it brings to light, and through the evidence it supplies as to the relative value of such criteria; yet its distinctions are to be used in connection with all others that are available. And they have been thus used by the writer in his attempts to present the true system of arrangement among species.

I have been led to place the Homopters near the Lepidopters, and the Hemipters near the Coleopters, by the following considerations:—

a. The Homopters, as most authors assert, have close structural relations to the Lepidopters. The Hemipters are much less near the Lepidopters, and approximate, as some authors have admitted, to the Orthopters and Coleopters, especially the former. The fact that the anterior wings in Hemipters, as in the Coleopters and Orthopters, are not flying wings, is an important point of resemblance to the latter tribes, independently of any sthenic value attached to this character.

b. The distinctions of (1) *prosthenic*, (2) *less prosthenic* or *metasthenic*, and (3) *degradational* correspond with the higher grand divisions in several orders and classes of animals. This fact, in connection with the comprehensiveness of the characteristics prosthenic and metasthenic among Insects, favors the conclusion that they are here of like importance.

c. It is common for a natural group to have affiliations in two or three directions; so that, if arranged in one division, it will have its representatives, or what might be almost regarded as its branchings, in another; and many of the fundamental relations of species can be exhibited only by systems of parallelisms with cross connections. I have observed that the Hemipters, among Metasthenic Insects, and the Homopters, among the Prosthenic, afford an example of this kind, and thus have recognized their intimate relations. Viewing the subdivisions of the classification in the lineal order in which they are presented on the printed page, the tribes of Hemipters and Homopters stand far apart, as if remote in the system of Insects. But making the Metasthenics and Prosthenics parallel divisions these two tribes stand side by side. And if the two tribes overlap through some species, it is not a solitary case of this kind in the system of animal life.

I would add here, with regard to the Trichopters, that their addition to the Lepidopteroid group, or the Amplipens, is not made as a direct inference from facts under the principle of cephalization, but on other considerations, and especially their relations to the Lepidoptera in structure. If the group were restored to the Neuropters, this would not affect at all the principles I advocate.

Passing by some other statements equally exceptionable with those which have been considered, we touch on one single point more.

9. Our objector enters his "protest, in the name of science," against "the arithmetical monomania, which is perpetually seeking to fetter the limbs of Nature in mathematical formula," alluding here to the approximate uniformity in the number of subdivisions through the system of classification proposed by me.

But Nature is throughout in a strait-jacket of mathematics. Chemical combinations, crystals, light, heat, electricity, all prove that there are simple numerical relations in the very constitution, and in all the movements, of matter; and even the multitudinous leaves of the forests are in mathematical order. It is not therefore *a priori* absurd that regular numbers should preside to some extent throughout the wide system of Nature's living species; and if found, and not a device of the systematist, they may be recognized as a legitimate part of science, notwithstanding the above protest. Reasons for the frequent recurrence of *three*, as the number for the higher subdivisions in zoological classification, have been given in my former papers, and need not be here repeated. Protests like the above, while always exhibiting a large excess of self-confidence, might sound less presumptuous were there not *many facts in nature yet to be learned.*

ART. XXII.—*Discovery of Fossil Footmarks in the Liassic* (?) *Formation in Kansas;* by B. F. MUDGE, late State Geologist.

IN returning recently from an examination of the salt deposits of the Republican valley, we obtained a slab of sandstone, *in situ*, containing four impressions, and, at least, two varieties of fossil foot marks, (Ornithichnites). Although the number is small and the prints not in the best state of preservation, yet the specimens are valuable as showing a new point in the distribution of such fossils.

The locality, at which the tracks were found, is on the southwesterly bank of the Republican river, about fifty miles from its mouth. The sandstone here rises from below the bed of the river in a bluff over one hundred and twenty-five feet. The stratification is not very regular; in many cases showing an unconformable deposit, such as is frequently seen where sand is deposited in shoal water by varying currents. This was very well shown in the bluff a few feet below the strata containing the tracks. The larger portion of the bluff, in fact, bears evidence that the deposits of sand were made in shoal water. The effects of water in determining the character of the deposition are, if possible, even more marked than in the Connecticut sandstone formation.

The slab containing the tracks was found near the highest point of the bluff, on a projection within one hundred yards of the river. It is much weathered, which injures the distinctness of the footmarks. In hardness and appearance the stone is much like that obtained at Portland and other quarries in the Connecticut valley, but it varies more in texture, being frequently quite soft. The harder portions have a considerable admixture of iron, sometimes as much as ten or fifteen per cent. The iron, in its oxydation and other changes, has so affected the condition of the deposit, as, in many cases, to have obliterated all impressions made either by animal, vegetable or mechanical agents.

We could find no other track, or any other fossils at this locality. Yet it is most probable that they will be found in other places, as the deposit has a long extent in a northeasterly and southwesterly direction.

The weathered state of the specimen prevents our giving an accurate description, such as is desirable for a full identification of the species. Still, there can be no doubt that they are new kinds of Ornithichnites. The slab contains four prints, two (A, B,) on the left hand by one animal, (?)—one (C) on the upper right hand by another, and the fourth print (D) indistinct, but probably by a third bird.

A partial description may be of some value, which we give as follows. Both are *three-toed* and *leptodactylous.*

Species 1. *Track number* C.—Divarication of the lateral toes, 65°; of the inner and middle toes, 35°; of the middle and outer toes, 35°; length of the inner toe, 3·75 inches; of the middle toe, 5·1; of the outer toe, 3·75; of the foot, 5·5; distance between the tips of the lateral toes, 4·1; projection of the middle toe beyond the others, 2·1.

Species 2. *Track number* A.—Divarication of the lateral toes, 65°; of the inner and middle toes, 35°; of the middle and outer toes, 35°; length of the inner toe, 2·6 inches; of the middle toe, 3·5; of the outer toe, 3·1; of the foot, 3·75; distance between the tips of the lateral toes, 3·2; between the inner and middle toes, 2·1; between the middle and outer toes, 2·2; projection of the inner toe beyond the others, 1·2 inches.

Track number B appears to be the left foot of the bird which made No. A, as the angles and length of the toes are the same; but the position of the inner toe standing so far back of the others throws some doubt upon it. Number D may be the track of still another species, or it may belong to species 1; it is so indistinct that we cannot decide on this point.

We give no name to either of the species, as we hope more perfect prints may yet be found, which will give fuller characteristics of the animals which made the tracks. There are no marks of the claws on either of the tracks. Nor could we find any imprint of rain-drops or other peculiarities common to the Connecticut deposits. The slab containing the footprints is about four inches in thickness; it is not laminated, and shows no depression of the tracks on the under side.

We have regarded these footprints as those of birds, and we feel confident, that when more tracks are found, this conclusion will be confirmed. But every one who has studied the fossil footprints of the sandstone of the Connecticut valley, or who has read the numerous articles of the late Dr. Hitchcock on the subject, knows how difficult it frequently is to identify the order or genus to which an individual footprint belongs.

As to the geological age of the strata where the tracks were found, we cannot speak with confidence, as we have found no fossils near the locality. A few miles distant we discovered impressions of exogenous leaves, which we suspected were in the same geological horizon as the footprints, but were unable at that time to verify it. Unfortunately the specimens were lost the next day, by the upsetting of our wagon in fording a swollen stream. But we are inclined to place the formation at least as high as the Lias. Future observations may fix it still higher.

The Triassic, Jurassic and Cretaceous in this part of Kansas, are all represented by their deposits. Major F. Hawn (Rocks of Kansas, p. 4), makes the former 420 feet thick, which is more than exists in the vicinity under consideration.

Quindaro, Wyandotte Co., Kansas, Dec. 21, 1865.

ART. XXIII.—*Note on the Geology of Petroleum in Canada West;* by Prof. A. WINCHELL.

HAVING just spent a week at Oil Springs and Petrolea, in the township of Enniskillen in Canada West, and having scrutinized the statements of well-borers in reference to more than one hundred wells, and examined many actual specimens brought up from various depths, I am prepared to offer a more definite statement than heretofore of the geological position of the accumulations of oil in that region.

The surface materials at Oil Springs are from 38 to 72 feet in depth below Main street; at Petrolea, 7 miles north, about 66 feet below the general level of the country; and at Wyoming, 5 miles farther north, 120 feet deep. They consist of grayish or somewhat ferruginous clays, 10 to 14 feet deep, succeeded downwards by tough, sometimes plastic, generally stratified, blue clay, with calcareous spar, pyrites, fossils of the Hamilton group and fragments of the same formation extending to the rock or within a few inches of it. At the bottom is generally found, at Oil Springs, a bed of porous materials consisting of glacial boulders, fragments of Hamilton limestones, gravel, and in some cases flowing quicksand.

The principal mass of rock beneath, to the Corniferous limestone, consists of a series of argillaceous and calcareo-argillaceous shales; shaly, argillaceous, often pyritous and eminently fossiliferous limestone; dark, or brown, highly crystalline, hard, fossiliferous limestone, and rarely a bed of sandstone. At the base is frequently found a buff-colored, granular, porous, magnesian limestone, often described as a sandstone. In some of the wells several feet of dark bituminous shale are found occupying a variable position in the series. In some parts of the oil-producing region the above series is overlaid by from 2 to 100 feet of black, hard, bituminous and somewhat calcareous shale. In other parts this has been denuded, and in still others the Hamilton Series is found worn down to varying depths.

The Black shale has been shown by me from stratigraphical data (Mich. Geol. Rep., 1860, p. 79; this Jour., [2], xxxiii, p. 353; Ib., xxxix, p. 351) to be the western equivalent of the Genesee shale, though by some geologists referred to the Portage group, and by others to the Marcellus shale. More recently—in May, 1865,—I obtained a few fossils (embracing *Discina Lodensis*, and *Leiorhynchus multicosta*) which perfectly establish the correctness of my former determinations. I know of no rocks of the age of the Portage group in Canada West.

The series of rocks below the Black shale is unequivocally Hamilton, and identical with the series outcropping at various places in Canada West and Michigan. The buffish magnesian limestone is likewise found at the base of the Hamilton group in Little Traverse bay in Michigan. The entire thickness of the Hamilton group proper in the oil region of Canada West is about 350 feet.

Petroleum accumulates in the porous beds at the bottom of the drift; in the fossiliferous, argillaceous and broken limestones occurring at various depths; in the porous magnesian limestone at the bottom of the series, and in numerous vertical fissures and horizontal spaces occupying various positions in the group. The various deposits are of local extent, those at the same depth in the formation not communicating through considerable distances. It sometimes occurs imprisoned in sandy spaces in the overlying clays. It is often accompanied by large or small volumes of water, and is often free from it. The oil is sometimes forced out by the elastic pressure of accumulated gas, sometimes by the hydrostatic pressure of water. Flowing wells have been fed from various depths in the rock.

Whether the supply originally ascended from the underlying Corniferous limestone or not, it is certain that no supply has ever been found by boring into that formation. Most of the wells are supplied from the Hamilton rocks; and some of the surface wells are supplied from above the Black shale. It is quite erroneous to insist that the wells are bored into the Corniferous limestone, or that they are supplied from the Upper Silurian.

In conclusion, I desire to call attention to the existence of copious oil wells bored in the Lower Silurian in Kentucky, Tennessee and the Great Manitoulin island of Canada—a fact which I announced in a publication which appeared Nov. 28th. Some of the southern Kentucky wells commence in the Cincinnati group of argillaceous limestones and penetrate the underlying black shale.

It seems to have become established from recent researches that the petroleum of the northwest not only accumulates in several different formations but also originates from materials stored up in rocks of different geological ages from the Utica slate to the Coal conglomerate, and perhaps the Coal-measures.

University of Michigan, Jan. 3, 1866.

ART. XXIV.—*On the Aqueous Lines of the Solar Spectrum;*[1] by JOSIAH P. COOKE, JR.

A CAREFUL examination of the solar spectrum continued during several months with the spectroscope described in a recent article[2] in this Journal has led me to the conclusion that a very large number of the more faint dark lines of the solar spectrum hitherto known simply as *air* lines, are due solely to the *aqueous vapor* of our air, and hence that the absorption of the luminous solar rays by the atmosphere is chiefly at least owing to the aqueous vapor which it contains.

The appearance of the Fraunhofer's line D, seen under precisely the same conditions, but with increasing quantities of aqueous vapor in the atmosphere, is shown in figures 1, 2, 3, and 4. The D line is selected because being a favorite test-object for the spectroscope its general appearance is well known to all observers. But even more marked changes than those here illustrated have been noticed in others, but chiefly in contiguous, portions of the solar spectrum.

These changes attracted my attention from my earliest observations with the spectroscope; but with my first instrument, and the bisulphid of carbon prisms then employed, it was almost impossible to eliminate the effects which might be caused by the variations in the condition of the instrument itself; and, as these were known to be very great, it was possible that they might account for all the variations observed. With the improved instrument, however, just referred to, absolute constancy of action is obtained, and all merely instrumental variations avoided.

A peculiar condition of the atmosphere gave the first clue as to the cause of the changes under consideration. The weather on the 17th of November, 1865, at Cambridge, Massachusetts, was very unusual, even for that peculiar season known in New England as the Indian Summer. At noon the temperature on the

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[1] Communicated to the American Academy of Arts and Sciences, Jan. 9, 1866.

[2] Vol. xl, Nov., 1865.

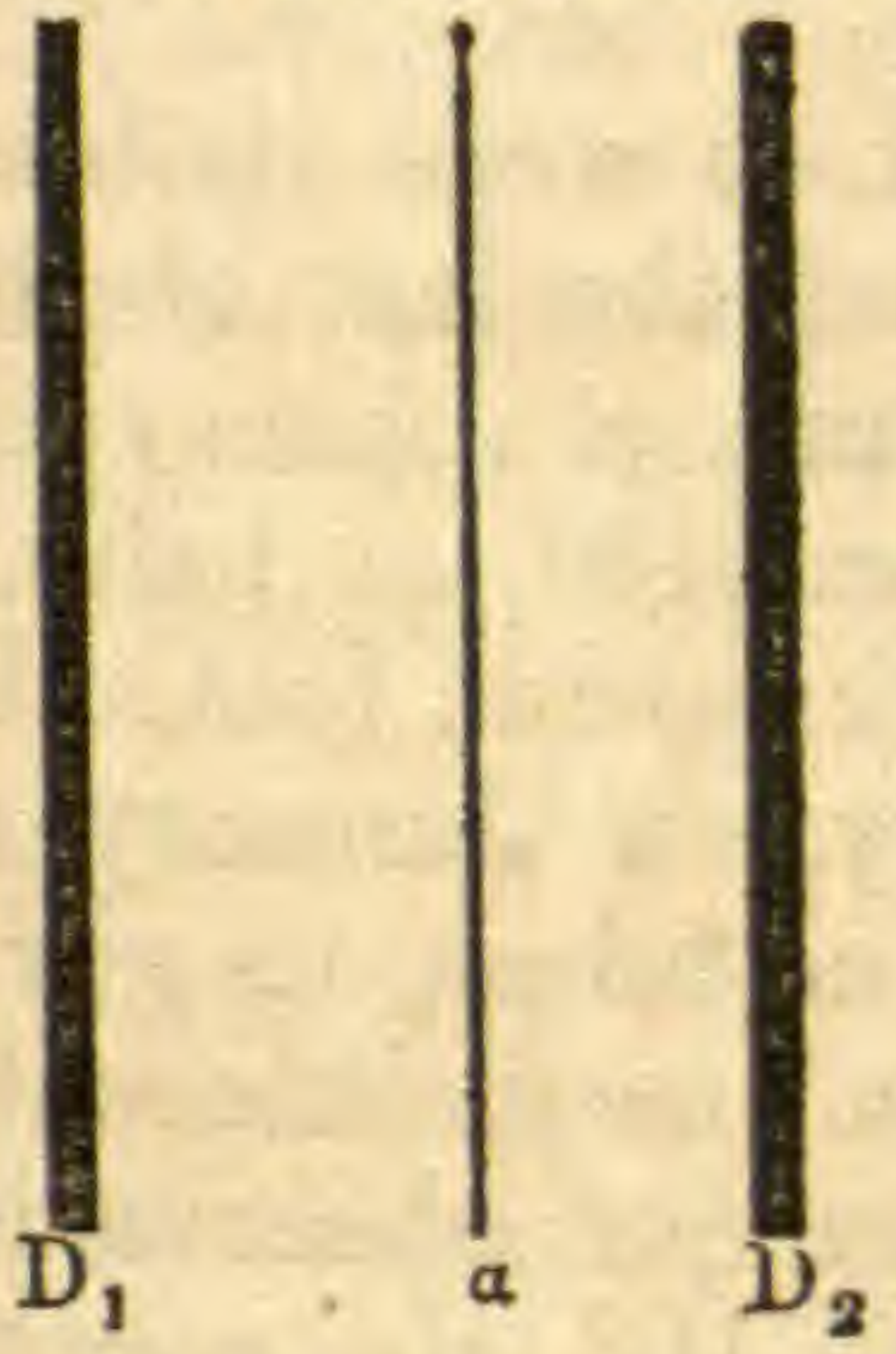
east side of my laboratory was 70° F., while the wet bulb thermometer indicated 66°, showing an amount of moisture in the atmosphere equal to 6·57 grains per cubic foot. At the same time the atmosphere was beautifully clear and the sun shone with its full splendor. I have never seen the aqueous lines of the spectrum more strongly defined than they were on this day, and the total number of lines visible in the yellow portion of the spectrum was at least ten times as great as are ordinarily seen.

1.

January 5, 1866.

Temperature 10° F.

Dew Point 1°·5 F.



Weight of Vapor in one Cubic Foot of Air, } 0·81 grains.

2.

December 25, 1865.

Temperature 46° F

Dew Point 33°·4 F.

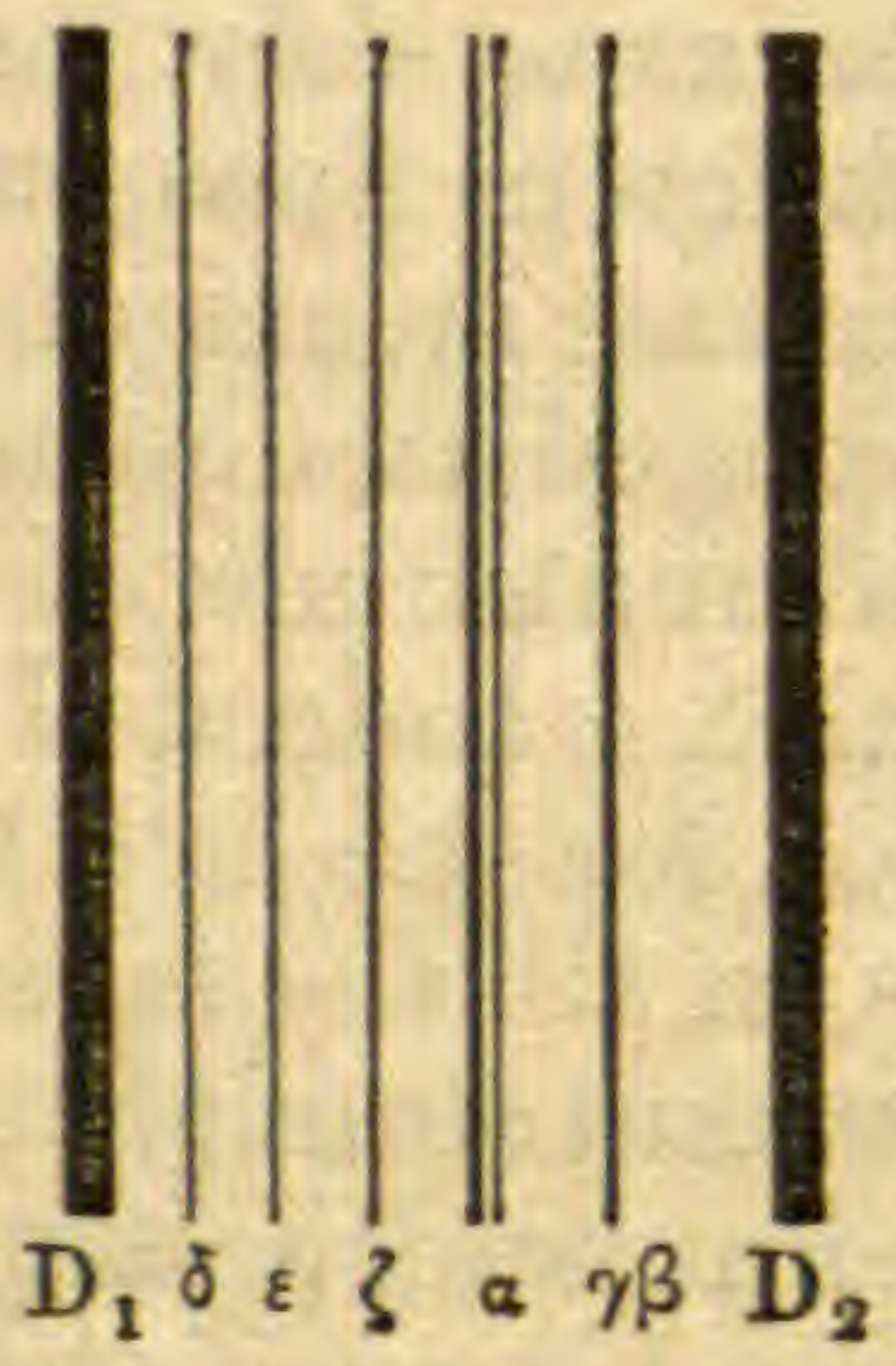
Weight of Vapor in one Cubic Foot of Air, } 2·42 grains.

3.

December 26, 1865.

Temperature 55° F.

Dew Point 46° F.



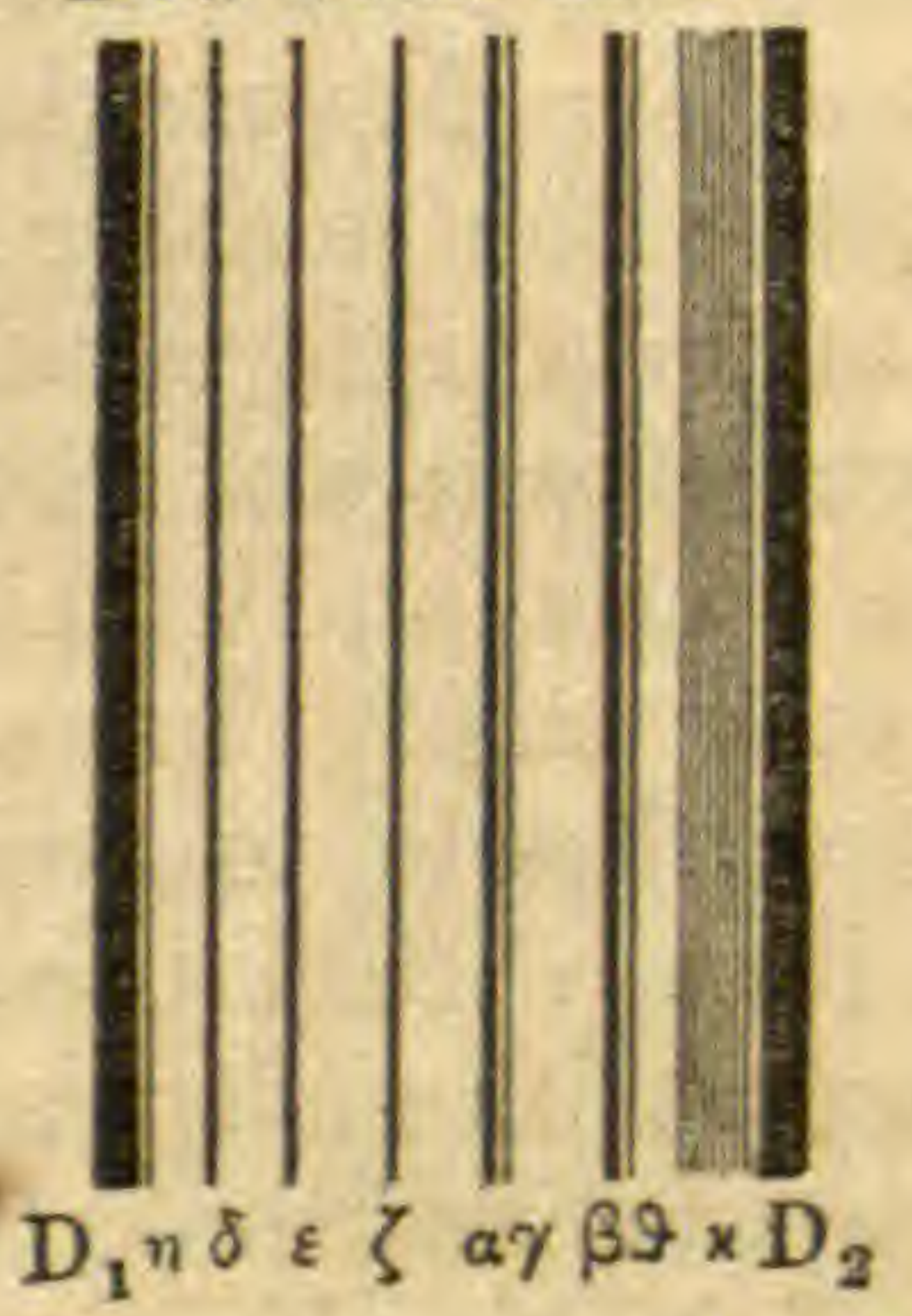
Weight of Vapor in one Cubic Foot of Air, } 3·76 grains.

4.

November 17, 1865.

Temperature 70° F.

Dew Point 64° F.



Weight of Vapor in one Cubic Foot of Air, } 6·57 grains.

The appearance of the D line on that day is shown in fig. 4. Between the two familiar broad lines D_1 and D_2 there were eight sharply defined lines of unequal intensity, which is only very imperfectly represented by the wood-cut. In addition to these on the more refrangible side of the space between the two D lines there was a faint but broad nebulous band, barely resolvable into lines of still lower magnitude.[2] It is impossible to represent this band accurately with a wood-cut, and the shaded broad band marked $\varkappa$, on the right hand side of fig. 4, only serves to indicate its position and approximate breadth.

The 26th of December was also a warm day for the season, with a brilliant sun. At 1 P. M. the dry bulb thermometer marked 55°, the wet bulb 50°, and hence the amount of moisture in the atmosphere was 3·76 grains per cubic foot. The appearance of the D line at this time is shown in fig. 3. Two of the lines, η and ϑ, and the nebulous band $\varkappa$, seen on the 17th of November were invisible, and moreover, the group of three lines δ ε ζ, on the left hand side of the figure, were only just within the limits of visibility.

On the 25th of December only two lines were visible within the D lines marked α and β in fig. 2, and the last of these was quite faint. The temperature at the time of observation was 46°; the wet bulb thermometer indicated 40°, and the amount of moisture in the air was 2·42 grains per cubic foot. The sky was clear and the sun brilliant. Lastly, on January 5, 1866, one of the clear cold days which are so common in our climate during the winter, only the single line α was visible within the D line, as is shown in fig. 1. At the time of observation near noon the dry bulb thermometer marked 10°, the wet bulb 9°, and hence the amount of moisture in the atmosphere was only 0·81 of a grain per cubic foot. The sun, however, was as brilliant as in either of the previous cases. The D line also appeared as in fig. 1, on the 8th of January, 1866, when the thermometer at noon stood at 10° below zero Farenheit, and when the barometer attained the unusual height of 31 inches.

The above figures have been drawn so as to show as nearly as possible the relative intensity of the different lines under different atmospheric conditions. As no accurate means of making the comparison are yet known, I was obliged to depend upon my eye alone, and small differences at different times of observation may easily have escaped my notice. Indeed I should have been liable to great error were it not for the fact that one of the lines within the D lines, marked α in all the figures does not vary in intensity, and served as a constant standard in making the observations. This is the only line which is given by Kirchoff in his chart of the solar spectrum between the two D lines, and it is referred by him to the nickel vapor as the D lines themselves are to the sodium vapor in the sun's atmosphere. It is an undoubted solar line and has been drawn with the same strength in all the figures in order to show that it is invariable.

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[2] We use this word in the same sense in which it is used by astronomers in reference to the fixed stars.

With a very dry atmosphere the line α is the only one which appears within the D lines, as shown in fig. 1. As the amount of vapor increases the line β makes its appearance. At first it is barely visible, but as the amount of vapor increases still further it becomes more and more prominent, until at last, as shown in fig. 4, it is even more intense than the line α. A careful comparison of these two lines might indeed serve as an approximate measure of the amount of vapor in the atmosphere, and a series of comparison, made under the same conditions at different heights would give data for determining the law according to which the amount of vapor decreases with the elevation above the sea level.

All the aqueous lines change in intensity like the line β. They first appear very faintly when the amount of vapor in the air reaches a definite point, varying for the different lines, and gradually gain in intensity as the amount of vapor increases. Thus the group of three lines $\delta\,\varepsilon\,\zeta$ do not appear in fig. 2, are barely visible in fig. 3, but become very marked in fig. 4.[3] The lines η and ϑ and the nebulous band $\varkappa$ do not appear until the air is very moist and even when it contains 6·57 grains of vapor per cubic foot they are still very faint. Under still more unusual atmospheric conditions they will undoubtedly become more intense, and we shall then probably be able to completely resolve the nebulous band and count the lines of which it consists.

It is hardly necessary to repeat that the examples here given are selected from a large number of observations. During the cold dry weather of winter the appearance of the D line is uniformly as shown in fig. 1, the line β only occasionally appearing when the atmosphere becomes more moist. During the warm weather of summer, when the absolute amount of moisture in the air is in almost all cases greater than in winter, the appearance of the D line is as uniformly that shown in fig. 3. It is only very rarely in the dry climate of New England, even during the summer, that all the lines shown in fig. 4 are visible, and, as already stated, I never saw them before so sharply defined as on the 17th of November last. Several conditions must evidently concur in order that the aqueous lines should be developed in their greatest intensity. In the first place the air must be charged with vapor not only near the surface of the earth, but also through a great height of the atmosphere. Local causes might greatly increase the amount of moisture in the lower strata of the atmosphere and affect powerfully the hygrometer, which would not, to the same extent at least, influence the indications of the spectroscope. In the second place, other

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[3] With an increasing quantity of vapor in the atmosphere the line γ of fig. 3 is seen before the group of lines $\delta\,\iota\,\zeta$, and an intermediate figure between 2 and 3 might be given showing only the lines $D_1\,\alpha\,\gamma\,\beta\,D_2$.

things being equal the intensity of the aqueous lines must be strengthened by increasing the length of the path of the sun's rays through the atmosphere, and this is the longer the lower the altitude of the sun. But then again the intensity of the light has such an important influence on the definition of the lines, and the slightest haze in the atmosphere so greatly impairs the distinctness, that I have generally found that the aqueous lines are seen best when the sun is near the meridian. Hence with an equal amount of moisture in the atmosphere the late autumn may be a more favorable season for seeing the aqueous lines than the summer; for not only must the solar rays, when most brilliant at noon, traverse a greater extent of air, but moreover, the atmosphere at this time is usually clearer, and the reflected beam of light, which enters the spectroscope, is at times even more brilliant than when the sun attains a higher elevation and the light is reflected under less favorable conditions.

In the examples cited above the comparisons were made under as nearly as possible the same conditions so as to eliminate all causes of variation except the one under consideration. Days were selected when the atmosphere was perfectly clear and the sun's light, so far as I could judge, equally brilliant. Moreover, the position of the spectroscope and mirror remained unchanged during the whole time. This mirror which is used for reflecting the sun's light upon the slit of the spectroscope is so arranged that it can be turned into any position by the observer while his eye is at the eye-piece of the spectroscope, and it was always carefully adjusted to the position of best definition at each observation. The manipulation of the mirror is fully as important in the use of the spectroscope as it is in microscopy.

It will be of course understood that the power of developing these faint aqueous lines depends very greatly on the optical capabilities of the spectroscope, and that the figures here given are relative to the instrument used in the observations. This instrument has been fully described in the article already cited. It is sufficient for the present purpose to state that it is provided with nine flint glass prisms of 45° refracting angle, which bend the rays of light corresponding to the D line through an angle of 267° 37′ 50″, and that corresponding to the H_1 line through an angle of 260° 42′ 20″, when each passes through the prisms at the angle of minimum of deviation. The dispersive power, therefore, of the instrument for these two rays is equal to 13° 4′ 30″, and the rays corresponding to the two D lines are separated 1′ 10″. The object glasses of the two telescopes of this spectroscope are 2¼ inches in diameter and have a focal length of 15½ inches, and lastly the size of the prisms and of the various parts of the instrument is adapted to these dimensions. With a more powerful instrument a larger number of aqueous lines would be seen under the same atmospheric conditions. My own instrument has a set of sulphid of carbon prisms which disperse the light nearly twice as much as the flint prisms. These sulphid of carbon prisms are very variable in their action; but, under the best conditions, they might show the D line as in fig. 3, when with the flint prisms it would appear as in fig. 2.

The facts stated in this paper fully account for the discrepancies in the representations which different observers have given of the D line. Some time since Mr. Gassiot of London gave in the Chemical News a representation of the D line as seen with his instrument, showing several lines in addition to those seen by myself and other observers. On visiting the Kew Observatory, in the summer of 1864, I was surprised to find that this instrument was less powerful than the one I was then using, and I also learned that these lines were only seen on a single occasion. The moist climate of England is the evident explanation of the additional lines.

As I stated at the first of this paper the D line has been selected simply to illustrate a general truth. The development of aqueous lines in contiguous portions of the spectrum is even more marked than in the exceedingly limited portion here represented. Indeed, as has been already intimated, the number of these lines seen in the yellow region of the spectrum on the 17th of November was at least ten times as great as that of the true solar lines. That part of the yellow of the spectrum which lies on the more refrangible side of the D line, and in which during dry weather only a comparatively few lines can be distinguished, was then as thickly crowded with lines as the blue or the violet, but the lines were of course far less intense.

Professor Tyndall of London has shown by a remarkable series of experiments with the thermo-multiplier not only that aqueous vapor powerfully absorbs the obscure thermal rays; but also that the elementary gases of the atmosphere exert little or no action upon them. I have endeavored to establish in this paper, from direct observations with the spectroscope, a similar truth in regard to the luminous rays. It has been estimated by Pouillet and others that about one-third of the solar rays intercepted by the earth are absorbed in passing through the atmosphere, and it now appears that aqueous vapor is the most important if not the chief agent in producing this result. It is impossible, however, from any data we yet possess, to determine how great a power of absorption is exerted by the oxygen and nitrogen gases which constitute the great mass of our atmosphere. I have shown that a very great many, and I have no doubt that almost all the lines, hitherto distinguished as air lines, are simply aqueous lines, but it is very difficult to distinguish atmospheric lines from the true solar lines, and our knowledge of the first is as yet very incomplete. It still remains to make careful comparisons throughout the whole extent of the spectrum before we can determine absolutely the relative absorbing power of the different constituents of our atmosphere.

One other inference from the facts here developed is worthy of notice before closing this paper. It has been for some time suspected that the blue color of the sky was in some way connected with the vapor in the atmosphere, and it is a fact of common observation that this color is more intense during the moist weather of summer than during the dryer weather of winter. The distribution of the aqueous lines through the solar spectrum not only confirms the opinion previously entertained, but also points to the cause of the color. So far as my observations have extended the aqueous lines are almost wholly, if not completely, confined to the more refrangible portions of the spectrum. Here they are found in vast numbers, and I am not positive that they exist anywhere else. If, then, the aqueous vapor absorbs most powerfully the yellow and red rays of the spectrum, the blue color of the sky is the necessary result. The color is therefore due to simple absorption and not to repeated reflections from the surface of drops of water, as some physicists have supposed.

As can readily be seen the aqueous lines of the solar spectrum present a very wide field for investigation, but one which can only be cultivated under peculiar atmospheric conditions. This paper is only intended to open the subject. I hope to be able to continue the study on every favorable opportunity, and shall take pleasure in communicating through the pages of this Journal any future results.

Cambridge, Jan. 9, 1866.

ART. XXV.—*The Distribution and Migrations of North American Birds;* by SPENCER F. BAIRD, Asst. Sec. Smithsonian Institution. (Abstract of a memoir presented to the National Academy of Sciences, Jan., 1865.)

[Continued from p. 90.]

ATTENTION has already been called to the fact that certain species, characterizing the eastern province, make their appearance in the Rocky mountains. The following is a list of those collected by Mr. Drexler at Fort Bridger (about in lat. 41°, long. 110°) in the center of the Rocky mountain range, nearly all of which have been found still farther to the northwest, toward Puget Sound. The birds found at Fort Bridger probably arrived there by way of the Platte, those of Washington Territory by both the Platte and upper Missouri.

Although thus extending westward, almost, if not quite, to the Pacific, along the northern boundary, they appear to always return the way they went as none of the species have yet been met with in California.

I have added to each species the locality on the Missouri river up to which it was observed by Dr. Hayden in one of his early explorations.

Species of Eastern birds found at Fort Bridger.

Tyrannus Carolinensis,	Fort Union and Yellowstone.
Turdus fuscescens,	
T. Swainsoni,	
Seiurus Noveboracensis,	
Dendroica coronata,[1]	
Setophaga ruticilla,	Fort Pierre.
Vireo olivaceus,	" Union (Mr. Audubon).
Mimus Carolinensis,	" Lookout.
Zonotrichia leucophrys,	(not found farther west).
Quiscalus versicolor,	Fort Benton (Pearsall).

It will be sufficiently evident, as most birds change their residence from winter to summer, and *vice versa*, that unless we devote especial attention to their distribution during the breeding season, we shall not be able to mark their boundaries with precision. Species which go north to the Arctic circle to nest, return to mix in Mexico, Guatemala, or the West Indies, with species resident in those countries, or of short migration, and are followed part way in their southern flight by Arctic birds starting from localities still farther north. The case is quite different with reptiles, and most insects and mammals, of which a few species only change their residence or leave their place of birth, not in obedience to the instinct of reproduction, but of necessity caused by overcrowding, the search for suitable food, &c. A true parallel, however, is seen in the movements of fishes in search of a suitable place to deposit their spawn, which takes place with the same regularity as to date and direction that we find in birds.

It is only of late years that we have been enabled to determine, even with approximate precision, the winter quarters of our North American birds. Many of the species of the Eastern province are limited by the waters of the Atlantic or Gulf, crowding into Florida, Georgia, and other southern states. Comparatively few visit the West Indies; a much larger proportion reach Mexico and Guatemala, and the number of those passing farther south diminishes with the latitude. Very few of the land birds pass into South America, the following being a list of

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[1] Found by Dr. Suckley on Puget Sound.

the principal species (and their southernmost mentioned limit) recorded as occurring in that portion of the continent, mostly as winter emigrants, although a few are resident.

Cathartes aura, S. America.
" atratus, "
Falco columbarius, Ecuador.
" femoralis, S. America.
" sparverius, "
Buteo Pennsylvanicus, Ecuador.
Asturina nitida, "
Nauclerus furcatus, Brazil.
Rostrhamus sociabilis, Ecuador to La Plata.
Coccygus erythrophthalmus, Bogota.
Turdus Swainsoni, Ecuador.
Mniotilta varia, Bogota.
Helminthophaga chrysoptera, Bogota.
Seiurus Noveboracensis, "
Dendroica Blackburniæ, Ecuador.
" cœrulea, Bogota.
" striata, "
" æstiva, "
Myiodioctes Canadensis, Ecuador.
Setophaga ruticilla, "
Pyranga rubra, "
" æstiva, "
Dolichonyx oryzivorus, Gallapagos.
Hirundo bicolor, Bolivia.
Vireo olivaceus, Bogota.

25 species.

The following species are recorded as occurring on the Isthmus of Panama and Darien in addition to most of those just mentioned:

Antrostomus Carolinensis,
Ceryle alcyon,
Tyrannus Carolinensis,
" Dominicensis,
Myiarchus crinitus,
Empidonax Trailli,
" flaviventris,
Dendroica coronata,
" castanea,
" Pennsylvanica,
" maculosa.
Myiodioctes mitratus,
Hirundo horreorum,
Hirundo lunifrons,
Turdus fuscescens,
Protonotaria citrea,
Geothlypis Philadelphia,
Oporornis formosus,
Helminthophaga peregrina,
Dendroica virens,
Chrysomitris Mexicanus,
Euspiza Americana,
Guiraca Ludoviciana,
Icterus spurius,
" Baltimore,
Quiscalus macrourus.

27 species.

One circumstance will attract our attention in examining these lists of North American birds reaching the Isthmus of Panama or passing beyond it as far as Bogota and into Ecuador, namely: that they embrace absolutely none of the species characterizing the middle province, all belonging to the eastern. It would seem to be the case that the migratory birds of the Rocky Mountain region go only a comparatively short distance southward into Mexico, few of them even reaching Guatemala, but preponderating on the west coast. It has already been remarked that the birds strictly characteristic of the Pacific region of the United States scarcely appear to go into Mexico at all.

While the number of land birds reaching the gates of South America, and passing through them, principally along the Andes into central New Granada and Ecuador, is so small, the case is very different with the waders, a large proportion of which are during our winter spread over the entire continent, almost as far as Patagonia. Comparatively few, however, of the Natatores follow them in this journey.

The following list comprises the principal indications of the winter visitors to the West Indies from the United States, all of them, excepting *Nephocœtes niger*, belonging to the eastern fauna.

	Bahamas.	Cuba.	Jamaica.	Other Islands.
Cathartes aura,	*	*	* ?	
" atratus,		*	*	
Falco anatum,	*	*	*	
" columbarius,		*	*	Tobago.
Buteo borealis,		*	*	
" Pennsylvanicus,		*		
Rostrhamus sociabilis,		*		
Circus Hudsonius,		*		
Pandion Carolinensis,	*	*	*	Trinidad.
Nauclerus furcatus,		*	*	
Brachyotus Cassini,		*		
Otus Wilsonianus,				Tobago ?
Coccygus (uncertain),				
Sphyropicus varius,	*	*	*	St. Croix.
Trochilus colubris,		*		
Nephocætes niger,		*	*	
Antrostomus Carolinensis,		*		
Chordeiles popetue,	*	*	*	
Ceryle alcyon,	*	*	*	St. Cruz, Tobago.
Tyrannus Carolinensis,		*		
" Dominicensis,	*	*	*	St. Cruz, St. Thomas.
Myiarchus crinitus,		*	* !	
Contopus virens,		* ?		
Empidonax Acadicus,		*		
Turdus mustelinus,		*		
" fuscescens,		*		
" Swainsoni,		*		
" Aliciæ,		*		
" migratorius,		*		
Sialia sialis,		*		
Mniotilta varia,	*	*	*	St. Cruz.
Parula Americana,	*	*	*	St. Thomas.
Geothlypis trichas,	*	*	*	
Oporornis formosus,		*		
Helmitherus vermivorus,		*	*	
Protonotaria citrea,		*		
Helminthophaga Bachmani,		*		
" chrysoptera,		*		
" perigrina,		*		
Seiurus aurocapillus,		*	*	St. Domingo, St. Cruz.
" Noveboracensis,		*	*	St. Cruz.
" Ludovicianus,		*	*	
Dendroica virens,		*		
" Canadensis,	*	*	*	
" coronata,	*	*	*	St. Domingo.
" Blackburniæ,	*			
" Pennsylvanica,	*			
" striata,	*	*		
" maculosa,	*	*		
" tigrina,	*	*	*	St. Cruz.
" palmarum,	*	*	*	St. Domingo.
" superciliosa,		*	*	St. Domingo.
" discolor,	*	*	*	St. Cruz.
" cœrulea,		*		
Myiodioctes mitratus,		*		
Setophaga ruticilla,	*	*	*	St. Domingo, St. Cruz.

	Bahamas.	Cuba.	Jamaica.	Other Islands.
Pyranga rubra,		*	*	
" æstiva,		*	* ?	
Hirundo horreorum,		*		St. Cruz.
" bicolor,		*		
Cotyle riparia,		*	*	
Ampelis cedrorum,		*	*	
Vireo olivaceus,		* ?		
" barbatula,	*	*		
" Noveboracensis,		*		
" solitarius,		*		
" flavifrons,		*		
Galeoscoptes Carolinensis,		*		
Polioptila cærulea,		*		
Certhiola Bahamensis,	*			
Passerculus savanna,		*		
Coturniculus passerinus,		*	* ?	
Spizella socialis,		*		
Guiraca Ludoviciana,		*		
" cærulea,		*		
Cyanospiza cyanea,		*		
" ciris,		*		
Dolichonyx oryzivorus,	*	*	*	
Agelæus phœniceus,	*			
Xanthocephalus icterocephalus,		* !		
Icterus cucullatus,		*		
" Baltimore,		*		
" spurius,				
Columba leucocephala,	*	*	*	St. Cruz, Porto Rico.
Ectopistes migratoria,		*		
Zenaidura Carolinensis,		*		
Melopelia leucoptera,		*	*	
Chamæpelia passerina,	*	*	*	
87 species.				

From an examination of this list it will be seen that, with but few exceptions, the species that reach Panama and pass into South America occur also in Cuba as winter visitors, the principal exceptions being *Empidonax Traillii* and *flaviventris*, *Geothlypis Philadelphia*, *Dendroica castanea* and *æstiva*, *Myiodioctes Canadensis*, *Euspiza Americana*, and one or two species belonging to the middle province. It will also be remarked how many more of our species are recorded as visiting Cuba than Jamaica, 80 species instead of 36, the number becoming still less as we proceed eastward in the group. The Bahama winter fauna will probably exhibit as many continental species as Cuba, or even more when we are better acquainted with it. The comparative superiority of numbers in Cuba, is probably owing to the fact that the island, the western end especially, with the Tortugas, is a stepping stone or resting place for our species passing from Florida to Yucatan and Guatemala. This is probably the route by which most species of the Eastern province reach middle America, rather than along the coast of Texas and Mexico, many species being recorded in Guatemala and Honduras, not noted in Mexico north of Yucatan. It is the species of the Middle province that characterize more especially the winter fauna of Central Mexico, particularly its western slope and Cape St. Lucas, and it is an interesting fact that very few of the birds peculiar to the Western province are known to occur in Mexico at all. The North American winter birds of Western Mexico, as stated, belong almost entirely to the Middle fauna, the most notable exceptions being the occurrence at Colima and Manzanillo of *Dendroica superciliosa*, *Sterna Antillarum*, and *Chroicocephala atricilla*, and at Mazatlan of *D. superciliosa*, *Mniotilta varia*, and *Seiurus aurocapillus*, none of them being found in California. The birds of Eastern Mexico are likewise in large proportion from the Eastern province of North America.

It may perhaps be proper to recall attention to the fact that, in defining the southern boundary of the Middle province and at the same time that of North America as a zoological region, I drew the line from the mouth of the Rio Grande of Texas to that of the Yaqui River at Guaymas on the Gulf of California. The space embraced between this line and the continental portion of South America, including Mexico, Central America, the Isthmus of Panama and of Darien, and the entire West Indies, I term Middle America; all south of this, South America. Trinidad alone, of the West Indies, belongs rather to South America, most of its species being common to the adjacent main land, though some are, perhaps, peculiar to it. Tobago, farther north, though with some South American species, has yet a considerable number peculiar to itself.

In concluding this part of my remarks I may state that the present lists and generalizations in regard to the distribution of our birds are to be considered merely as provisional, and that investigations at present in progress by myself and others will, it is hoped, impart much greater precision to the knowledge of the subject. In many instances I have omitted species which might have been considered as entitled to a place in one or the other tables, but this has been in most cases the result of recent determinations and different identifications than those of other authors.

Having thus briefly indicated the boundaries of the principal provinces of the North American ornithological fauna, I propose to call attention to some generalizations that have suggested themselves in reference to certain influences exerted upon species by their distribution according to latitude, longitude, and elevation, and by their association with each other. The most important of these, is the law that North American birds of wide distribution in latitude, whether migrant, or residents, will be found to be larger the higher the latitude of their place of birth.

It is well known to zoölogists that of all animals, birds are the most constant in their dimensions, so much so indeed, that size is generally considered as a most important specific character. The comparison of many specimens of the same species from widely remote localities has shown me, however, that there is a certain variation in size, dependent on the extension northward and southward of the limits of distribution during the breeding season, the more northern being the larger, the more southern the smaller. Nor does this depend upon a greater development of body by more constant use of the muscular system in flight, as suggested by Gloger, who observed the same fact in Europe (but confined it especially to the increase in length of wings and tail), or upon a greater variety or amount of food, since the difference is as strongly marked in species constantly resident, as in those which migrate over great distances, and the development extends to the bill, feet, and all parts of the body. And in fact birds most remarkable for their great range show the least variation in size, while the variation is most evident in certain species of woodpeckers as *Picus villosus* and *Hylotomus pileatus*, which have a very wide distribution in latitude, without any special migration at all. In these woodpeckers the difference between specimens from Florida and from Canada is so great as to have given rise to the impression of there being several species of each, differing in size.

In nearly every instance where I have compared summer specimens from localities widely remote in latitude, I have found the difference referred to. A similar law prevails in regard to mammals as shown very clearly in the American deer, *Cervus Virginianus* and in the gray Squirrel, *Sciurus Carolinensis*, which are much larger in the north than in the south and larger in the mountains than in the lowlands. In mammals, if not in birds, a second law comes into play: that in the same latitudes in North America the specimens from the greater altitudes are the larger, this law appearing to extend even to man, as shown by the greater size of the inhabitants of the Appalachian region, than in those of the lowlands.

If we assume the parallel of 40° as an average line, while the specimens born farther north are larger, those born in the most southern localities are even disproportionately smaller. This is very evident in species from Cape St. Lucas, the extreme southern limit of the Middle province, where, almost without exception, the indigenous birds are so much smaller than specimens of the same species inhabiting the United States, as readily to convey the impression of being distinct new species. The same is the case, although to a less degree, in Florida, where there appears to be a tendency (found to some extent also at Cape St. Lucas) to absolute increase of the size of the bill, even with diminution in general bulk, seen especially in *Corvus Americanus*, and *Ortyx Virginianus*.[2]

While some Florida birds are thus characterized by larger bills than their more northern brethren, several of the birds of the Middle and Western provinces have an increase in the length of the tail as compared with the same or allied species in the east. Thus *Icteria longicauda* of the Western and Middle provinces is only to be distinguished from *I. viridis* of the Eastern by the longer tail, while *Mimus polyglottus*, and *Harporynchus rufus* have each a long tailed Western variety.

Both these generalizations in regard to varieties of size and proportion, have been used with advantage in testing the claim of supposed species to this rank, and have aided in materially diminishing the accepted number of species of both mammals and birds.

Another fact which may be mentioned in reference to birds of the different provinces, is that specimens from the Pacific coast are apt to be darker in color than those from the interior, the latter frequently exhibiting a bleached or weather-beaten appearance, possibly the result of greater exposure to the elements and less protection by dense forests.

In a careful study of large series of birds of any two representative species collected near the line of junction of their respective provinces, a combination of characters of both species will often be met with, explicable only on the supposition of the hybridization of the two. Whether such hybrids are themselves fertile, or whether the cross is kept up by the constantly recurring union of individuals of pure breed of either species, I am not prepared to say, but the general facts appear to be as stated. A notable instance of this is seen in the two northern species of *Colaptes*, one, *Mexicanus*, characterizing the Western and Middle provinces, the other, *auratus*, the Eastern. The lines of distribution of the two intersect on the upper Missouri near the mouth of the Yellowstone River, and all along that portion of its course we find *Colaptes* of every possible grade of transition, or combination of the several characters of the two species; scarcely any two exactly alike, and the same individual not even agreeing in the markings of opposite sides.[3] A similar combination of characters of *Cyanura Stelleri* and *macrolopha* is met with on the headwaters of the Columbia, and on the Yukon, of *Junco hyemalis* and *Oregonus*, and of *Helminthophaga celata* and *peregrina*. Other instances can be adduced, but these will be sufficient to illustrate the facts.

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[2] This disproportionate difference of size at Cape St. Lucas and south Florida is probably connected with the limited range of the species in those regions which have thus an insular rather than continental relationship.

[3] See Baird. Birds of North America, 1858, 122.

The possibility of hybridity as referred to, is another element to be taken into consideration in discussing the claim of a supposed new species to that rank.

Having thus discussed the laws of distribution and migration of the birds of North America on the continent itself, and the influence of region upon the development of the individual, I proceed to consider the subject of their movement eastward toward Greenland and Europe; that of European birds toward North America, and the several causes that appear to influence such migrations; and to present various tables of geographical distribution bearing upon the question introduced.

[To be concluded.]

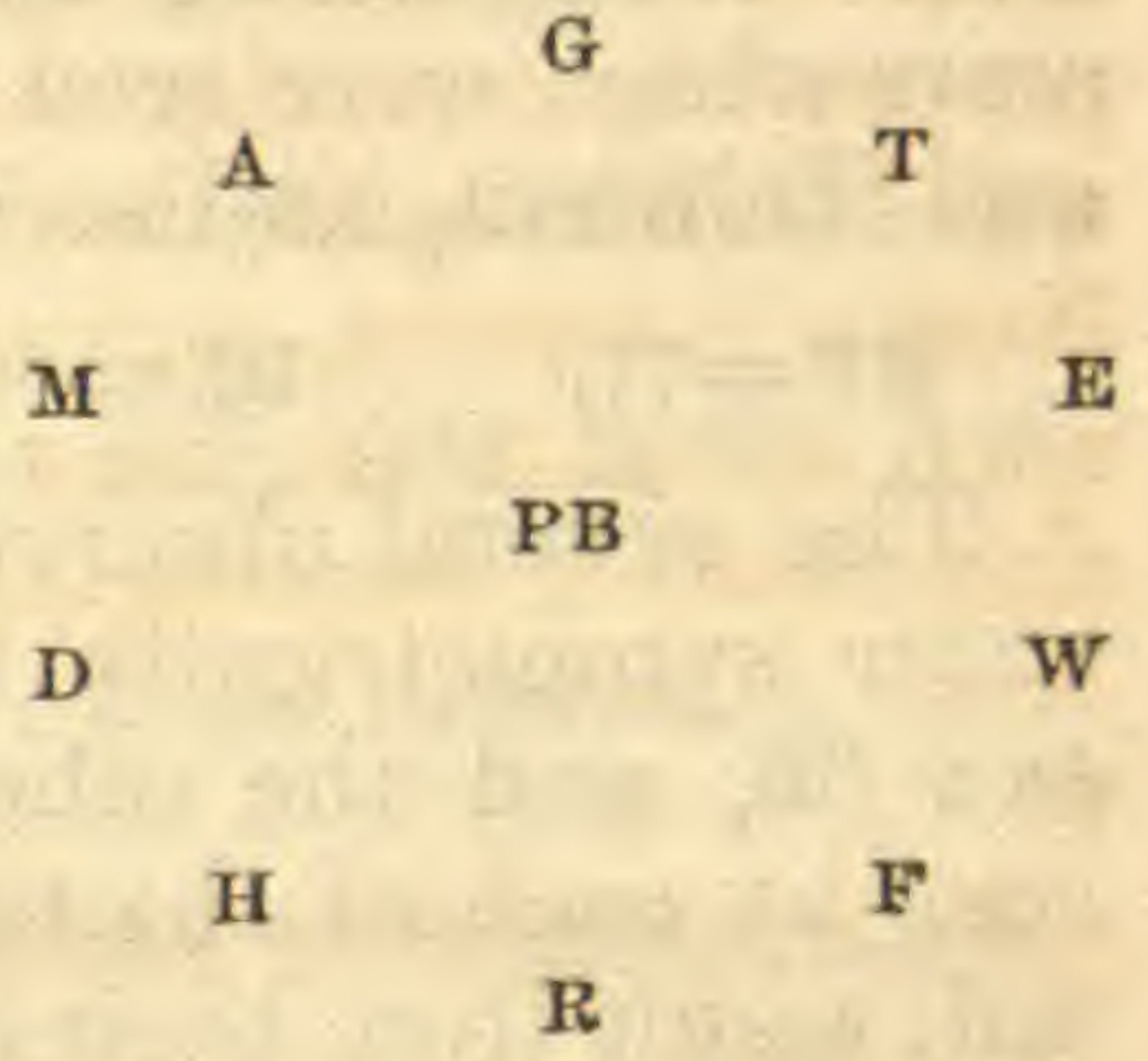
ART. XXVI.—*The relative numbers of Shooting Stars seen in a given period by different numbers of observers;* by H. A. NEWTON.

IT is often desirable to compare the hourly number of shooting stars seen by one or more observers at one time and place, with the hourly number seen by observers at some other time and place. Allowance in such cases must be made for the state of the sky, for the moonlight or twilight, for the hour of the night, and still more for the number of persons counting. In order to obtain constants for eliminating as nearly as possible this last element, I arranged, and with the assistance of others carried out, a series of observations on two nights, the 15th and 16th of August, and the 14th and 15th of November, 1865.

Evidently two persons will not see quite twice as many as one, since some meteors will in general be seen by both. Still less will three or four persons see three or four times as many as one person. Experience has moreover shown that a small number of persons cannot see all that are visible, since each one usually catches some not noticed by the others. There must, however, be some finite limit toward which, as the number of observers increases indefinitely, the hourly number seen approaches asymptotically. For we cannot regard as infinite the whole number visible at one place in a finite time.

On the night of Nov. 14th and 15th, we began our watch at midnight, and continued it until three o'clock, twelve observers counting in that time 186 shooting stars. We were stationed upon the top of one of the towers of Graduates' Hall, from which there is an unobstructed view of the heavens. Most of my assistants were students in the college. They were directed to keep their eyes constantly upon the heavens. I made the record, and did not attempt to observe. Whenever a meteor was seen each person perceiving it called out his own name, and I entered it (or rather an initial letter of it) on the record.

The heavens were divided as follows among the several observers: Mr. C. G. Rockwood (R) looked toward the south, Mr. N. P. Hulst (H) to the west of south, and so on, following around the horizon, Messrs. J. J. DuBois (D), M. D. Mann (M), A. H. Adams (A), G. H. Perkins (G), J. H. Tallman (T), E. W. Miller (E), A. Warren (W), and F. W. Russell (F). Mr. L. T. Brown (B) and Mr. W. A. Peck (P) looked to the zenith. The letters in parentheses were used to denote the several observers. Their arrangement is represented in the diagram.



The following is a summary of the observations. We denote by A the number of shooting stars seen during the three hours by Adams that were not seen by any other person; by AE the number seen by both Adams and Miller, but not seen by any one else; and so on.

A=8
B=7
D=5
E=5
F=0
G=11
H=10
M=7
P=4
R=6
T=9
W=2
AE=3
AG=1
AM=2
AR=2
AW=1
BF=2
BP=1

BR=1
DH=1
DM=3
EM=1
ET=1
EW=1
FR=3
GT=2
HM=1
HR=5
PR=2
PW=1
ADM=1
ADR=1
AEG=2
AGM=1
AGT=1
AGW=1
AMR=1

AMT=1
BDR=1
BFH=1
BFP=1
BFR=2
BFW=1
BEP=1
BHR=2
DFH=1
DHM=3
DHR=3
EGW=1
EPW=1
ETW=1
FHR=2
ABGT=1
ADHM=1
AEGP=1
AEGW=1

AETW=1
AMPT=1
BDMR=1
BFHP=1
DHMR=1
EFPR=1
EFPT=1
EFRW=1
EFTW=1
EGTW=1
FHPR=2
FMPT=1
GMTW=3
ABDGM=1
ABEPW=1
ADEMP=1
AEFPW=1
AEGMT=1
AEGTW=1

AGMTW=1
BEFPR=2
BEGTW=1
BFHPR=3
BFPRW=1
DHMPR=1
EFGPW=1
EFHPR=1
EFPRW=1
FHMPR=1
ABFHMP=1
AEFPTW=1
AEGMTW=2
EFHMPR=1
ABEFPRW=1
AEFHPRW=1
BDFHMPR=2

If we denote by **A** the whole number seen by Adams, and so of the others, we find from this table the following equations:

$\mathbf{A}=45$, $\mathbf{B}=36$, $\mathbf{D}=27$, $\mathbf{E}=42$, $\mathbf{F}=39$, $\mathbf{G}=36$,
$\mathbf{H}=45$, $\mathbf{M}=41$, $\mathbf{P}=40$, $\mathbf{R}=52$, $\mathbf{T}=32$, $\mathbf{W}=31$.

The mean is 38·75, which is the average number seen by each observer. Hence we have the proportion,

No. seen by one person : No. seen by twelve : : 38·75 : 186.

The numbers seen by individual observers vary between 27 and 52. The difference in the state of the sky in different directions as to haziness and clouds, and the difference in powers of vision of the observers, and in fixedness of attention, may account for this variation. In the mean of the results these peculiarities of observers and of direction, are evidently to a great extent eliminated.

When two persons count the number of shooting stars which they can see, they naturally look in opposite directions. We shall therefore take account only of such couples, of which there are five. Designating by the symbol **HT** the number of shooting stars which were seen by one or both of the two observers Hulst and Tallman, and so of like symbols, we have the equations,

HT = 77, **DE** = 68, **MW** = 66, **AF** = 79, **GR** = 87.

The several observers, except the two looking to the zenith, enter symmetrically into these equations. One of these two saw 36, and the other 40 meteors, while the average number seen by each of the twelve is 38·75. Hence, only a small error will result from their omission from the equations. In the mean of the numbers above given we should have, therefore, the number seen by two observers looking to opposite quarters of the heavens, freed very nearly from personal peculiarities. This mean is 75·4. Hence,

No. seen by two persons : No. seen by twelve persons : : 75·4 : 186.

The following equations contain the same ten observers arranged in groups of threes, each observer included in three equations, and each group of three persons arranged very nearly symmetrically around the horizon. The zenith observers as before are omitted.

EMR = 113, **GHW** = 97, **DGW** = 79, **DFG** = 96, **AHW** = 105,
AEH = 109, **AER** = 108, **DFT** = 91, **FMT** = 93, **MRT** = 106.

The mean of these is 99·7. Hence,

No. seen by three persons : No. seen by twelve persons : : 99·7 : 186.

Again, selecting groups of four observers that shall be arranged as nearly as possible symmetrically around the horizon, we have,

DEGR = 123, **GMRW** = 124, **HMTW** = 113,
AFHT = 124, **ADEF** = 112, Mean = 119·2.

Hence,

No. seen by four persons : No. seen by twelve : : 119·2 : 186.

In selecting groups of five or more observers we may include those looking to the zenith :

ABDEF = 123, **AFHPT** = 134, **BHMTW** = 131, **GMPRW** = 133,
DEGPR = 134, **ADRTW** = 133, **EFGHM** = 135, Mean = 131·86,

the number seen by five persons.

Again,

ADPRTW = 141, and **BEFGHM** = 145. The mean = 143,

the number seen by six persons.

For seven observers we find the numbers for the seven groups formed by leaving out of the whole twelve successively the groups of fives given above. The mean of the seven numbers is 152·86.

For eight observers we form three groups by omitting successively from the twelve, DGPW, BEMR, and AFHT. The mean of the three numbers is 160·67.

For groups of nines we omit successively BDE, GPR, FMT, and AHW. The mean result is 166·75.

For groups of tens we omit in succession HT, DE, MW, AF, BR, and PG. The mean result is 173·5.

For eleven observers we omit each one of the twelve in succession. The mean result is 179·83.

These means are given in column A of the following table. Column B shows how many would be seen by a number of observers in a period during which four of them would see 1000 meteors. It is obtained by dividing the numbers in column A by the decimal ·1192:

	A.	B.	C.
Seen by one observer,	38·75	325	359
" two observers,	75·40	633	651
" three "	99·70	836	856
" four "	119·20	1000	1000
" five "	131·86	1106	1136
" six "	143·00	1200	1249
" seven "	152·86	1282	
" eight "	160·67	1348	
" nine "	166·75	1399	
" ten "	173·50	1451	
" eleven "	179·83	1509	
" twelve "	186·00	1560	

In column C are given the results of a discussion similar to that just detailed, of observations made on the night of Aug. 15th–16th, 1865. Six persons, in three hours ending at two o'clock, saw on that night 172 shooting stars. Five of them were looking in different azimuths, and one to the zenith.

It should not be forgotten that these numbers are in each instance obtained from observations continued for only three hours, a period too short to furnish a result free from accidental irregularities.

These numbers depend evidently to some extent also upon the intrinsic brilliancy of the shooting stars on the night of observation; upon their uniformity, or want of uniformity, of brilliancy; upon the clearness, or haziness, or cloudiness of the sky; upon the power and quickness of vision of the observers; and upon the degree of fixedness of their attention during the watch. The essential agreement of the two series in columns B and C, however, justifies confidence in them as a first approximation.

Toward what limit the series of numbers in column B would approach as the number of observers increases indefinitely we cannot say. The uniformity of increase in the last part of the series is due, in part, to the fact that in dividing up the heavens among the observers, to each was left a comparatively unoccupied field. It seems probable, however, that the number would attain to, and even exceed, 2000, and hence that four persons do not see more than about half of the visible meteors. The table also shows that four persons see about three times as many as a single observer.

Observers may easily furnish materials for correcting the results in this table. The *n*th number of column B, should be to the first number of the column, as the total number of shooting stars seen in a given period by *n* observers, to the average number seen by each observer. The last two terms of this proportion being furnished by observation, the ratio of the first two is computed. The following method is suggested when two or more persons undertake to count the meteors visible. Let the observers look in different directions, so as to divide the heavens, as nearly as may be, symmetrically among them. Let the whole number of shooting stars seen be counted aloud to prevent duplication. At the same time, let each observer note how many are seen by himself. To prevent confusion this may be done by marking upon a card, the eyes meanwhile not being turned from the heavens.

ART. XXVII.—*On Molecular Physics;* by Prof. W. A. NORTON.

[Concluded from p. 78.]

Magnetic Condition of the Sun.—The intimate magnetic relations subsisting between the earth and sun enforce, even in the present general exposition of terrestrial magnetism, a brief consideration of the probable magnetic condition of the sun. We have seen that the sun's surface must be traversed by magnetic currents developed in two ways: (1.) by reason of the sun's rotation about an axis; (2.) by reason of the combined effect of its motion of rotation and its motion of translation through space (p. 76). According to the most reliable determinations the sun's progressive motion is directed toward a point whose longitude is 253° 16′, and north latitude 57° 27′; and with a velocity of $4\frac{5}{8}$ miles per second, while his velocity of rotation, at the equator, is 1·3 miles per second. Accordingly the currents developed from the second cause must originate at the parts of the sun's surface that have a heliocentric longitude of about 163°; and with a gradually decreasing intensity, on both sides of that point. The north pole of this system of currents, as developed at any moment of time, will lie in the heliocentric latitude 33°, and longitude 73°. In the course of one complete rotation of the sun (25 days), this pole will be carried around the parallel of latitude which contains that point. The resultant of the currents thus developed that will traverse any locality, at the end of one or more rotations, will therefore run parallel, or nearly so, to the equator; like the currents that originate in the simple rotation. In all this we neglect the small inclination of the sun's equator to the ecliptic (about 7°); or suppose the equator and ecliptic to coincide. It appears, therefore, that the poles of all the permanent currents should coincide with the poles of rotation.

But it is important to observe that at every moment of time there will be, coëxisting with the permanent currents, a system of new currents, originating as above mentioned; and that, therefore, there will be a *secondary magnetic equator*, crossing the ecliptic in 163° and 343° of longitude, and a *secondary magnetic pole*, in longitude 73° and north latitude 33°. Or rather the nodes and pole should be somewhat to the east of these positions; since the currents developed must decline gradually, and the rotation carry them forward. The individual parallel currents of this system must decrease in intensity, in both directions from their equator; by reason of the increasing distance from the equator of rotation of the points of tangential action of the impulses of the ether and cosmical matter, and the decreasing size of the magnetic parallels followed by the currents. It will be readily seen, in view of the fact that the sun derives its magnetism in part from its motion toward a point in the northern celestial hemisphere, that the magnetic intensity of its northern must be greater than that of its southern hemisphere.

Origin of the Sun's Spots.—The systematic observations upon the sun's spots, made by Carrington, Schwabe, Wolf, Secchi, and others, and especially the detailed discussion to which all the observations have been subjected by Prof. Wolf, have served conclusively to establish that the sun's spots have their immediate origin in some action of the planets Jupiter, Saturn, Venus, and the Earth, upon the photosphere of the sun; or in such action coöperating with some other cause. (See Astronomische Nachrichten, Nos. 839, 1043, 1091, 1137, 1150, 1160, 1173, 1181, 1185, 1223, 1234, 1270, 1289, 1294, 1355, 1526, &c.).

Prof. Wolf has determined the epochs of maxima of the sun's spots for a period comprising 100 years; and finds that the period of the spots varies from 8 to 16 years, and that its mean value is 11·15 years. He gives a formula for determining the spot-condition of the sun at different dates, in which the several terms represent the specific actions of the four planets just mentioned, dependent upon their masses, distances, and annual motions; which gives results in close correspondence with the results of the observations made between 1826 and 1848 (Astr. Nachr., No. 1181). He has more recently extended his investigations, so as to include, but with less certainty, a much longer period.

The epochs of maxima and minima, from 1750 to 1856, are given in the following table, to which we have added the corresponding mean heliocentric longitudes of Jupiter and Saturn; the two planets upon which the varying number of spots developed during a year, chiefly depend.

Epochs of Max.	Jupiter.	Saturn.	Epochs of Min.	Jupiter.	Saturn.
1750·0	4°·42	231°·6	1755·7	177°·4	301°·4
1761·5	353·4	12·2	1766·5	145·1	73·5
1770·0	251·4	116·2	1775·8	67·4	187·3
1779·5	179·7	232·4	1784·8	340·5	297·3
1788·5	92·8	342·4	1798·5	36·3	104·9
1804·0	203·3	172·0	1810·5	40·5	251·5
1816·8	231·8	328·5	1823·2	66·0	46·8
1829·5	257·2	123·9	1833·8	27·7	176·4
1837·2	130·9	218·0	1844·0	337·3	301·2
1848·6	116·9	357·5	1856·2	347·6	90·4

It will be seen that, (omitting the results answering to the first two epochs of the table, which will be separately considered,) at the epochs of maxima Jupiter was in some position intermediate between the point toward which the progressive motion of the sun is directed (long. 253°), and the diametrically opposite point (long. 73°, which is the longitude of the secondary magnetic pole); reckoning from east to west, from the first point to the second. The average position is 183°; or *in the vicinity of the descending node of the currents of the secondary magnetic equator* (p. 197). Again, omitting the epochs 1755·7 and 1766·5, at all the epochs of minima the positions of Jupiter fell in the other half of the ecliptic; and his average position was in long. 23°. This is in the vicinity of the *ascending node* of the same equator, which lies somewhat to the east of 343° (p. 197). If we consider now the case of Saturn, we find that his average position at the epochs of minima was 182°; or 183°, if we take the first two epochs into account. If we separate the positions that fall in the two halves of the ecliptic, lying on opposite sides of the line from 253° to 73°, we obtain the average positions 162°, and 333°. If we include the first two epochs the latter average becomes 348°. The average position of Saturn at the epochs of maxima, was 236°.

If we now direct our attention to the first two epochs of maxima, we shall perceive that Jupiter was in that part of the ecliptic in which his ordinary action is the least; and if we refer to the first two epochs of minima, it will be seen that he was in, or near, the part of the ecliptic in which his ordinary action is the greatest. We must conclude then that from 1750 to 1766 the normal condition of things at the two nodes was greatly changed; and that the action of Saturn conspired with that of Jupiter, to produce the anomalous results.

In view of the general results that have now been obtained, we may infer, (1.) that in general the action of a planet to produce spots is greatest in the portion of the ecliptic which contains the descending node of the secondary magnetic equator, and least in the opposite portion; (2.) that the action is approximately the same at corresponding points, on one side and the other of either node. But the indications are that a somewhat greater liability to epochs of maxima exists when the planet is on the side of the line of the magnetic nodes toward which the progressive motion of the sun is directed, than on the opposite side. This is most observable in the case of Saturn, for his average position at the epochs of maxima was 236°, while that of Jupiter was 183°.

By an examination in detail of the diverse positions of the operating planets at all the different epochs, and following their motions from one epoch to another, it may further be shown, (1.) that a planet operates more effectively before and after it has passed either magnetic node, than at the very node; (2.) that the normal positions of the two nodes are not far from 0° and 180° of longitude,—the sun's rotation having the effect to displace them about 17° toward the east (p. 197); (3.) that the principal maxima of planetary action occur at about the positions 135°, and 230°, on opposite sides of the descending node, and that under certain circumstances other positions of inferior maxima manifest themselves, lying in the vicinity and on opposite sides of the ascending node; (4.) that the principal minimum falls at about 0°, or at the ascending node, and a secondary minimum at 180° (or the descending node),—but in the normal state of things the effect of the planet appears to experience small changes in the space from 320° to 70°. These positions of maxima and minima are given, here, only as first approximations.

These results of observation, deducible for the most part from the table we have given (p. 198), and confirmed by a detailed examination of Prof. Wolf's entire series of determinations, are all decided intimations of a dependence of the sun's spots upon the varying magnetic, or electric, condition of the sun; and indicate that they are closely connected with the varying intensity of the magnetizing, or demagnetizing, action of the system of secondary magnetic currents developed by the sun's progressive motion,—in conjunction with the coöperative action of the electric waves that proceed from the region (long. 253°, and lat. 57°) upon which the impulses of the ether and cosmical matter fall normally. Of these two operative causes, the first should augment on both sides of the secondary magnetic equator, and for considerable distances. It should be much greater on the side of the descending, than on that of the ascending node of this equator, because the new magnetic currents originate on the former side. The electric currents developed at any instant upon the ascending node side of the sun, run in the opposite direction, and tend to weaken the prevailing currents. The residual excess of the latter over the former, at any point, and at any instant, constitutes the new effective magnetic current at that point and moment of time (p. 62). Each of these two sets of currents may also play a certain part in conjunction with the magnetic currents that result from them. It will be seen, then, that the results of observation which we have signalized (pp. 198, 199,) are, in general, such as should ensue if the operative causes here considered coöperate with some action of the planets to develop the spots; each tending to enhance the effect of the other.

The tendency of the second operative cause, if it conspires in this manner with the planetary action, should be to make that action apparently the greatest when the planet is about in long. 253°; and therefore the region of the spots developed by the planet (which lies near the ecliptic on the side of the sun turned toward the planet) is nearest the central point of origination of the waves in question. On the other hand, the tendency of the same general cause should be to make the effect of the planet least at the diametrically opposite point (long. 73°).

It may be seen that if the three causes here supposed to be continually in operation,—and to be coöperating more or less according to the positions of the planets with respect to the special points of maxima and minima, alluded to, at the same time that the individual planets are conspiring more or less with each other according to their relative positions,—should determine spots by their conjoint action, their effects, in respect to the connection of the epochs of maxima and minima with certain positions of the planets, and the lengths of the periods comprised between these epochs, should correspond, in the main, with the results of observation.

From the point of view we have now reached we may gain an insight into the probable nature of the process of origination of the sun's spots. Conceiving the luminous matter of the sun's photosphere to be endued with the properties we have recognized in those emanations of solar matter that enter the earth's photosphere (p. 71–76), we may regard it as inductively magnetized by the sun's magnetic currents, and disposed in the lines of magnetic polarization; and probably also distributed into separate masses, having in the various latitudes all the diverse directions of the sun's directive force. We have reason to suppose that in the upper portions of such masses the molecules, on each line of polarization, will be so widely separated as to be subject to an effective force of molecular repulsion from the sun (p. 69); and that in the state of equilibrium this is neutralized by the magnetic attraction between contiguous molecules. Now such a state of equilibrium may be disturbed, and the matter expelled to an indefinite distance in three ways: (1.) by demagnetization; (2.) by electric discharges along the lines of polarization; (3.) by both of these causes operating together. A demagnetization may result, as we have seen, from the new currents developed in the upper photosphere, by the tangential action of the ether and cosmical matter; and electric discharges may ensue in consequence of the propagation of electric waves, in every direction from the region (in long. 253°, and N. lat. 57°), that receives the impulses from the ether and cosmical matter normally. The points of greatest and least demagnetization should be such as have been already indicated (p. 200). But the photospheric matter should also be subject to the molecular repulsion of the masses of the different planets, and one effect of the impulses of this force should be to develop electric waves, or currents, proceeding from the region normally exposed to them. Such waves are of the same character, and originate essentially in the same manner as the "radial currents," that we have recognized as playing a conspicuous part in terrestrial magnetic phenomena (pp. 67 and 68). They should be most energetic, as in the case of these radial currents, at a certain moderate distance from the point directly under the planet; i. e., in low latitudes. On the other hand it is to be observed that for a certain distance from this point, the repulsive force of the planet may check the expulsion of the solar matter by its direct action.

The tendency to the formation of spots should be wanting at the permanent magnetic equator (or rotation equator) because the lines of polarization are there parallel to the surface, and the induced magnetism feeble. Again, the effect of demagnetization should be greatest in low latitudes, where the total magnetic intensity is the least; and where also the new demagnetizing currents are most energetic. To this we may add that as we have reason to believe that the temperature of the *mass* of the sun decreases toward the poles (pp. 66 and 76), the molecules of the photospheric matter may be less widely separated there, or be combined in groups, so as to be subject to a less energetic force of repulsion from the sun. It is conceivable, too, that in special localities the electric waves, or currents, originated by the planets may operate to disunite molecules in the act of combining, or condensing at the surface of the photosphere (the state of things supposed by Faye); and so bring them into the condition to be repelled and completely dispersed by the repulsive force of the sun. The process of dispersion having once begun, from any cause, may extend indefinitely downward.

There is a special mode of origination of spots, connected with the sun's motion in space, that has not yet been noticed. It is, that the cosmical matter, as it flows away from the region of normal impact toward the equator, will become demagnetized, and thus initiate the process of dispersion of certain portions of the photospheric matter. This effect will be especially produced on the opposite side of the pole from the point of normal impact, as the changes of the induced magnetism will there be the greatest. A similar effect may ensue from a flow toward the equator of the matter at the very surface of the photosphere, produced by the impulses of the cosmical matter, or ether. The phenomena are precisely similar to the auroral phenomena that light up, occasionally, the earth's photosphere (p. 76). This is undoubtedly the origin of the annual maximum of spots, after the autumnal equinox, detected by Prof. Wolf. It is the result of the effects previously noticed, augmented by that here considered. An inferior maximum manifests itself in December, which is the direct result of this cause alone. (See Astr. Nachr., Nos. 1043 and 1223). It is important to observe here that when a planet is on that side of the sun, or in the vicinity of the ascending magnetic node before alluded to, it tends to check this southerly flow of matter at the surface of the photosphere, and so prevent the development of spots from the cause in question. We may add that we have doubtless another revelation of its operation in the predominating irregular disturbances of the magnetic needle in the autumnal months (or from August to December, inclusive; see Prof. Bache's Reports). The secondary maximum of the annual inequality of spots, and magnetic disturbances, near the vernal equinox, is to be chiefly attributed to the demagnetization in the vicinity of the descending magnetic node, already considered.

The spots are more numerous in the northern than in the southern hemisphere of the sun, because the low-latitudes at which they chiefly originate lie, in the northern hemisphere, nearest the region (long. 253°, N. lat. 57°), from which the electric and material currents radiate; and because in the northern hemisphere alone is the flow of the material currents in the direction to be attended with a demagnetization. Again, the spots are confined to a narrower belt in the northern than in the southern hemisphere; because the magnetic intensity of the northern hemisphere being the greatest (p. 197) the ordinary limiting parallel of the spots,—which is the circle at which the demagnetizing action, from either of the two causes specified, together with the electric discharges along the photospheric columns, cease to be sufficient to effect the dispersion of these columns,—must lie nearest the equator in that hemisphere.

It is to be observed that spots may arise from electric discharges along the photospheric lines of polarization, although no demagnetizing action may come into operation; and it is even possible that, indirectly, an increase of magnetic intensity may, in special cases, coöperate with such currents.

Note.—Since the foregoing was written, the line of investigation here entered upon has been followed up, and new and important general results obtained. One of the principul results is: that the *density or quantity of matter of the sun's photosphere, in the region of the spots, experiences periodical augmentations*, in consequence of certain effects produced by Jupiter and Saturn while passing by the first quadrant of heliocentric longitude, and the sun's north magnetic pole; and that these augmentations of density, in connection with the subsequent diminutions, are one of the determining causes of the great variations that occur in the length of the period of the sun's spots (viz. from eight to sixteen years). Another coöperative cause consists in the diverse positions of the planets, *especially of Venus*, with respect to positions of favorable action, at the epochs of heliocentric conjunction with the earth. The other causes have been intimated.

CHEMICAL ACTION.

The general nature of the process of combination of two dissimilar molecules has already been considered (p. 250). We must now contemplate it more in detail, and take note of certain distinctions, and possible differences of result. We have seen that two dissimilar molecules have an affinity for each other when their unequal molecular forces are so related that under their mutual action the atmospheres become polarized; that is, the electric ether accumulates upon one of the two contiguous sides, and is partly expelled from the other, so that the former will be positive and the latter negative. The attraction that results from this disturbance of the electric equilibrium, constitutes, as we conceive, the proper *force of affinity*, or *chemical attraction*. It ordinarily comes into operation beyond the outer limit of the molecular attraction proper (i. e., beyond Oc., fig. 1, p. 71); and draws the particles nearer together until they come within the range of this attraction,—which then determines their complete and permanent union. The force of electrical attraction, or affinity, thus brought into play should ultimately diminish, if not pass off entirely; by reason of the electric discharge that would ensue between the particles. Heat, or the electric spark, may increase the natural force of affinity, by augmenting the natural polarization that the molecular forces may have initiated. In fact all the various circumstances upon which the union of two dissimilar molecules depends are but so many different circumstances under which the molecules become polarized by their natural mutual action more or less modified.

We have seen (p. 241) that a compound molecule, when formed, becomes invested with its own proper atmosphere; and so comes into special relations with other molecules, whether simple or compound, similar or dissimilar. The density and extent of such an atmosphere may vary widely with the degree of approximation of the elementary particles, and other particulars.

The relations of heat to chemical phenomena may be deduced from the principles already stated. The heat of combination results from the condensation of the electric ether that takes place between the uniting particles, and from the compression of their individual electric atmospheres—one or both of these effects. Both of these effects should give rise to an emission of universal ether in heat-pulses.

But, according to Favre and Silbermann, certain substances combine with an attendant absorption, instead of an evolution of heat. To understand how this may happen we must observe that according to the received ideas of the true nature of chemical processes, the molecules of all substances are composed of two or more atoms associated together, and when two substances combine, it generally happens that one, or both of the two molecules presented to each other, is decomposed, and two new compound molecules are formed by condensation. Now the decomposition that precedes the combination should occasion a loss of heat, by reason of the expansion of the electric ether condensed between the constituent molecules (or "chemical atoms"), and of the atmospheres of these molecules; and the subsequent combination, by the reverse process, should develop heat. If the loss of heat from the one cause exceeds the gain from the other, there will be an effective absorption of heat, as the result of the combination. On the other hand, when chemical combination occasions an evolution of heat it is in general because the heat absorbed, while the decomposition of individual molecules is going on, is afterwards more than restored by the heat developed in the combination that succeeds the decomposition. Thus when oxygen and hydrogen combine to form water, heat is evolved because, as we conceive, much less heat is lost in the decomposition of the binary molecule of oxygen than is produced in the union of the two separated molecules (chemical atoms) of oxygen, each with a molecule of hydrogen. In some instances, as in the formation of the hydrate of lime, the molecules would seem to combine, without any previous decomposition, and any tendency therefore to absorption of heat. In the decomposition of substances, as well as in their combination, it is found that heat may either be absorbed or evolved. This fact admits of a similar explanation to that just given. M. Schröder Van der Kolk, in a memoir on the mechanical energy of chemical action, of which an abstract is given in the January

No. of this Journal (1865), lays down the following law of decomposition: "Bodies which evolve heat in being decomposed by heat are not again formed in the subsequent cooling." According to what has just been stated all such bodies must evolve heat because of the electric condensation that attends the formation of new compound molecules, after the primitive molecules have been decomposed. Now if these new molecules be cooled, the tendency would be to increase the molecular attraction by which their constituents are held together, rather than to favor their decomposition. The instances cited, viz: protoxyd of nitrogen, peroxyd of hydrogen, chlorous and chloric acids, the chlorid, iodid, and sulphid of nitrogen, seem to sustain this explanation.

It is frequently found by experiment that if heat is absorbed in the act of decomposition, the separated components will reunite on cooling. It is probable that in such instances, there is no formation of new molecules following the first decomposition, and that the heat which may be absorbed in addition to that consumed in the act of separation, is due solely to an expansion taking place after the receding molecules have been urged beyond the limit of molecular attraction, and become subject to molecular repulsion. In that event, a subsequent cooling, by contracting the atmospheres of the molecules and so increasing their attractive force, might favor a reunion. Hydrate of lime may be cited as a case admitting of this explanation.

We have seen that heat, by expanding and augmenting the repulsive energy of molecular atmospheres, tends, virtually, to polarize a surface positively; and that in this fact we have the probable origin of thermo-electricity, (p. 61), and the explanation of the effect of heat in the development of electricity by friction (p. 250). The same polarizing action of heat should favor the oxydation of metallic surfaces. The condensing action of platinum, and certain other metals upon gases, and of surfaces generally upon aqueous vapor, with evolution of heat (see this Journal, vol. xxxviii, p. 109), may be referred to a polarization developed by the mutual action of the surface and the gas or vapor. The attraction thus resulting, we must suppose, is not in general sufficient to bring the gases within the range of the natural molecular attraction, and so into complete union with the surface.

Combination by Volume.—The assumption is now generally made that the molecules of all substances in the gaseous state occupy the same volume. This conclusion to which chemists have been conducted, implies that there are the same number of molecules in equal volumes of different substances, and therefore that the elastic tension of the individual molecules, is the same for all gases. This result corresponds with the determination of the repulsive energy of molecules at the greater distances, as given in Table I (p. 68); if we regard the coefficient, m, as constant, whatever may be the value of r. In fact the value of m, depends upon the pressure to which the molecular atmospheres are exposed (p. 241, foot note); and this, in gases, must depend mainly upon the barometric pressure, and be constant for the same pressure. It is to be observed that the results given in Table I hold good for compound molecules, provided as they are with their own especial atmospheres (p. 241), as well as for simple molecules. If r, the radius of the atmosphere of the molecule, be increased in any ratio, the value of $k\left(=\frac{m}{r^2}\right)$ will be diminished in proportion to the square of this ratio, but if we estimate the force at a given distance, this distance, as expressed in terms of r, will be diminished in the same ratio that r is increased, and hence if the force varies inversely as the square of the distance, its value at the given distance will be the same as before. The elastic force of molecules posited at the same distance from each other should therefore be the same, whatever may be the radius, r, of the molecule, simple or compound. This result depends upon the assumption that the force of molecular repulsion varies, beyond a certain limit, inversely as the square of the distance. Table I shows that for the smaller values of the ratio, $\frac{n}{m}$ (which should be taken for liquids that furnish vapors, and substances that habitually exist in the gaseous form), we have nearly reached this limit at the distance $80r$.

To this it should be added that the calculations are made upon the supposition that the ratio $\frac{n}{m}$ remains constant for each set of computations, answering to each special value of $\frac{n}{m}$. But as a matter of fact, in the transition from the liquid to the vaporous state, as we have seen (p. 75), the molecular atmospheres expand, which should diminish the value of n, and of the ratio $\frac{n}{m}$. Accordingly, to represent truly the vaporous state, it is probable that the calculations should be made for a smaller value of $\frac{n}{m}$ than any of those given at the head of the Table. If this be true the limit above referred to may be greatly reduced. This should be the case especially with the permanent gases. The distinction between the gases and vapors lies, in all probability, in the fact of a smaller value of $\frac{n}{m}$ for the former than the latter; in consequence of which compression, or reduction of temperature of the permanent gases does not increase this value to the limit 4·93 at which the liquid state becomes possible.

The received theory among chemists, of combination by volume is in entire accordance with these results derived from our theory of molecular forces, and with the conception to which we have been led, of the constitution of simple, and compound molecules (p. 239, &c.). If we suppose, with the chemists, that in general the ultimate molecule is composed of two "atoms," this is equivalent to saying, in the language of the present theory, that the ultimate molecule is a compound molecule consisting of two simple molecules united together, and provided with its own proper atmosphere.

All such binary molecules of elementary gases will occupy, as we have seen, the same space, which may be called the unit of volume. If v represent any given volume, as a cubic inch, and n the number of atoms in v, then this unit of volume will be $\frac{v}{n}$. Now if one volume of one gas be presented to one volume of another the general result is that two volumes of a compound gas are formed. This implies that each of the binary molecules is decomposed, each atom of the one combines with one of the other, and thus two new compound molecules are formed, each occupying one unit of volume. If, as in the formation of carbonic acid, one volume of one gas unites with one volume of another, and one volume of compound gas is formed, we must suppose that the two binary molecules unite, as wholes, and form one new molecule containing four atoms associated in pairs. Again, if, as in the formation of aqueous vapor, two volumes of one gas combine with one of the other, and two volumes are formed, we now have two molecules a and b combining with one, c; c must be decomposed, and one of its atoms must combine with a, and another with b. Thus each molecule of water contains two atoms of hydrogen, associated with one atom of oxygen. If, as in the production of ammonia, three volumes unite with one, and two volumes are produced, three molecules must combine with one and two new compound molecules result. This implies that the single molecule and one of the three molecules are decomposed, and that the disunited atoms combine with the other two. If the molecules of the two gases, or vapors, that combine, be ever so complex, and the same number of volumes unite as we have above supposed, with the same result as to the number of volumes produced, the processes will be essentially the same as just indicated. Each compound molecule will occupy one unit of volume, whatever number of atoms, or groups of atoms, it may contain.

The decomposition of molecules which occurs in such cases, must be attributed to the molecular polarization that precedes and accompanies the act of combination; in conjunction with, under special circumstances, the exertion of a separating force due to heat, light, or an electric current. We have seen already, in considering the process of decomposition of a molecule of water by the chemical action of zinc (p. 251), that such action upon one of the elements of a binary compound tends to separate it from the other, if the two are in conducting communication; as they would be in every true compound molecule, by reason of the electric ether condensed between them.

Chemical action of the Actinic rays.—We understand by the actinic rays, the solar rays of high refrangibility, which are capable of producing chemical effects entirely distinct from the effects of heat. From the view we have taken of the origin of rays of heat and light (p. 217, &c.), we are led to conceive of all the solar radiations as essentially of the same nature, and differing only in the rapidity of vibration, and in the intensity of the impulses propagated in the ray; and that they owe these differences to the fact that they originate in the vibrations of the atomettes of molecular atmospheres, posited at various distances from the central atoms of the molecules (p. 217). The most refrangible actinic rays should then emanate from the atomettes that lie at the greatest distances from these atoms.

The chemical action of light, and of the actinic rays in general, appears to be a consequence of the feeble repulsive individual impulses propagated in the rays that originate in the upper portions of molecular atmospheres. Such feeble impulses cannot penetrate far into the molecular atmospheres upon which they fall, and must pass around them. They should accordingly tend to urge a portion of the electric ether that may lie in their route around to the farther side of the molecule, and so to bring it into a state of positive electrization. The nature of the action that will ensue, in consequence, upon the next molecule beyond that which receives the ray, must depend upon whether there is an electric conducting connection between the two or not. If there be such connection the tendency of the action of the free electricity set in motion will be to separate or decompose the two molecules; which, in the case supposed, will be chemically united. The action here considered is essentially the same as that which occurs in the decomposition of water by zinc (p. 251). Most cases of the chemical action of light would seem to be explicable upon this idea. Thus we may explain the action of light upon an explosive mixture of chlorine and hydrogen, by the decomposition of the elementary molecules of the two gases, and the resulting formation of two molecules of hydrochloric acid. The reduction of the chlorid of silver to a subchlorid by the action of light, might result from the same general tendency to effect a decomposition of united molecules.

Heat may, in some cases, produce the same chemical result as light, or the actinic rays generally. For example, it explodes the mixture of chlorine and hydrogen. But the effect must be ascribed to the repulsive action of the heat-pulses taken up by the molecular atmospheres, at considerable depths below their surface; whereas the separating action of the actinic rays is probably due to a movement of the electric ether effected at the surface of the atmospheres. It is questionable whether the actinic rays are capable of imparting any sensible polarization to molecules. In this respect their tendency is the reverse of that of heat, viz: to impart a negative, instead of a positive polarity. For their impulses act directly upon the ether of the molecular atmospheres, but the heat impulses, as we have seen, act indirectly, producing expansion. The distinction is the same, essentially, as that taken between the two modes of action of the external impulses exerted by electric currents (p. 65); the one, analogous to light, developing magnetic currents in groups of molecules, and the other, like heat, determining a reverse polarization of molecules, compound, or simple, by an indirect expansive action.

New Haven, Jan. 15, 1866.

ART. XXVIII.—*Analyses of Rahtite, Marcylite* and *Moronolite;* by Mr. S. W. TYLER, A.B., member of the Mining School of Freiberg, Saxony, with prefatory remarks by Prof. CHARLES U. SHEPARD.

1. *Rahtite.*—This mineral was distinguished by me as a new species in March, 1861, during a survey of the Ducktown copper mines, Tennessee, where it was found in the upper, decomposed portions of the great copper-lodes, associated with melaconite and with various mixtures, of chalcopyrite, redruthite and melaconite, and also more rarely with galena and cuprite.

In structure it is quite massive, though at first inspection it seems highly crystalline; but this deceptive appearance arises from its being traversed in all directions by slender prismatic cavities imparted to it by some unknown mineral which has wholly disappeared. The walls of these cells are polished and bright. The color of the mineral is dark lead-gray with a tinge of blue, not unlike some of the ores of antimony. Its hardness and density are given below by Mr. Tyler. Thus far, it has only been found in small quantities. The name is bestowed in honor of Capt. Raht, himself a student of the Freiberg School, and now for many years the well known manager of the principal Ducktown mines.

The following are Mr. Tyler's description and analysis of the specimen submitted to him by me for examination:

"The fragments of the mineral which afforded material for the following analysis appeared to be composed of crystals, but so interwoven and indistinct that a determination of their form was impossible.

The mineral possesses a hardness of 3·5; specific gravity, 4·128 (mean of three trials which gave respectively 4·07, 4·126 and 4·188); light reddish-brown streak; metallic luster; and is of an iron-black color.

Before the blowpipe, on charcoal, it melts, with the appearance of effervescence, and coats the charcoal with oxyd of zinc. With carbonate of soda melts to a bead; which, if moistened and brought in contact with silver, blackens the latter, showing sulphur to be present. A coating of oxyd of zinc is also formed upon the coal, and metallic particles remain in the soda, of iron and copper. With microcosmic salt, in the oxydizing flame, after being strongly ignited on charcoal, it gives a bead which is green while hot, but on cooling becomes blue; and which, if treated with tin, in the reducing flame, turns of a dull red. Heated in an open glass tube it gives off sulphurous acid and turns brown. In the closed tube it remains unchanged.

The mineral was dissolved in fuming nitric acid. The sulphur which separated was collected on a dried and weighed filter, dried at 100° C., and weighed with the filter. The sulphur which had been oxydized in the process of solution to sulphuric acid was precipitated with chlorid of barium. After the excess of the latter had been removed by adding sulphuric acid, the copper was precipitated by means of sulphuretted hydrogen, and determined as sulphid of copper ($Cu^{2}S$) by Rose's method, viz: heating with a little sulphur, to redness, in a current of hydrogen gas. The iron was then precipitated, after neutralization, with acetate of soda as basic acetate of iron, ignited and weighed as oxyd of iron. Sulphid of ammonium was added to precipitate the zinc, which was determined as sulphid (ZnS) in the same manner as the copper.

·5935 grm. of the mineral gave ·0675 S; ·9505 $BaOSO^{3}$, containing ·1305 S; ·1041 $Cu^{2}S$, containing ·0831 Cu; ·0552 $Fe^{2}O^{3}$, containing ·0366 Fe; ·4238 ZnS, containing ·2840 Zn.

Per cent as follows:

	Found.	Ratio of equivalents.			Formula.		Calculated.
S	33·36	2·085	10	1			33·36
Cu	14·00	0·441	2	1	$\frac{2}{10}$Cu	S.	13·22
Fe	6·18	0·220	1		$\frac{1}{10}$Fe		5·84
Zn	47·86	1·468	7		$\frac{7}{10}$Zn		47·58
	101·40						100·00"

2. *Marcylite.*—Marcylite is described on page 405 of my Mineralogy; but from less pure specimens than those submitted to Mr. Tyler. Mine appears to have contained an intermixture of

atacamite. The following is Mr. Tyler's account of his investigations.

"The specific gravity of a small piece of the mineral which I analyzed, was 4·3. It agreed in other physical characteristics with the description given in the Mineralogy.

On charcoal, the mineral swells, effervesces and melts at last to a globule of CuO. Held in the blue flame with the platinum forceps, it tinges it a bright green color. Heated in the closed tube it gives off sulphur, sulphurous acid and water. With microcosmic salt it gives the copper reaction.

This mineral was dissolved in concentrated nitric acid. From the solution, copper was precipitated by means of sulphuretted hydrogen, and determined, by Rose's method, as Cu^2S; the iron was precipitated with ammonia, and the lime with oxalate of ammonia.

To determine the sulphur, a separate portion of the substance was treated with fuming nitric acid; the sulphur which remained undissolved was filtered off, dried and weighed as such, and that which was oxydized to sulphuric acid was precipitated from the solution with chlorid of barium and weighed as sulphate of baryta.

1·0137 grm. of the mineral gave ·8132 Cu^2S, containing ·6444 Cu; ·027 Fe^2O^3, containing ·0189 Fe; 009 CaO.

·8110 grm. gave ·6437 Cu^2S, containing ·5140 Cu; and ·0205 Fe^2O^3=·0143 Fe.

·8749 grm. gave ·0372 S and ·8268 $BaOSO^3$, containing ·1135 S.

Several trials to determine the loss by igniting gave from 15 to 20 per cent—nothing constant however. The amount of sulphur driven off, and the degree of oxydation which the copper assumes, appear to vary according to circumstances.

	In per cent.				
	No. 1.	No. 2.	No. 3.	Average.	The composition given below demands
Cu	63·57	63·37	....	63·47	63·40
Fe	1·86	1·77	....	1·82	1·82
CaO	0·88	....	....	0·88	0·88
Na	trace	....	....	trace	....
S	....	....	17·22	17·22	17·54
Cl	trace	....	....	trace	....
		supposed	O	8·00	8·00
			HO	9·00	9·00
				100·39	

The composition then would be this:

CuS	47·70	=	31·7 Cu	and	16·0 S
FeS	2·86		1·82 Fe	"	1·04 S
CuO	39·70		31·7 Cu	"	8·0 O
$CaOSO^3$	2·13		0·88 CaO	"	1·25 SO^3 or 0·5 S
HO	9·00		....		....
	101·39"				

If now we consider the iron and lime as not essential, the formula will be $CuS+CuO+HO$.

I have considered one of the atoms of copper here as combined with oxygen; and have taken the difference necessary to make 100 as water, (or, what amounts to the same thing, have taken the water at one equivalent). The direct determination of the latter is in this case a difficult matter, and I have not the opportunity now of making it. That the above is the true composition of the mineral I think the following considerations show.

1st. The fact that sulphur is given off when the mineral is heated in a matrass proves the presence of CuS, not of Cu^2S. This leaves an atom of Cu which can be combined only with oxygen.

2nd. The presence of CuO is indicated by the following reactions. The mineral tinges the blowpipe flame green: gives off sulphurous acid in the closed tube: ammonia dissolves part of it when pulverized, to a deep blue liquid, and as CuS is insoluble in ammonia this must be CuO.

3d. All pure sulphurets of the metals hitherto described are anhydrous; the presence of water, therefore, in combination, and to such an extent as here, is a strong argument for considering the mineral partially an oxyd.

4th. There are exactly two equivalents of Cu present, and just enough excess of S above one equivalent to combine with the Fe and CaO. If now we consider the extra atom of Cu as combined with oxygen, there remain about nine per cent (8·61), which we are justified in regarding as the correct amount of water contained in the mineral.

3. *Moronolite.*—A description of this species will be found in the appendix to my Mineralogy. From the analyses here given it would appear to be nearly identical with the Gelbeisenerz found at Kolosoruk near Berlin, and analyzed by Rammelsberg, and in alum slate at Kirchspiel Modum, Norway, as analyzed by Scheerer (both referred to below by Mr. Tyler). All these substances are closely akin to the Jarosite of Breithaupt from Jaroso, Spain.[1]

Mr. Tyler gives the following as the result of his examinations.

"The analysis was conducted in the usual way so far as the bases are concerned. To determine the amount of water, (which could not be found by simple heating, as sulphuric acid would

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[1] Analyzed by J. Richter with the following result:

		Oxygen,	Atoms.
Sulphuric acid,	28·8	17·25	15·1
Peroxyd of iron,	52·5	16·84	14·5
Alumina,	1·7		
Potasa,	6·7	1·14	1·
Water,	9·2	8·18	7·2

$(\dot{K}\dddot{S}+\dddot{\bar{F}}e^{5}\dddot{S}^{4})+7$ aq.

also be driven off,) I proceeded as follows. The hygroscopic water was first determined by heating the substance at 100° C., until the weight became constant, then by strong ignition in a platinum crucible over a gas-blast ("gas-gebläse"), all the chemically combined water and a great part of the sulphuric acid were driven off, and the loss of weight was noted after the operation. The residue was treated with hydrochloric acid, in one case, in the other it was melted with carbonate of soda, and the remaining sulphuric acid was precipitated from the solution with chlorid of barium, and determined in the usual manner. In another portion, the sulphuric acid, the whole amount was found. Knowing now the amount of water and sulphuric acid together, and of the latter alone, the water is determined by the difference. The results of the analyses are as follows:

	No. 1 and 2.	No. 3 and 4.	A previous analysis.	Average.	Without the hygr. HO and the Insol.
SO^3	29·29	29·08	....	29·19	34·17
Fe^2O^3	failed	41·19	40·32	40·05	46·89
Al^2O^3	·71			·71	·83
CaO	·94	....	....	·94	1·10
NaO KO	2·88	3·26	2·79	3·26[2]	3·81
HO	10·83	13·30		11·26	13·18
HO hygroscp.	1·46		1·62	1·53	....
Insol.	11·35	11·05	11·10	11·17	....
				98·11	99·98

This result agrees pretty well with the two analyses of "Gelbeisenerz" (from Bohemia and Norway) by Rammelsberg and Scheerer, given in Rammelsberg's Mineralchemie. I annex them for comparison.

	By Rammelsberg.	Oxygen.	By Scheerer.	Oxygen.		Ox. ratio of above.	Rammelsberg's ratio.
SO^3	32·11	19·26	32·43	19·47		20·50	15
Fe^2O^3	46·73	14·02	49·63	14·89	$\bar{\text{F}}\text{e}$ $\bar{\text{A}}\text{l}$	14·45	12
KO	7·88	1·34	....	....			
NaO	....	....	5·20	1·33	$\dot{\text{K}}$ $\dot{\text{N}}\text{a}$	·98	1
CaO	0·64	0·18	....	....		·31	
HO	13·56	12·05	13·11	11·64		11·71	9
	100·92		100·39				

The formula of the mineral therefore would be this, $\left(\frac{\dot{\text{K}}}{\dot{\text{N}}\text{a}}\dddot{\text{S}}+4\bar{\text{F}}\text{e}\,\dddot{\text{S}}\right)+9\text{Aq.}$; the only peculiarity being that while the above have each but one of the alkalies, they are both present in the Moronolite.

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[2] As the amount of alkali found was in all cases too small, I have taken the largest one here, instead of the average, as most correct.

ART. XXIX.—*Note on the Mechanical Equivalent of Light;* by MOSES G. FARMER, Electrical Engineer.

IN the October number of the L., E. and D. Philosophical Magazine is copied, from Poggendorff's Annalen, an article by Prof. J. Thomsen, of Copenhagen, on the mechanical equivalent of light.

His results show that about 13·1 foot-lbs. per minute represent the mechanical equivalent of a spermaceti candle, burning at the rate of 126½ grs. per hour.

On the evening of the 4th of July, 1863, there was exhibited by Mr. E. S. Ritchie, from the cupola of the State House in Boston, an electrical light, developed by the action of 250 Bunsen cells, arranged in five rows of 50 cells.

The intensity of this light was estimated by Prof. Wm. B. Rogers, by direct measurement, as equal to that of from 10,000 to 13,000 standard candles.

If we consider the electro-motive force of a Bunsen cell as equal to the evolution of one cubic centimeter of mixed oxygen and hydrogen gases per minute in a circuit of which the total resistance is equal to that of 4400 ft. of a round wire $\frac{1}{20}$th of an inch in diameter, made from electrotype copper; and if we assume also the internal resistance of such a cell to be equal to 15 ft. of such wire, (these are about the average measurements), then the maximum available electrical energy, which these 250 cells would evolve, would be

$$\frac{1}{2}\times\frac{(n\varepsilon)^2}{2\times\frac{nr}{m}}=\frac{1}{2}\times\frac{(50\times4400)^2}{2\times\frac{50\times15}{5}}=80666666$$

Since about 614 of these units of electrical energy are the equivalent of one unit of mechanical energy, we find $\frac{80666666}{614}$ $=131000$, foot-lbs. as the mechanical energy equivalent to the light developed.

Dividing this by the estimated amount of light we get $\frac{131000}{10000}$ $=13{\cdot}1$, or $\frac{131000}{13000}=10{\cdot}1$ foot-lbs. per minute as the mechanical equivalent of a candle light, a remarkably close agreement with the results of Prof. Thomsen.

Salem, Mass., Dec. 15, 1865.

ART. XXX.—*On Scheeletine at the Southampton Lead Mine, Massachusetts, and Uwarowite at Wood's Chrome Mine, Texas, Pennsylvania;* by CHARLES UPHAM SHEPARD.

1. *Scheeletine.*—This mineral was handed me for determination early in November by Mr. Clark of Northampton, who has watched with much diligence the materials thrown out during the recent working of the old Southampton lead mine. He found the few unknown crystals, of which he presented me four, occupying together a cavity in a cellular quartz gangue that appeared to have once contained galena. They prove to be Scheeletine. They are more or less coated by yellow crystals of carinthite, in small, low, double eight-sided pyramids; and one of them is also partially incrusted by a red-brown, somewhat botryoidal mineral which affords the blowpipe reaction of vanadinite, though the quantity employed in the trial did not permit a complete verification of this inference.

The scheeletine crystals are nearly half an inch long by ⅜ths of an inch in diameter, having the form of right square prisms, imperfectly terminated by acute four-sided pyramids, whose sides have an intermediary inclination betwixt the lateral edges and planes, and are therefore hemihedral. The lateral faces are not altogether plane, but present a dissected or unfinished appearance,—a quality also perceptible in the terminations. The color is pale wax-yellow, passing into gray. The inner portions are grayish-black with a shade of blue, and have a submetallic luster. Otherwise the luster is adamantine.

Before the blowpipe, it decrepitates slightly. It melts easily, yielding vapors of lead, and leaves a dark gray globule. With borax on charcoal, it affords globules of lead, is yellow while hot, but becomes gray and opaque on cooling. With salt of phosphorus the color is yellow while hot; but it becomes colorless on cooling, unless the mineral is in excess, when it is greenish-yellow while warm, and opaque and grayish after it is cold.

With nitric acid it is partly dissolved, leaving a yellow residue. Ammonia throws down protoxyd of lead from the solution. The yellow residue on being fused with four times its weight of carbonate of soda containing a little nitrate of potassa, and treated with hot water, gave a colorless solution, which, after being acidulated with hydrochloric acid and the addition of metallic zinc, gave in a short time a rich blue color, from the precipitation of the oxyd of wolframium.

It is quite possible that this mineral may have been noticed before at the mine and been mistaken for cerasite or matlockite, one or the other of which, under the old name of the muriate of lead, has been supposed to exist at this locality.

The discovery is the more interesting when coupled with that of tungsten (scheelite) which I lately made known through this Journal, as existing along with minute crystals of cassiterite in the neighboring town of Chesterfield. Wolframium is eminently a stanniferous metal in its geological associations. And now that we have it in all its known species, either in this region or in the not far distant one of Monroe and Trumbull, Conn., we may well be encouraged to persevere in efforts to find tin in workable quantity not far distant.

2. *Uwarowite.*—This mineral was received in April, 1861, from Capt. Harris, the manager of the Chrome mines at Texas, Pa., in a collection of minerals from that region; but has been left in my laboratory here unexamined until now. The crystals are scattered through a coarsely granular, pale green clinochlore, which is also intermingled with a brownish-gray vermiculite. They are not abundant, ten or twenty in number to the square inch of the gangue. In size the largest are scarcely $\frac{1}{10}$th of an inch in diameter. The color is equal to that of the emerald, and they are nearly transparent. The hardness and luster are those of garnet. Alone before the blowpipe, it is infusible; but it slowly dissolves in borax to a beautiful chrome-green globule. Patches of apple-green chlorochromite are also scattered through the aggregate.

Charleston, S. C., Jan. 1, 1866.

ART. XXXI.—*On Sodium Amalgamation;* in a letter from HENRY WURTZ to Professor B. SILLIMAN.

IN the opinion of yourself and others upon whose judgment I rely, the time has arrived for the promulgation of the discoveries made by me, now many years since, of certain new properties of the alkali-metals, rendering them of value in the amalgamation of ores of the precious metals.

You are aware that, pending the repeated investigations which I have conducted upon this important subject, I have made communications of my results, both oral and written, from time to time to many persons, yourself among the number; but that until the latter part of the year 1864, no final step was taken to place these discoveries before the public in a tangible form. On the 27th of December, 1864, a patent of the U. S. Government was granted to me for specified modes of applying the said discoveries; the specification having been at my request retained on file in the Patent Office for six months (as the new patent law permits); so that the expiration of the term of this patent did not commence until the 27th of June, 1865.

It appears, however, that my frequent communications had led to wide discussion of the remarkable phenomena involved, phenomena which I seldom hesitated to exhibit, even to the most casual acquaintances, taking only the precaution of silence as to the agent employed (the sodium); and the inevitable consequence has been the occupation of other minds with the subject, both here and abroad. In fact, since the issue of my patent, I am informed that several applications (necessarily fruitless) have been made at Washington by others for patents covering some or all of my uses of the alkali-metals; and an English patent has been procured in the name of the eminent chemist Wm. Crookes, dated Aug. 12, 1865 (about eight months subsequent to the filing of my specification at Washington): of the specification of which I have procured a copy, and find it to present a remarkable similarity to my own. Moreover, I frequently find allusions and statements relating to this subject, generally more or less imperfect and obscure, in the public prints throughout the world.

It has clearly, therefore, become incumbent upon me—if only as a matter of justice to the mining community and others interested — to furnish authentic information as to what has actually been done, and what it is proposed to do. I have, therefore, prepared an abstract of my specification, embodying in a condensed form such portions of its substance as appear of present importance to miners and metallurgists.

Other portions of the subject-matter of the specification will form a sufficiently voluminous, and I hope interesting, topic of a future communication; as, for instance, my new modes of preparing amalgams of the alkali-metals in large masses with any desired rapidity, safety and economy; and which you, with other chemical scientists who have witnessed its operation, deem important in a purely scientific view; as involving novel phenomena, and illustrating molecular laws obscurely seen at present.

With a few explanatory observations, which seem needed, I shall conclude. I have found it necessary, for practical purposes, to prepare three different grades of the sodium amalgams, differing from each other in their proportions of sodium about as the numbers 1, 2 and 3; and which I designate accordingly.

A few lines, also, regarding the term "magnetic amalgams," which not a few will deem fantastic, and as suggesting unauthorized analogies. I hope to show, however, at some other time, that in applying the term I have followed the dictates of reason, and even the direct path of the modern leaders in cosmical dynamics, the apostles of the doctrine of correlation of physical forces; and that the analogical element which I find is that between attractive and repulsive antagonistic force which exerts a *chemical*, or rather an *elementary discrimination* between bodies at *insensible* distances, and the antagonistic force of magnetic attraction and repulsion, which is so eminent an example of a similar elementary discrimination, though at *sensible* distances also. No one (to offer an illustration nearly, though not quite perfect) doubts the intimate relation between radiated and convected heat, although the one propagates itself throughout the universe of space, whilst the other is susceptible only of diffusion throughout insensible distances, from molecule to molecule.

More of this, however, hereafter. The term, from its convenience alone, will doubtless come into extensive use, as a technical term, among those who are most concerned in the utilization of the magnetic amalgams.

39 Nassau St., New York, January 15, 1866.

SPECIFICATION.

My invention consists: In imparting to quicksilver * a greatly enhanced adhesion, attraction, or affinity for other metals and for its own substance; by adding to it a minute quantity of one of the highly electro-positive metals * sodium, potassium * etc.

My invention * is applicable:

1st. In all arts and operations in which amalgamation by quicksilver can be made available to separate or extract gold, silver or other precious metals from their ores.

* *

3d. In all operations in which amalgamation by quicksilver, in conjunction with reducing metals, such as iron or zinc, can be made available in recovering metals from their soluble or insoluble saline compounds; such as silver from its sulphate, chlorid or hyposulphite; lead from its sulphate or chlorid; gold from its chlorid or other solution.

* *

8th. In the mercurization of metallic surfaces in general; for instance, in the amalgamation of the surfaces of zinc in voltaic batteries; of the surfaces of copper plates, pans, etc., used in the saving of gold from its ores; * *

9th. In the more convenient transportation of quicksilver, by the reduction thereof into solid forms.

* *

I shall now proceed to the description of those special and peculiar qualities of these amalgams of the alkali-metals which I have discovered, and which have led to my new uses of them in the chemical and metallurgic arts.

A quantity of one of the magnetic amalgams, dissolved in one hundred times its weight or more of quicksilver, communicates to the whole a greatly enhanced power of adhering to metals; and particularly to those which, like gold and silver, lie toward the negative end of the electro-chemical scale. This power of adhesion, in the case of these two metals, is so great, that the resistance which I have found their surfaces, when in the native state, usually oppose to amalgamation (a resistance which is much greater and more general than has been hitherto recognized, and which is due to causes as yet undiscovered, or at least uninvestigated) is instantly overcome; whether their particles be coarse, fine, or even impalpable. Even an artificial coating of oil or grease (which is such an enemy to amalgamation that the smoke of the miners' lamps is pronounced highly detrimental in gold and silver mines) forms no obstacle to immediate amalgamation by this magnetic quicksilver. The atoms of the quicksilver are, as it would seem, put into a polaric condition by a minute addition of one of those metals which range themselves toward the electro-positive end of the scale; so that its affinity for the more electro-negative metals is so greatly exalted that it seizes upon, and is absorbed by, their surfaces instantaneously; just as water is absorbed by a lump of sugar or other porous substance soluble in it.

Such quicksilver (unlike ordinary quicksilver) even adheres strongly to surfaces of iron, steel, platinum, aluminum and antimony; an adhesion which, however, as I have discovered, in the case of these five metals is not of the nature of a true amalgamation, there being no penetration whatever into the substance of the metal; so that the superficially adherent magnetic quicksilver may be readily wiped off clean, just as water may be from glass. The only metal I have as yet found, which cannot be enfilmed by the use of the magnetic amalgam, is magnesium.

I shall now specify the details of my various new and useful applications of the alkali-metals:

I. *Applications of the magnetic amalgams to working the ores of the precious metals.*

My improvement in methods of amalgamating gold and silver ores consists in adding from time to time to the quicksilver used in amalgamation, about one-hundredth part, or less, of its weight of one of the magnetic amalgams. The frequency with which the amalgam is to be added cannot be exactly specified, as it will be found to depend more or less on a multitude of circumstances; such, for instance, as the temperature, the purity of the water and the quantity of water used, the ratio borne by the surface of the quicksilver to its mass, the amount and mode of agitation of the quicksilver, the nature of the process and of the apparatus used, the character of the ore, the strength of the amalgam, etc., etc.; so that this important point can only be determined by experience in each case. Some general directions may, however, be derived from the experiments which have been made. It has been found that very much less sodium is requisite in those cases in which much water is employed, and that water frequently renewed; for instance, in the rifles of a sluice, and in all forms of amalgamators through which a continual current of fresh water is kept running; mercurial solutions of sodium, as I have discovered, being little affected by water which is free from acid, alkaline, or saline impurities. In those cases, however, in which little water is employed, and especially when the ore and quicksilver are ground up together into a "slum" or slime, this water soon becomes alkaline, and an oxydation of the sodium sets in, necessitating its frequent renewal. In such cases, therefore, the following manipulation is recommended: The whole amount of quicksilver to be used for working up a batch of slime, say 50 pounds, is magnetized by dissolving in it one per cent of amalgam No. 2; or better, two per cent of the soft amalgam No. 1, which dissolves more readily; half of the whole, or 25 pounds, is then thrown into the mill with the ore at first, and, as the incorporation proceeds, certain fractions of the other half are gradually added, at intervals of time varying according to circumstances, until the whole has been added. If, as is usual, the quicksilver is a portion which has been separated from the slime of a previous operation, it will usually retain some sodium, and therefore will require fresh amalgam in proportionately smaller quantity.

In sluicing operations the soft amalgam No. 1 is most suitable, on account of its ready solubility in mercury; and in these cases it is practicable to *test* the quicksilver in the rifles and ascertain when the magnetic quality requires restoration, by throwing in a few grains of gold-dust. Similar tests are easily applied to slimes, and in amalgamating methods generally, a slip of tarnished sheet copper being a very suitable agent for such testings.

It may be remarked in passing, that the amalgam No. 1 is at any time easily prepared from No. 2, by melting it in an iron ladle with about its own weight of quicksilver, or from No. 3, by melting with twice its weight; considerable time, however, being requisite, in the case of No. 3, to produce the additional combination. In copper-plate amalgamation, that is, in those cases in which auriferous materials are brought into contact with amalgamated metallic surfaces, it is better to substitute altogether for quicksilver itself (both in the first coating of the metallic surfaces, and in any subsequent additions of quicksilver made) the pasty amalgam No. 1. In these modes of amalgamation great economy in wear and tear of apparatus, as well as in first cost, is effected by using, in connection with the magnetic amalgam, plates or surfaces of *iron* instead of copper. The power of coating or enfilming iron renders the amalgams in fact peculiarly valuable in every form of arrastra, drag-mill, or other apparatus for amalgamation which has internal surfaces of iron, these surfaces becoming coated over with quicksilver, and thus immensely extending its chances of contact with those particles of gold which are so fine as to remain suspended in the water.

Other important devices arise out of this power of enfilming iron surfaces, such as the keeping of iron surfaces of stamps, and of other apparatus used in *crushing* ores continually coated with quicksilver. Quicksilver possessed of the magnetic quality may be kept dropping or trickling upon the surfaces of crushing-rollers; or in those crushers in which iron balls are used, the surfaces of these balls may be kept enfilmed. In like manner as the *adhesion* of quicksilver to other metals is exalted by the alkali-metals, so, also, as I have discovered, is its *cohesion* with itself greatly increased. It is rendered more viscid, more difficult to divide mechanically, and when thus divided runs together again instantly upon contact. Hence arise new results of incalculable value. For instance, the so-called "flouring" or granulation of the quicksilver, which in the amalgamation of ores always occasions so great losses, both of the quicksilver itself and of its amalgams with the precious metals, is reduced to a *minimum* or altogether prevented.

The recovery of floured quicksilver and amalgams from slimes and similar mixtures is also greatly facilitated and accelerated thereby. For this purpose some strongly magnetized quicksilver is thrown into the separator. Such slimes may even be operated upon with advantage by the ordinary process of *panning by hand;* a little magnetic quicksilver being thrown into each pan and stirred about at first for a few moments with the hand, which will collect together and incorporate all the scattered globules of auriferous amalgam. In fact, in all panning operations, even upon the pay-dirt of placer diggings, much labor, gold, and time may in this way be saved.

It is necessary to specify an important precaution applicable in some cases in which magnetic amalgams are used, and particularly in those cases in which the ore is ground or agitated with quicksilver in contact with metallic iron. This arises from the liability of the adhesion of some abraded particles of iron to the amalgam. The following plan is therefore recommended in these cases: The amalgam, after separation from the excess of quicksilver, and before retorting, is fused in an earthen dish or iron ladle (with addition of a little quicksilver, if necessary, to make it more fluid), and the iron, which will rise and form a scum on the surface, is skimmed off. The excess of quicksilver may then, after cooling, be again separated from the amalgam in the usual way. Any amalgam which may adhere to the iron-scum is readily detached therefrom by boiling in water to remove the sodium. This process depends on the simple fact that the adhesion to the iron totally disappears with the extraction of the last traces of sodium from the quicksilver. In fact, it is possible to remove all the iron from the amalgam by boiling directly in water, without any previous fusion; more particularly if the water be made somewhat acid or alkaline. The presence of iron in a sample of amalgam is readily detected by the magnet, which instrument may be sometimes used to advantage also in separating intermixed iron from amalgam, after all sodium has been extracted from the latter. There are still other metals which will usually be found adherent to the amalgam when sodium has been used; such as platinum and osmiridium. These, like iron, immediately detach themselves on the removal of the sodium by boiling the diluted amalgam in water. A mixture of platinum or osmiridium, or both, with iron, may of course be freed from the latter by the magnet. It will generally be found desirable, as in other cases where quicksilver is used and ores containing arsenic or sulphur operated upon, to remove as much as practicable of the arsenic or sulphur by previous roasting or other chemical treatment.

* *

III.—*Applications to the recovery of metals from their saline compounds.*

In the common operation of reducing silver to an amalgam from its native or artificial chlorid, or from its sulphate, by the action of metallic iron or zinc in conjunction with quicksilver, immense advantage arises from the use of the magnetic amalgams, especially in the reduction of the time occupied to a fraction of that heretofore required. This applies as well to ores in which the silver occurs naturally as chlorid, bromid or iodid, as to those in which the silver has been previously converted into chlorid, or sulphate, or both, by roasting with common salt or otherwise; and to chlorid which has been precipitated from solution. * * *

When gold has been obtained in solution, either from ores or from other materials, by the action of chlorine, aqua-regia, cyanid of potassium, or any other solvent, also when silver has been obtained in solution, in hyposulphites or otherwise, the most rapid and thorough mode of saving these metals will be found to be their conversion into amalgams, by precipitation with metallic iron in contact with magnetic quicksilver, more especially when the solutions are dilute. * * *

The greater rapidity and perfection of the precipitation, in these cases, are obviously due to the absolute contact at once established with the iron surfaces by the magnetic quicksilver, and the perfect and powerful voltaic circuits thus kept up constantly throughout the two metals and the solution.

* *

VIII.—*Applications to the Mercurializing of Metallic Surfaces in general.*

In all cases in which it is an object to save time and labor in the coating of surfaces of other metals with quicksilver, * * * the magnetic amalgams come into play; * * *

By virtue of the adhesion to iron and other non-amalgamable metals imparted by the magnetic amalgams, I am enabled to apply quicksilver, or fluid or pasty amalgams, to any metallic surface, with great rapidity and facility, *with a brush*, after the fashion of a paint; the material of such brush being fine wire of iron, steel, aluminum, or platinum. Of these the material most generally suitable is the finest steel wire, tempered to about a spring temper, or somewhat softer; and the most generally useful form for such brushes, is that of a *flat* varnish or white-wash brush.

Among the important uses of such brushes may be instanced: the amalgamation of copper (or iron) plates used in saving gold from ores; * * *. Another valuable use is the recovery of quicksilver which has been spilled or scattered in the form of globules; such a flat brush, saturated with magnetic quicksilver, instantly collecting, incorporating, and sucking up the scattered globules, even from the most irregular surface.

The same principle of adhesion of magnetic amalgams to a brush of steel wire, is applicable, in many obvious ways, to the separation of metals from ores, and of granulated or floured quicksilver from ores and slimes, etc.

* *

IX.—*Applications to the Transportation of Quicksilver.*

The ordinary mode of packing and transporting quicksilver in bulk, is very expensive and troublesome; and in its ordinary form its transfer from one vessel into another is accompanied by great liability to loss. It will therefore be found very convenient and useful to possess simple, cheap and practicable modes, such as those described above, of converting it into solid forms, susceptible of transportation in vessels of lighter and cheaper material than the ordinary wrought-iron bottles; such, for instance, as glass or earthen ware jars, wooden kegs, bags or bottles, or other envelops of caoutchouc or gutta-percha, etc., etc.

This plan also enables quicksilver to be packed, stored, transported and sold in convenient forms; such as bars, ingots, cylinders, blocks, cubes, spheres, or pellets, of definite sizes and weights, the convenience of which for many uses, and particularly for that of miners, is at once obvious. When the quicksilver is to be used in any of the arts above specified, it will then be already in a suitable condition, or will merely require admixture with some fluid quicksilver; and when to be used as pure quicksilver, the sodium may be removed by throwing the solid amalgam in fragments into hot water, preferably mixed with a little sulphuric or acetic acid.

The modes of packing such ingots, for preservation and transportation, are already sufficiently set forth in a preceding paragraph.

Claims.—The claims attached to this specification are twenty-three in number; and those only are here given which directly concern the miner and amalgamator.

What I claim as my inventions are:—

1st. The combination with quicksilver, when used for the extraction by amalgamation of any metal or metals from ores, slimes, and mixtures with other materials; of metallic sodium, or metallic potassium, or any other highly electro-positive metal equivalent in its action thereto; as above set forth.

2d. In those amalgamators in which amalgamated plates of copper or other metal are used; the substitution therefor of plates or surfaces of iron, coated with quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

3d. The coating of iron surfaces, between or under which ores or other materials are crushed, with quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

4th. The prevention of the granulation or flouring of quicksilver, when used in any method of amalgamating ores or other materials; by addition thereto of sodium, or other highly electro-positive metal; as above set forth.

5th. The separation of intermixed iron from double amalgams of gold and sodium, or of silver and sodium; by fusion with excess of quicksilver and skimming; as above set forth.

6th. The separation of intermixed iron, platinum, osmiridium, and other non-amalgamable metals, from amalgams containing sodium or its equivalent; by action thereupon of water or other oxydating liquid; as above set forth.

7th. The separation of intermixed iron from amalgams containing sodium or its equivalent, or from any metal or metals extracted from such amalgams; by magnets, either permanent or electro-magnetic; as above set forth.

8th. The combination with quicksilver, when used in conjunction with iron or other reducing metals, for reducing to an amalgam, silver from its chlorid or other compound, or any other metal from any saline compound or solution; of sodium, or other highly electro-positive metal; as above set forth.

* *

12th. In all cases in which metallic surfaces, such as copper plates, the zincs of voltaic batteries, etc., are to be amalgamated; the use of quicksilver combined with sodium, or other highly electro-positive metal; as above set forth.

13th. The more rapid and convenient application of quicksilver to surfaces with metallic brushes; by virtue of its previous combination with sodium, or other highly electro-positive metal; as above set forth.

14th. The use of metallic brushes, enfilmed with an amalgam of sodium or its equivalent; for incorporating together particles of quicksilver, gold, silver, or any other metal, scattered throughout ores, slimes, or any other materials; as above set forth.

15th. The more convenient transportation, handling and subdivision of quicksilver; by conversion into solid forms; in the manner herein substantially described.

* *

Editorial Note.—At the session of the National Academy of Sciences held in Washington in January last, Prof. Silliman read a paper upon the sodium amalgamation, detailing the results of a series of experiments conducted by him upon a scale of sufficient magnitude to test the value of this discovery upon gold quartz. In one experiment made on over 500 pounds of low grade ores, worth about $15 per ton, the sodium amalgam extracted practically all the gold not existing in the sulphids. This experiment was conducted in a large-sized Freiberg amalgamator and was continued through one hour, the sodium amalgam being added in four successive portions of one ounce each, dissolved in a portion of the 20 pounds of mercury employed. The loss in mercury was about one ounce in this experiment, the quantity of the sodium amalgam being 1·2 per cent of the total quantity of mercury in use.

In a second series of experiments conducted on carefully prepared samples of richer ore, worth $320 per ton, treated in a revolving barrel, the saving by ordinary mercury was from 40 to 60 per cent of the total quantity of gold present. With the aid of sodium amalgam 83·3 per cent were recovered. The results in the large way in actual practice would probably be more satisfactory than those last named. Prof. S. stated that experiments had also been set on foot in California to test this process on a large scale in the actual working of quartz mills. The results of these experiments will be noticed hereafter.

ART. XXXII.—*Caricography*; by Prof. C. DEWEY.

(Continued from vol. xxxix, p. 73, 1865.)

No. 286. *Carex Hartii*, Dew.

Spicis staminiferis 1–3, sæpe 2, interdum 1, vel raro nulla, cylindraceis gracilibus variis erectis, suprema longiore in medio vel supra vel infra fructifera, sessilibus squamas lanceolatas acutas subfuscas ferentibus; spicis pistilliferis 2–7, vulgo 4, cylindraceis oblongis sublaxifloris et infra præcipuè subremotis plerumque erectis foliaceo-bracteatis, superioribus sessilibus sæpe ad apicem staminiferis, inferioribus exserto pedunculatis interdum supra staminiferis infimis duobus longo-exserto-pedunculatis interdum recurvis, cum bracteis culmum superantibus; fructibus *tristigmaticis* ovatis inflatis vel conico-ellipticis longo-rostratis et teretibus bidentatis nervosis infra teretibus et stipitatis lævibus divergentibus et adultis prope retrorsis, squama lanceolata acuta margine albida latera fusca multum longioribus; culmi foliis longis strictis nodosis per-angustis margine scaberrimis et sæpe culmum lævem plusquam duplo præcedentibus.

Culm 15–25 inches high, erect, slender above, smooth except the highest part of the edges, with bracts and leaves surpassing the culm, and the leaves very narrow and long, often more than twice the length of the culm and very scabrous on the edges, knotted: spikes very variable; the wholly staminiferous 1–3, commonly 2, nearly half 1, very rarely 3 or none, cylindric, slender, sessile; some staminiferous have a few fruit in the middle or at the base or vertex; the terminal much the longest, and all clothed with lanceolate acute scales; pistilliferous spikes 2–7, usually 4, the highest with stamens at the summit or in the middle or both and sessile, the next higher exsert pedunculate and erect, the lowest one or two very long-exsert pedunculate sometimes recurved, and the lowest sometimes staminate at apex, all oblong-cylindric, ½ to 2½ inches long, mostly erect, rather distant, loose-flowered, especially below, bracteate and the lower with long-leafy bracts surpassing the culm and rough-edged; stigmas 3; fruit ovate-conic, inflated, long conic-rostrate, bidentate, nerved, tapering below, and stiped, diverging or nearly retrorse in maturity, much longer than the slender ovate lanceolate scale.

Wet grounds, Dundee, Yates Co., N. Y., discovered by Dr. S. Hart Wright, Ludlowville, Tompkins Co., H. B. Lord. Hastings Rood, Canada West, J. Macoun.

The *retrorse* fruit brings up *C. retrorsa*, but the difference in the spikes and culm and fruit is too great, and the achenia are very dissimilar. *C. retrorsa* has achenia long and round sub-triquetrous; the other has shorter triquetrous achenia tapering from the middle toward each end, and not roundish.

Var. *Bradleyi*, Dew.

Staminate spikes less various; pistillate spikes more loosely flowered; fruit smaller; and plant more slender.

Wet grounds, Greece, ten miles west of Rochester, Dr. S. B. Bradley. Here Dr. B. had discovered *C. mirata*, and was searching for its rediscovery, 1861. Also, at Belleville, Canada West, J. Macoun.

No. 287. *C. vaginata*, Tausch 1821.

Spicis distinctis; staminifera unica oblonga culmo stricto fulta vel "sub-anthesi rectangulè refracta;" pistilliferis sub-binis oblongis laxifloris remotis erectis linearibus exserto-pedunculatis lato-vaginatis; fructibus *tristigmaticis* triquetro-ovatis basi attenuatis brevi-rostratis bidentatis, squama oblonga sub-obtusa longioribus; culmo lævi foliato, foliis longis lato-linearibus margine supra scabris, bracteæ vagina vix foliaceum cuspidem abruptam ferente; culmo perlævi.

This plant is widely spread over Germany and Scandinavia, but it is so variable that Kunze in 1840–50 gave twelve synonyms in the nineteen authors he quotes on this species, and omitted the name given by Fries, *C. sparsiflora.* In my specimens from Europe, and one of them from the hand of Fries (in my collection), there is too great a difference for identity of species; and if so, different plants may have been confounded by some authors. The one from Fries has a pair of too close-fruited spikes, scarcely sheathed, too nearly sessile, and bracts too leaf-like. The others correspond chiefly to the above description, authorized by those of Fries, Lang, Anderson, Kunze and Steudel. In Hooker's Flora Bor.-Amer., Dr. Boott gave *C. phœostachyæ*, Smith, as synonymous with *C. vaginata*, Tausch, as does Kunze also, and credited it to Greenland, Fort Norman on Mackenzie River, and Rocky Mts. It is doubtless the European plant. Dr. Gray informed Mr. Paine, who had found a variety in this vicinity, that *C. vaginata* had been found near Montreal by the late Mr. Macrae, and later at the "Riviere du Loup by W. Boott." A recent examination of Dr. Macrae's plants by Prof. Brunel of Quebec did not detect any plant of that name. I had hoped to ascertain whether the Montreal specimens agreed with the European or with the varieties found by Mr. Paine. This differs however from the European in so many particulars that a more full account is given under the following name.

Var. *alto-caulis*, Dew.

Spica staminifera brevi cylindracea erecta vel infra "*rectangulè refracta*;" pistilliferis spicis 1–3, sæpe 1, vulgo 2, per-raro 3, cylindraceis brevibus laxifloris vel alterno-fructiferis sub-vicinis vel remotis, suprema subsessili, infima interdum subradicali exserto-pedunculata, bracteatis vaginantibus, fructibus *tristigmaticis* ovatis ovato-conicis ellipticis interdum obovatis infra teretibus substipitatis subtriquetris lævibus nervosis brevi-rostratis bidentatis, rostro recto vel refracto, squama subacuta duplo longioribus: culmo alto-cauli infra lævi inclinato longi- et arcti-foliaceo: vagina angusta cum folio.

Culm 12–30 inches high, very slender and nearly filiform above, stiff and inclined, with culm leaves about half as long, sometimes longer; staminate spike single, short-cylindric or oblong, often distant from upper pistillate, erect or with *stem bent rectangularly above* and near that pistillate, with scales oblong and obtuse, green on the back and reddish on the sides or wholly; pistillate spikes 1–3, often 1, commonly 2, very seldom 3, cylindric, short, erect, loose-flowered or alternate-fruited, near or often quite remote; lowest rarely subradical, long-pedunculate, upper sometimes nearly sessile, lower enclosed or exsertly pedunculate, bracteate with a narrow and longer foliate sheath; stigmas three; fruit ovate or ovate-conic-elliptic, sometimes obovate-triquetrous, tapering below, stiped, short-rostrate and the beak often turned one side or refracted, two-toothed, smooth, near twice longer or rarely little longer than the ovate or oblong obtuse or sub-acute scale.

Discovered in a marsh in Bergen, 20 miles west of Rochester, by Rev. J. A. Paine; the first known locality in the United States; fruit mature in June, 1865. On some of the Bergen specimens, the *refraction* of the *culm* below the staminate spike and of the *beak* of the fruit, especially of the early mature plants, is striking. Both of these curious particulars are found on many of the European specimens. The former is given in the description of Kunze and Steudel as a common fact, and in some popular remarks of Fries; and the latter is alluded to, with the other, as of no consequence, by Andersson in his Cyperaceæ Scandinaviæ; while Lang states of the former that he had examined it on the *C. vaginata* cultivated in a botanic garden, but had never found it on one of the numerous specimens he had collected or growing in their indigenous state. Of course Dr. Lang did not introduce the *refraction* of the stem into his description of this species.

The height of *C. vaginata* (5 to 12 inches by Steudel), the greater width of the leaves (foliis latis, Lang); the short cuspid-like leaf or termination of the broad sheath in Andersson, so clear on the specimens from Europe and on the figures of Kunze and Andersson, the more thick and coarse leaves and more stocky form, as well as differences in the fruit, distinguish the Bergen plant from the European.

No. 288. *C. Macounii*, Dew.

Spicis variis *ordinatis* distinctis vel *inordinatis* cylindraceis erectis bracteatis; ordinatorum staminiferis 2, inferiore breviore longo-bracteata, terminali longiore, squamas longas graciles lanceolatas infra sparsas ferentibus; et pistilliferis 4, suprema subsessili, cæteris remotis longo-pedunculatis: ordinatorum terminali staminifera longa et fructifera pistillis paucis supra vel medio vel infra interpositis, vel interdum terminali apicem pistillifera et dimidio inferiore fructifera, tunc terminali pistillifera longa et in medio vel basi pauco-staminifera; spicis pistilliferis subquinis cylindraceis erectis laxifloris, inferioribus longa exserto pedunculatis, infima apice vel medio rarò staminifera: fructibus *tristigmaticis* ovatis longo-conico-subinflatis lævibus nervosis brevi-furcatis substipitatis longo-gracili-rostratis divergentibus vel rectangule separatis, squamam ovato-lanceolatam ad basin aequantibus vel supra superantibus; bracteis foliisque margine vix scabris et culmo lævi longioribus; culmo foliis basin breviore.

Culm one to two feet high, erect, smooth; bracts and leaves long, narrow, linear-lanceolate, the lower much surpassing the culm, smooth but slightly scabrous on the edges, nodose; spikes six, cylindric, pedunculate; the pistillate 1–2½ inches long, sessile above and sheathed exsert-pedunculate below, very *variable;* as (1.) regular, staminate spikes 2, terminal, cylindric, long, the lower short with a long slender bract, both bearing long lanceolate scales very lax below, and the pistillate 4, uppermost subsessile and the others remote, long pedunculate, erect; (2.) irregular, staminate spike terminal long, with a few scattered fruit at the vertex or in the middle or below, and pistillate 5, with some stamens at the vertex of the upper, sometimes the terminal 2–3 inches long and upper half pistillate with the lower half staminate, sometimes the terminal pistilliferous long with few stamens in the middle or at the base, sometimes the lowest pistillate with some stamens at its apex and in the middle; all the pistillate loose-flowered especially below; stigmas 3; fruit ovate long-conic, inflated at base, rostrate with beak slender and bidentate, diverging or nearly rectangular below, smooth, nerved, generally longer than the narrow oblong acute and awned or ovate-lanceolate scale, or at the base of the lower spikes the fruit is sometimes scarcely longer than the scale; plant straw-yellow.

At streams in Seymour, Northumberland Co., Canada West, J. Macoun, whose name the discovery honors. Though related to *C. folliculata* L., it seems quite different, and the achenia wholly unlike; future forms may show more clearly its relations.

No. 289. *C. Canadensis*, Dew.

Spicis distinctis; staminifera unica perlongo-cylindracea erecta remota et bractea foliata e basi distante, squamas longas latas lanceolatas ferente: spicis pistilliferis 1–3, vulgo 2, sæpe 1, per-rarò 3, oblongis cylindraceis erectis subdensifloris, inferiore interdum brevi-ovata et sæpe per-longo-pedunculata; fructibus *tristigmaticis* ovato-conicis inflatis conico-rostratis bifurcatis subtriquetris nervosis glabris, squama ovata brevi-acuta vel aristata plus duplo longioribus; bracteis foliisque margine supra scabris culmum lævem superantibus.

Culm 15–24 inches high, erect, rather slender, very smooth, leafy toward the base; leaves and bracts surpass the culm; spikes distinct; terminal staminate long-cylindric, remote from its bract and more from the pistillate, erect and slender, covered with long broad lanceolate scales; pistillate spikes 1–3, commonly 2, often 1, very rarely 3, cylindric, oblong, erect, the lowest sometimes short and ovate and long exsert-pedunculate, bracteate and sheathed, sub-close-fruited; stigmas 3; fruit ovate, inflated, conic-tapering into a 3-sided beak, which is rather deep bifurcate and sub-scabrous on the edges, nerved and smooth, more than twice longer than the ovate acute or awned scale; plants yellowish.

Small ponds at Seymour, Northumberland Co., Canada West, J. Macoun. I have seen nothing like it in the specimens obtained by me. It has been referred to *C. lupulina*, but the achenia much differ, as well as the spikes and fruit.

No. 290. *C. Bella-villa*, Dew.

Spicis staminiferis 2–3, ferè 3, cylindraceis erectis vulgo approximatis sub-remotis, terminali longiore et omnibus bracteatis sessilibus longo-squamiferis; pistilliferis vulgo 2, interdum 1, cylindraceis erectis exserti-pedunculatis brevi- et lato-vaginatis per-laxifloris suprema apice staminifera; fructibus *tristigmaticis* longis gracilibus ovato-lanceolatis conicis basin inflatis nervosis lævibus per-divergentibus rectangule positis vel sub-retrorsis rostro longi-bifurcato subtriquetro longo-stipitatis, squamam longam lanceolatam dorso viridem infra subæquantibus supra prætantibus bracteis foliisque margine scabris culmum foliatum superantibus. Achenium est triquetrum infra teres supra brevi-rotundum triquetrum.

Culm about 1½ foot high, erect, strong, leafy toward the base, rough a little on the upper part; bract-leaves rise from short broad sheaths, and with the leaves surpass the culm; staminate spikes 2–3, commonly 3, cylindric, erect, near or sub-remote, the terminal often longer, all sessile and bearing long lanceolate scales, rough to the eye but soft to the touch; pistillate spikes commonly 2 and rarely 1, cylindric, exsert-pedunculate, erect, very loose-flowered, short and broad sheathed, the highest staminate at the apex and nearly sessile, the lowest sub-remote; stigmas 3: fruit long, slender, ovate-lanceolate, conic, nerved, smooth, diverging and horizontal or sometimes retrorse, stipitate, with a back deeply bifid or bifurcate, quite equalling the scale at the base and exceeding the scale at the upper part of the spike. Plant yellowish.

Near Belleville, Canada West, J. Macoun: a fine species.

No. 291. *C. verticillata*, Boott. Illust. 1858.
— *angustata* var. *verticillata*, Boott. Fl. Bor.-Am. 1850?

Spicis cylindraceis 5–6, angustis; staminifera unica terminali squamas fuscas obtusas ferente; pistilliferis, 4–5, erectis, superioribus apice staminiferis sub-densifloris, inferioribus 1–2, infra laxifloris et basin attenuatis sejuncti-floris vel *verticillatis* pedunculatis bracteatis; fructibus *distigmaticis* ovalibus parvi-orbiculatis plani-convexis brevi-apiculatis, squama obtusa vel subacuta brevioribus; culmo gracili basin foliato infra lævi.

Culm 18 inches high, slender, smooth below and leafy: bracts not sheathing, leaf-like, the tower about as long as the culm; staminate spike single, erect, scarcely bracteate, and with obtuse tawny scales; pistillate spikes several, cylindric, 1–2 inches long, rather close-flowered above, the lower remote and verticillate-flowered, scarcely pedunculate; stigmas 2; fruit oval or oblong, small, roundish, flat-convex, shorter than the oblong-acute scale below or the oblong-obtuse scale above.

Columbia River, Scouler; Oregon, Nuttall; and Kansas, Hayden.

To Dr. Boott's description of this species corresponds *C. Haydenii* Dew., in this Journal, 1854, except the two important characters of the fruit and its scale. Though the Kansas specimens are not very definite, they seem referable on the whole to this species, which only Dr. Boott had recognized.

No. 292. *C. Ræana*, Boott. Illust. No. 63, et Rich. Exp. Arc. 1851.

Spicis distinctis cylindraceis erectis; staminifera 1–2, terminali pedunculata, interdum vel raro obtusa brevi sessili subremota, squamas oblongas brevi- vel longi-acutas ferente; spicis pistilliferis sepius 2, sessilibus remotis, inferiore subinde vaginata brevi- et exserti-pedunculata, bracteatis; fructibus *tristigmaticis* oblongi-ovatis rostratis bifurcatis parvi-inflatis nervosis, squama oblonga lanceolata acuta vel cuspidata margine albi-hyalina paulo longioribus; culmo 1½ pedali gracili triquetro lævi vel subscabro foliaceo; foliis angustis involutis culmum æquantibus.

North America, Methyc Portage, Richardson, as stated by Dr. Boott. In form this species much resembles *C. oligosperma*, but Dr. B. gave to it the name of Richardson's "friend and companion Dr. Raea." It differs from *C. oligosperma*, in its longer pistillate spikes many flowered, and the lowest loose flowered, especially below, in its longer-rostrate and less inflated fruit; in its achenium. So well marked by Dr. Boott are these differences that it is likely to stand an acknowledged species. The seed or nut given by Dr. Boott differs greatly also from that of *C. oligosperma* in his Illust., No. 62. Some specimens from the base of the White Mountains, N. H., are near it at least. As the plant may be found in the northern and colder part of our country, it is desirable to extend the circulation of Dr. Boott's description.

[To be continued.]

ART. XXXIII.—*Whitney's Geology of California.*[1]

IN the last number of this Journal the publication of the second volume of the Reports of the Geological Survey of California, was announced. This is the first volume of the Geology, the preceding volume being devoted to Paleontology. We have perused it with care, and with unusual interest, but find it difficult to epitomise it within the limits of an article suitable for this Journal. The volume is a "Report of Progress and Synopsis of the Field-work, from 1860 to 1864," so far as this work related to general geology, and is a record of the facts observed, condensed to the last degree.

It is evident from its perusal that the geological structure of California is by no means so simple as that of similarly large areas east of the Rocky Mountains. It may be simple in its main outlines, but it is very complicated in its details, and it is only by a study of these details that the wider generalizations are apparent. Professor Whitney foreshadowed some of the results here given, in his preface to the first volume of the Paleontological Report, and more fully in an article in this Journal, vol. xxxviii, pp. 256, 298.

It was then announced that he considered the Coast Ranges to be made up of the Cretaceous and Tertiary, and the Sierra Nevada of newer Carboniferous, Triassic, and Jurassic formations, the auriferous rocks on the western slope and argentiferous deposits of the east, being mostly in the Triassic and Jurassic, judging from the fossils obtained and the number of localities in which they occur.

In the volume before us he gives as many of the data from which these and other conclusions have been derived. We proceed to notice some of the more interesting facts.

The subject is naturally divided into two parts, one relating to the Coast Ranges, the other to the Sierra Nevada; but in the arrangement of the subordinate parts, no systematic order has been pursued except such as is most convenient. The main

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[1] Geological Survey of California, by J. D. WHITNEY, State Geologist. Geology Volume I. Report of Progress and Synopsis of the Field-work, from 1860 to 1864. 498 pp. roy. 8vo, with numerous illustrations. Published by authority of the Legislature of California. 1865.

In the field-work of the survey Prof. Whitney was assisted during the whole period by Prof. W. H. BREWER, who had charge of the Botanical Department, but who labored also in geological exploration; during 1860 to Feb. 1861, by Mr. WILLIAM ASHBURNER, as assistant in the Geological field-work; from 1861 to 1864, by Mr. C. F. HOFFMANN as topographical assistant; 1862–1864, by Mr. W. M. GABB, as paleontologist; 1863–1864, by Mr. CLARENCE KING, as volunteer geological assistant; in 1864, by Mr. GARDINER, also volunteer assistant. The force is very small for a country so vast in extent as California, the state having an area of 188,982 square miles, equal nearly to the areas of all New England, New York, Pennsylvania and Ohio, and but little less than that of France.

features of the mountain system of the state, Professor Whitney illustrates in the following manner.

In order to bring vividly before the mind the grand simplicity of the topographical features of California, we may draw on the map of the state five equidistant, parallel lines, having a direction N. 31° W., and 55 miles apart.

Let the middle one of these be drawn at the western base of the Sierra Nevada, touching the edge of the foot-hills, as it will be found to do, with the given direction, from Visalea to Red Bluff; the first parallel line east of this, drawn at 55 miles distance, will pass through or very near the highest points of the Sierra Nevada, beginning with Mt. Shasta on the north, and touching in succession, toward the south, first Lassen's Peak, then Spanish Peak, Pilot Peak, the Downeyville Buttes, Pyramid Peak, Castle Peak, Mt. Dana, to Mt. San Bernardino and San Jacinto, touching also the high group of peaks discovered during the explorations of 1864. This line, if straight, would pass very near the culminating peaks of the Sierras for 500 miles.

The next parallel east of this, (at the same distance of 55 miles), crosses a series of depressions, occupied by lakes and deserts. The Klamath, Wright, Pyramid and Walker lakes, Death valley, Soda lake and the sink of the Mojave lie on it.

The first line to the west of the central one will be found to follow very closely the eastern base of the Coast Ranges from near Kern lake, northward for near 300 miles.

The second line west, and last parallel, represents very nearly the coast line of the Pacific, or the western base of the Coast Ranges.

These lines divide the state into four belts of nearly equal width, which preserve their main physical features over about five degrees of latitude, and for a distance of 400 miles, which embrace the most important part of the state, comprising nearly the whole of the agricultural, and by far the most of the mineral districts. These belts are designated as follows, naming them from the east to the west: the Eastern slope, the Sierra Nevada, the great Californian Valley, and the Coast ranges.

He further divides the state into the Southern, Central, and Northern Divisions, by two lines at right angles to these parallels, the first passing through Fort Tejon, near the southern end of the great Central Valley, the other through Fort Reading, near the northern end. In this article we will only notice

THE COAST RANGES.

These, as their name indicates, lie near the coast, and when seen from the sea, appear to form an almost unbroken wall rising directly from the water. They consist of a number of chains or ranges, known under separate local names; they are generally much inferior in height to the Sierra Nevada, yet the culminating points rise to perhaps 8000 ft. There are not, however, many points above 5000 ft. These chains, or ranges, although each is nearly distinct, are all connected, with the exception of the peaks which form the outlet of the great Central Valley, at the straits of Carquines and the Golden Gate. Both north and south of this, each separate chain, after being separated from its next neighbor by a valley of greater or less width, then joins some other chain lying nearly parallel, the whole system joining topographically with the Sierra Nevada at either end. In some of these valleys may be found the most fertile soil and lovely climate of this favored state, and these, with their adjoining lower hills, together with parts of the great Central Valley, contain nearly all of its agricultural lands.

Geologically, these Coast ranges are not known to contain any strata older than the Cretaceous. Certain it is that Cretaceous and Tertiary rocks make up the whole of the portion that has been examined. Both of these formations are more or less extensively metamorphosed, and almost everywhere have been greatly distorted since their deposition; and in places this disturbance is going on at the present time. Both volcanic rocks and granite occur, but neither forms a conspicuous part in the system as a whole. The volcanic, however, constitute a considerable mass near St. Helena, and the granitic in the St. Lucia. Considered geologically, it is believed that this system does not extend farther south than lat. 33°, nor north farther than lat. 41° 30′ or 42°. They lie almost entirely within a length of 550 miles; on either side of this they are feebly represented, and apparently die out at the limits mentioned.

In breadth they are remarkably uniform for over three hundred miles of the length, being about 55 miles wide; but each side of the middle they swell out to 60 miles or over.

There is no central axis, nor is there a dominant chain, to which the others are subordinate. We will therefore notice some of the details as briefly as possible, and then return to some of the generalizations deduced.

The Monte Diablo Range.—This range possesses peculiar interest, and was studied with more care than most of the others. It forms the eastern member of the series, lying south of the bay of San Francisco. It commences at the straits of Carquines, and runs in a southeasterly direction to Pass El Roble, a distance of about 220 or 230 miles. The range has no central ridge upon which are located the culminating points, but consists of a belt of irregular hills 20 to 35 miles wide, the higher points associated in groups. On the eastern side the base is well defined, sinking to the plain of the great Central Valley; but on the western side it receives several other chains which commence distinct, but which finally become merged into the main mass. The chain is traversed by several depressions, separating the higher groups of peaks, and in these depressions are the more important passes. The following table shows the subdivisions, and the heights of the higher peaks of each group, and of the intervening passes.

Groups.	Highest point.	Name and height of next Pass south.
Monte Diablo,	Mt. Diablo, 3856,	Livermore Pass, 686.
Mount Hamilton,	Mt. Hamilton, 4440,	Pacheco's " 1470.
Panoche,	Mariposa peak, 3700,	Panoche " 2500.
San Carlos,	San Carlos, 4977,	Estrella " ?
Estrella,	?	Pass El Roble, ?

Monte Diablo, the culmination of the most northern group, is about 30 miles from San Francisco, and forms a most interesting and conspicuous feature, and by far the best known landmark, in the state. Although less than 4000 ft. high, its position is such in respect to the surrounding country that it can be seen for a great distance in nearly every direction; and from its summit the view is one of uncommon extent and beauty. The snow-covered Sierra Nevada is visible for more than 300 miles along its crest, and the whole area spread out before the eye is nearly 40,000 square miles.

The mountain consists essentially of a double arch of Cretaceous strata, highly metamorphosed near the crest; this metamorphic center embraces about six or seven square miles, entirely surrounded by unaltered Cretaceous, and this in turn is encircled by the Tertiary which rests upon it.

The metamorphism of the Cretaceous can be here well studied, and the passage of the Cretaceous shales into jaspers, and of sandstones into serpentines and other forms of rock, are seen to perfection. These metamorphic rocks bear a little gold, quicksilver, copper and iron, but perhaps neither in quantities or conditions of economical importance; and we may here state that this is the case with several other of the groups. There is no unmistakably eruptive rock, but an inconsiderable portion closely resembles it in character, and may prove eruptive.

Resting conformably on the metamorphic in some places, and passing into it in others, are unaltered Cretaceous strata, rich in fossils, many of which have proved to be new species, their descriptions having already appeared in the volume on Paleontology. In the upper members of this Cretaceous, on the north side of the peak, occur the beds of coal in which are the "Monte Diablo Coal Mines." The coal beds, as stated, are two in number (possibly more); they dip to the north at a considerable angle, and yield a very good quality of bituminous coal. The produce of the mines in 1864 was 37,453 tons, and a larger quantity might be obtained. These are the only coal mines in the state of any considerable extent, in successful operation, although coal exists in several other places in similar geological position. Resting on these Cretaceous strata, apparently conformably, is an immense thickness of Tertiary, of Miocene and Pliocene beds, the latter passing gradually into the more recent formations forming the plains. If the Eocene exists here or elsewhere in the state, its presence has not yet been proved by fossils.

Lying west of this mass is a lower range of ridges known as the San Pablo hills, which are eight to twelve miles wide; they continue distinct from the main chain for over fifty miles, and then unite with the Mt. Hamilton group. Opposite San Francisco they are 1400 to 1700 ft. high, but farther north they rise to near 2000 ft. Between this and the main chain are two valleys, like basins; the drainage of one is north to the straits of Carquines; the other is drained through a break in the hills near the head of the bay, by a cañon, which will probably at some future time, furnish the available gap for the Pacific Railroad to reach the bay and coast, the low Livermore Pass being the most practical place for such a road to cross the eastern members of the chain. There is here the usual admixture of Tertiary, Cretaceous and metamorphic. In the northern part the unaltered strata form for some distance a well defined synclinal axis (see section p. 14); but farther south they are more broken and irregular. A belt of metamorphic runs nearly the whole length; and in several places eruptive rocks come through, but they do not appear to have exerted any considerable influence either on the elevation or metamorphism of the mass. West of this group lies the bay of San Francisco.

Passing south from Monte Diablo, at Mt. Livermore's Pass, low Tertiary hills, less than a thousand feet high, denuded with rounded outlines, and rather steep irregular valleys, make up the range. They are treeless, and with the exception of the early spring, when they are covered with the annual herbage, are very barren and desolate.

South of this lies the greater mass of the Mt. Hamilton group, little known except from the labors of the survey, and containing the highest point within sight of San Francisco, Mt. Hamilton, 4440 ft. Here the chain is wider and very rough, denuded into deep cañons; the whole center consists of metamorphic Cretaceous strata, which are so broken and contorted that all regularity of dip and strike are lost. Along its eastern edge lies a belt of unaltered Cretaceous, in places of most enormous thickness. At Arroyo del Puerto it is believed to be over 20,000 ft., the whole dipping to the east, and consisting of heavy beds of sandstone, with interstratified shales, and some conglomerates.

Fossils are not abundant, but are sufficiently so for a satisfactory determination of the age. Evidences of the enormous thickness of this formation, and also of that of certain members of the Tertiary, were found in other parts of the State.

Along the most of this group, the Cretaceous rocks extend to the base on the eastern side; but on the west, there are Tertiary, altered in places. The San José valley lies west of this group.|

The metamorphic center of this mass is not broken on the south, but extends along the chain to an unknown distance on the southeast, certainly beyond San Carlos, and probably much farther, or over 150 miles. No eruptive rock is known in this group.

In the next group south, the Panoche group, there are a number of peaks of eruptive rock, which are its culminating points. Pachecos peak is the most conspicuous, although not the highest, being but 2845 ft., the highest points being about a thousand feet higher. Antimony occurs in this part of the chain, but has not been turned to economical use. West of this group lies the San Juan valley.

Near the line of the next depression south, the Panoche Pass, there are remarkable evidences of the lateness of the disturbances; for Post-tertiary gravels are elevated at various angles, in some places nearly vertical, and have the great thickness of nearly two thousand feet; the deposit is rather local, and appears to have been formed in a closed valley, which has since been drained, and the gravels denuded and in places greatly disturbed.

The next group south of this, the San Carlos group, is the greatest of the chain, both as regards magnitude of mass and of altitude. Tertiary and Cretaceous rocks occur unaltered along its eastern side; the whole center is of metamorphic rock, so far as is known: the character of the western side is unknown. This group has not been extensively examined. It is very rough, barren and forbidding, and near the eastern edge of the metamorphic the New Idria quicksilver mines are located. These mines attracted at one time much attention, and have yielded a considerable quantity of the metal, but they have not as a whole proved eminently profitable. The ore is much scattered, and occurs at intervals of several miles, the two principal mines being the New Idria, and the San Carlos. An immensely large vein of pure chromic iron occurs in the vicinity.

South of this nothing is definitely known of this chain, further than that it is very rough; that it decreases in width and altitude as we approach its southern end; that it apparently receives another range of hills that crosses the Salinas valley below the San Antonio river; that the hills along its eastern margin grow more dry and barren south of the Pachecos Pass; and that in the Estrella Pass and Pass el Roble, Tertiary fossils have been found by the Pacific Railroad surveyors. This last pass is very low, and terminates the chain under a distinct name, the hills here joining the larger chain that stretches west from Fort Tejon.

We have noticed this chain more at length, because, in some respects, it is typical of the Coast Range as a whole; without any central axis, without any great intrusions of eruptive rock, it is a broad belt of elevated country, rather than a ridge. Valleys extend up in it, and closed basins occur in it, with but a narrow outlet, of which the Livermore, Suñol, and Panoche valleys are the most marked. On its western side it receives several other chains which enter it at a sharp angle from the northwest, and such ridges enter each group except the northern.

In short, the chain appears to have been elevated by forces acting along two different directions, the principal one nearly parallel with the chain, giving it its general direction; while others, acting diagonally to the first, modified its shape, and gave rise to the *groups* we have noticed, nearly every one of which is on the line at which another chain enters, and produced the peculiarities of dip and strike which are described with considerable detail in the work, but which we here necessarily omit.

While no chains of mountains pass off from the main chain on its eastern side, yet the strata show a great tendency to pass out and sink beneath the San Joaquin plain, the strike being nearly parallel with the direction of the chain, but diagonal to it, great masses passing out opposite each group, while in the center of all of the groups examined, except that of Mt. Diablo itself, the metamorphic rocks have every possible dip and strike. Although the chain may be considered a unit geographically, it is not so geologically. Aside from its union with the chain on the west, already noted, it is separated to the northwest, by the narrow strait of Carquines from ridges of the same age and general character, while on the south, it blends with other ranges; only its eastern edge seems to be well defined, where it everywhere sinks into the dry San Joaquin plain.

The great mass of the chain is Cretaceous, and the most of this is metamorphosed; the Tertiary plays but a subordinate part, and the disturbance of the strata have continued to the latest times.

Economically considered, the chain has no great sources of wealth. The soil is mostly barren; but valleys of limited extent, especially in its northern part, are very fertile and many of its lower hills afford pasturage to limited herds and flocks. No forests occur in any part of its length, but the center is covered with scattered timber or chapparal, and scattered trees occur on some of the lower hills. Coal is its most valuable mineral, and this occurs in workable conditions only at its northern portion, near Mt. Diablo. Quicksilver occurs in many localities, from

Mt. Diablo to San Carlos, and considerable quantities have been mined at and near the latter locality; all the others seem unpromising. Copper occurs in very numerous localities, and has been the subject of several mining "excitements," but thus far no well defined vein has been found, nor has a single deposit been profitably worked. Chromic iron occurs also in several localities; one vein near New Idria is of great size, but it has thus far been turned to no account. Antimony occurs near Pachecos peak, but is not worked. Silver has been reported several times, and some mining excitements have been raised, but the labors of the prospectors have not been rewarded. Gold occurs at very numerous localities, but at all in too small quantities to be profitably worked. Hydraulic cement occurs in the Cretaceous shales, and near Martiñez may yet be turned to account; but thus far it is not worked. Asphaltum and oil occur near the two extremities of the chain, but thus far they do not bid fair to be profitable.

North of the bay of San Francisco, we have a continuation of the Cretaceous, also mostly metamorphosed, being a system of ridges and hills, occupying the region between the ocean and the Sacramento valley, and mostly without the wide valleys so common south. Russian River, and Napa valleys are similar to those, but narrower. The metamorphic Cretaceous bears the same mineralogical and lithological features, and quicksilver occurs in many localities, in some of which it has been worked, but thus far with questionable profit. It occurs generally as the sulphuret, but considerable quantities of the native metal are found in certain localities in Lake county.

There is a smaller proportion of unaltered rock than in the ranges south of the bay, and a larger of volcanic material. Near the sea, along the western members of the group, Miocene Tertiary rests unconformably on the highly disturbed and altered Cretaceous, but the extent of the formation is rather limited. Gold has been found in numerous localities, but never in sufficient abundance to be of importance. Numerous warm springs occur, some of which are celebrated for their medicinal qualities, and the so-called Geysers are widely known as objects of scenic interest. A small lake near Clear Lake, is yielding borax in considerable quantities to commerce. Some of the valleys are among the most fertile and beautiful of the state.

Between the bay of San Francisco and San José valleys on the east and the Pacific on the west, and extending from the Golden Gate to the bay of Monterey, are a series of ridges known under a variety of local names, the principal of which are the Peninsula of San Francisco, the San Bruno hills, and the Santa Cruz mountains. This series is about 75 miles in length, and has a maximum width of about 25 miles. They begin quite narrow and low on the northwest, and increase in height and breadth to near New Almaden, where they attain their greatest breadth, and above Mt. Bache, 3780 ft., is the culminating point, then decrease to the southward. These ridges rise directly from the sea, without intervening plains along the coast.

In this series, the Cretaceous strata, so far as seen, are mostly altered and very much broken and contorted, and Tertiary rocks, mostly of the later groups, are largely developed. The formations which compose these ridges on the north are but a continuation of those found in Marin Co., on the opposite side of the Golden Gate and on the south, and they throw out spurs, one of which apparently crosses the San José valley by a series of hills of highly metamorphic rock a few miles below San José, and again by ridges near the southern part, which cross the Pajaro river, and connect with the Gavillan range, which series are in turn absorbed by the Monte Diablo range farther east.

Beginning at the north, the most of the rock in and about San Francisco is of highly altered Cretaceous, so broken and contorted that no prevailing dip or strike can be observed. These constitute the rocky hills in the city, and about it, and also the most of the rocky islands in the bay. The rocks have precisely the lithological character of the rocks of similar age in the Mt. Diablo group, and a few fossils have been found to fix the age beyond cavil.

In places, beds of Pliocene rest unconformably on them. As we proceed northward, the Miocene comes in, and throughout the rest of the range plays a more conspicuous part.

By far the most interesting feature of this group, is the great abundance of cinnabar at and near the New Almaden mines. So much has been written about these mines, that an extended description here is unnecessary, except to say that the labors of the survey appear to have demonstrated that they lie wholly in metamorphic Cretaceous rocks.

Cinnabar occurs in limited quantities in many localities in these beds, from the city of San Francisco to near the Pajaro river, always associated with rock of such peculiar character that it is readily recognized by the explorer familiar with the coast ranges, and precisely similar to that in which the same ore occurs at New Idria, San Carlos and other mines, Monte Diablo, San Pablo hills, and the very numerous localities in Lake and Napa counties, the most of which are certainly in the Cretaceous.

The greatest deposits of ore, so far as is known, are at New Almaden, where these well known mines have a capacity of production at present of about 5,000 flasks per month, or four and a half millions of pounds per year.

The Enriquita mine is now merged in the New Almaden, or is worked by the same company. The Guadaloupe mine has furnished considerable of the metal, but vastly less than the New Almaden. These three mines lie on a ridge—the culminating points of which are about 1,600 to 1,700 feet high,—lying east of the main mass of mountains. Traversing this ridge are a series of limestones, which may be traced much farther in each direction. Serpentine in large quantities, and bitumen in small quantities, are associated with the cinnabar in all of its localities. Prospecting has been largely prosecuted in both directions without important results.

A mass of Tertiary is folded between this ridge containing the mines, and the main mountain range west. This is seen in limited quantities back of Mine peak, and it occurs again much more largely to the northwest. Whether the larger masses of Tertiary, lying in front of the main chain both to the northwest and southeast, are continuous along a belt behind the Mine ridge, is not demonstrated; the strata are so broken, that much more labor is needed before the details of structure can be known.

The mountains back of the Mine ridge of New Almaden are peculiarly rough and forbidding; many points rise to above 3,000 ft., and the region is denuded into deep and precipitous ravines. The slopes are covered in some places with scattered timber, in others with a dense growth of chapparal or chamisal, making exploration laborious.

On the western side altered limestone again occurs, but its extent is not known. Quarries in this rock near Santa Cruz supply the most of the lime used in the San Francisco market.

Between the summits and Santa Cruz on the south, large masses of Tertiary occur, slightly disturbed near the bay, but much broken farther back. Five terraces near the coast indicate changes of level at no very remote period geologically.

Granite occurs, in comparatively limited masses, at various places in this chain, as well as in its continuation north of the Golden Gate, in Marin Co., and of the same character, generally highly decomposable. Its precise relation to the other rocks has not been studied. Near the southern end of the large mass, and a few miles north of Santa Cruz, gold has been found in sufficient quantities to pay at times for working on a limited scale. One mass of gold-bearing quartz was worked with a profit for a very short time, but it soon ceased to pay. Elsewhere in this range gold has been found in small quantities, generally on the metamorphic portion, and we have heard it repeatedly stated that it may be detected in certain of the sands in the city of San Francisco itself.

Unsuccessful exploration for coal in workable quantities has been carried on at various times, and at various points, and more recent explorations for oil have thus far also been unsuccessful.

With regard to the entire region south of the bay of Monterey, and belonging to the coast ranges, less can be said, because less is known, either geographically or geologically. A mere reconnoissance has been made of a part of it, while of large areas we are wholly in the dark, as neither the explorations of the Geological Survey, nor of other exploring expeditions have there penetrated. We will notice, however, some of the more salient features.

Santa Lucia chain.—Beginning at Point Pinos, at the southern entrance of the bay of Monterey, commences another chain that follows the coast closely, for about a hundred miles, to Estero Bay, along a curve, which continued carries the chain from the coast at this point more to the eastward, until it connects with other chains which extend on in an unbroken series until they join the Sierra Nevada near Fort Tejon, 140 miles beyond. The main portion of this chain takes the name of *Santa Lucia*, but portions of the range, and spurs that branch from it, take local names.

The chain attains a width of 20 to 25 miles for a considerable distance, and in places is even wider. Its western base, for a hundred miles, sinks directly into the ocean and is peculiarly inaccessible, and both its geography and geology are entirely unknown, except the general features of the coast line. On the eastern side, for 120 miles, stretches the valley of the Salinas, separating it from the Monte Diablo range. Granite commences at Point Pinos, and occurs at intervals along the northern twenty or thirty miles, and is known to form large masses in the interior of the chain. For this portion, the rocks consist of this granite, metamorphic Tertiary, and unaltered Miocene and Pliocene strata, and in places limited eruptive rock. No Cretaceous beds have been found to exist here, but they are believed to occur farther within the chain.

The Carmelo valley cuts the chain from the northwest, and on its west side is a high range of hills known as the Polo Scrito hills, made up of metamorphic rock, including gneiss, dipping northeast, and containing some granite.

The highest part of the chain lies near lat. 36° N., where the mountains attain a height supposed to be 5,000 ft., or more, and over this region the country is especially difficult of access. The scarcity of water on the ridges, the density of the chapparal, the precipitous nature of the slopes, the absence of all roads and trails, and the ferocity of the wild beasts, have thus far deterred explorers. For nearly a hundred miles, along its western base, Tertiary rocks occur, often of great thickness, generally dipping away from the main chain, but often greatly twisted and contorted. These strata, so far as is known, are Miocene and Pliocene; but in the metamorphic, toward the center of the chain, Cretaceous strata are believed to occur. Portions of the Tertiary are highly bituminous, and asphaltum is often met with.

Gold occurs in small quantities, especially on the San Antonio river, and there have long been traditions of silver mines in the interior.

A range of Tertiary hills, known as the San Antonio hills, branches from the main chain, and crosses the Salinas valley about 75 or 80 miles from its mouth. Above this, are great deposits of modern gravels, lying horizontally, and in places most beautifully terraced.

From north of San Luis Obispo, we have a section of the rocks given (p. 144) which differs most remarkably from the supposed structure of the chain, as described by previous authorities. Instead of an anticlinal axis, having an eruptive center, with regularly arranged strata on the two sides, we have a fan-like structure, suggesting a synclinal axis; but the position on the north side of the chain is not given. With respect to the region east of this point we have no data.

South of San Luis Obispo, there is a lower range of hills, having also the fan-structure, shown on the same section; while between these chains are more or less isolated hills of serpentine and other kinds of metamorphic rock.

Between San Luis Obispo and Los Angelos, there is a succession of ridges having a more nearly east and west direction, separated by comparatively narrow valleys. Between the Santa Lucia and Santa Iñez chains, we have about two principal chains, of which we know little as to the details of their structure. So far as is known, they are composed almost entirely of Miocene and Pliocene strata, in places of immense thickness. There is much metamorphic rock, but little if any eruptive. It is believed that Cretaceous strata occur on the north of the Santa Iñez chain, but of this we have no proof. The strata are everywhere much broken and disturbed, and the details of structure very much complicated. In the valleys there are occasional stratified deposits of more modern age resting on the upturned Tertiary. The member of the Tertiary known as the "Bituminous slates" is largely represented, and asphaltum and its kindred bituminous substances are of frequent occurrence.

The Santa Iñez chain.—The Santa Iñez chain begins at Point Conception, and stretches nearly east, joining in that direction the other chains that pass south of Fort Tejon, toward San Bernardino. Only the western part has been examined. Here it stretches in an almost unbroken ridge, the Gaviote pass being the only gap for many miles. The chain attains a height of near 4,000 feet east of Santa Barbara, but decreases in height toward the west to about 2,500 feet at Gaviote pass. So far as is known, the western end of the chain is composed entirely of

Tertiary sandstones, of the Miocene age, scarcely altered. The structure of the chain is somewhat remarkable.

At the Gaviote pass, the strata all dip to the south, presenting their broken edges to the north in a very conspicuous manner as we enter the pass from this direction. Twenty miles farther east, back of Santa Barbara, they still dip north, but at a higher angle, the broken edges of the uplifted beds forming a very ragged and most picturesque outline against the sky, the southern slope being very steep. A short distance farther east there is an anticlinal axis, of which the crown or northern portions are much removed, while at the most eastern part the strata have all a northern dip, and the chain a broader summit. It is in fact as if an anticlinal axis crossed the chain at an oblique angle; at the western end the northern side of the arch being wanting, and at the eastern end, the southern being removed, or inconspicuous.

At and near Santa Barbara, the crest of the chain consists of the thick sandstones; resting on these are the bituminous shales which become much broken and contorted in the Fort hills and near the sea. Both of these formations are remarkably non-fossiliferous; but few species were found. Resting on the worn and contorted edges of the bituminous shales, are more modern Pliocene and Post-pliocene deposits, nearly horizontal, and in places very fossiliferous. For sections of these strata, the reader is referred to the illustrations in the volume.

The bituminous shales yield much bituminous material. Asphaltum and oil occur in great quantities and at many localities, sometimes seen oozing directly from the shales, at others, filling cavities in or saturating the looser superficial deposits. Quicksilver has been reported since the date of these explorations in the mountains to the northeast of Santa Barbara, in rocks of Tertiary age.

Between the Santa Iñez and Santa Monica chains are a series of minor ridges, very much broken in their character, composed of Tertiary rocks, so far as is known, very complicated in their details of structure, of which we have only very limited information. The Santa Susanna range is the most considerable, rising on the north of the San Fernando valley, to the height of 3,000 feet. It is composed of beds of sandstone of immense thickness, very non-fossiliferous, which are overlaid by the bituminous shales that extend north into the valley of the Santa Clara river, all dipping to the north. There are evidences of an immense fault, and the San Fernando valley occupies the line of the break. The broken edges of the thick sandstone strata, presenting a rocky and precipitous front to the south and rising like a gigantic wall from the plain, are conspicuous and grand objects in the scenery of the region. The fault must be great, for the hills rise to at least 3,000 ft., the upper members being of the same series that sink beneath the plain on the south side, from the northern flanks of the Santa Monica.

The chain known as the Santa Monica is of less extent, its western end terminating in a bold headland on the Pacific. The length of the chain is about 36 miles, and it is about six miles wide toward its eastern end; but at its western it becomes mingled with the mountains that close around the western end of the San Fernando valley. The chain is especially interesting from its having a well-defined anticlinal axis, with a mass of granite forming the center, the strata dipping away from its center on either side. In places they are altered quite extensively, especially near the contact with the granite. The strata consists of both the sandstones and the bituminous slates of the Miocene age.

Of the chains south of this we have less information. The San Gabriel range is high and very rough, and rises abruptly from the San Gabriel plain to a height of over 6000 ft., a most picturesque object in the landscape. It is but little known geographically and geologically. It appears to be made up mostly of granitic and metamorphic rocks, and to have been elevated since the Cretaceous period, and hence to belong to the Coast Ranges, although it connects with the San Bernardino chain, which belongs to the series, as do the other chains of the Coast Ranges with the Sierra Nevada near Fort Tejon. Strata supposed to be of Tertiary age, of great thickness, lie along the southern flanks, which have been greatly disturbed and are traversed by numerous dikes of granite. The whole of this side of the chain shows most extensive disturbances and powerful metamorphic action to have taken place since the deposition of the Miocene.

The region south of this is also little known. The ranges known as the Santa Anna chain and the Temescal range were visited. The latter has attained some celebrity from the existence of tin ore in it, forming the so-called Temescal Tin Mines, which were the scene of considerable excitement five years ago. Enough tin ore has been found here to justify some hopes of its occurring in paying quantities; but thus far explorations have not been rewarded by any deposits of workable value. The geological age of the rocks in which it occurs has not been satisfactorily determined.

The islands that lie off the lower coast, at least the more northern of them, appear to be of the same age as the Coast Ranges, and to belong to the same periods of elevation.

The only other portion of the Coast Ranges that is treated of at any length in the volume before us is that lying to the south of the Tulare valley and closing around the head of it, uniting with the Diablo and other Coast Ranges on the west, and with the Sierra Nevada on the east, forming a perfect topographical connection. This is of special interest on two accounts: first, the geographical union of these chains of unlike geological ages; and secondly, because here Eocene strata have formerly been supposed to occur. This belief arose from fossils supposed to be Eocene found in a boulder near the Cañada de las Uvas, by one of the parties of the Pacific R. R. Exploration. The localities whence this boulder must have been derived was examined and found to be most unmistakably Cretaceous, a large number of characteristic fossils being found. At San Emidio Cañon these Cretaceous strata are of inconsiderable thickness compared with the enormous thickness of Tertiary that rests conformably upon them.

Some of this Tertiary would appear from position to be Eocene, but no unmistakable Eocene fossil has yet been found in the state. Certain fossils found near New Idria are of uncertain age, and Mr. Gabb inclines to the belief that they may be Eocene. Antimony occurs in at least one place, and there has been much useless prospecting for silver.

In the mountains to the south there has been "copper excitements," but thus far with no valuable results; and gold has been washed to some extent, and we believe it still is worked. The first gold extracted in California was found as early as 1841, in the region between this range and San Fernando valley.

We have thus glanced rapidly at some of the more interesting features of the Coast Ranges; we will now briefly review some of the generalizations.

We find in these chains every variety of structure. In the Santa Monica a well defined anticlinal axis; in the San Luis Obispo hills, in the San Pablo hills, and in other places, synclinal axes; in the Santa Susanna range a great fault, the broken edges of the strata forming one flank, the plane of the strata the other; in Mt. Diablo a double arch; in other groups of the Diablo chain a crumpled mass of strata. We see that the chains have been elevated by forces acting in directions transverse to each other; that these have not only determined the direction of the chains as a whole, but have modified the structure of each. These complications of structure, aided by most extensive denudations, have resulted in the peculiar topography of the region. It appears that the forces acting along the northwesterly and southeasterly directions have been the strongest, and hence have determined the directions of the larger chains, as well as the general direction of the coast.

Changes of level have taken place down to very modern times, and have even accompanied the earthquakes of recent years. Hot springs are numerous and occur along nearly the whole length of the chain and in many of the ranges.

In regard to the metallic and mineral wealth, we may review what has been already stated.

Quicksilver is the most valuable metallic product. Its place of greatest abundance is at New Almaden; but it occurs in numerous other places in metamorphic Cretaceous, but generally in quantities or under conditions which have forbid its profitable extraction. Gold occurs in very numerous localities, but has not repaid working except in a few rare instances and on a small scale. Silver has been reported at various times, but no mines of value have yet been found. Copper occurs in very numerous localities, but thus far no vein containing workable quantities of ore is known. Iron, tin, antimony, and manganese ores have been found in limited quantities, but not in conditions of commercial importance. Chromic iron occurs in large quantities, but also valueless. Coal occurs in workable beds at Monte Diablo, and in less quantities and under less favorable conditions at other places. Asphaltum occurs in immense quantities, and oil has been obtained, and extensive explorations have been made for the latter with reference to wells of commercial importance, but thus far unsuccessfully. Borax is extracted with success at one place, and sulphur occurs in some places which may hereafter prove of value.

The mountain ranges and their valleys are without forests except on the immediate coast, but the most of the hills have scattered trees. The higher ridges are very barren and dry, the lower hills yield pasturage, and the valleys are often very fertile, some of them possessing the finest climate as well as the most fertile soil of the State.

We will consider the Sierra Nevada in a future article.

W. H. B.

ART. XXXIV.—*Contributions from the Sheffield Laboratory of Yale College.* No. X.—*Mineralogical Notices;* by GEO. J. BRUSH.

1. *On Cookeite, a new mineral species.*

ASSOCIATED with the tourmaline and lepidolite of Hebron and Paris, Maine, there occurs a pearly micaceous mineral somewhat resembling *nacrite.* In searching for amblygonite on the Hebron specimens of lepidolite, Professor Cooke of Cambridge, some three or four years since, discovered that this substance had very remarkable pyrognostic characters. Before the blowpipe it exfoliates like vermiculite or foliated pyrophyllite, at the same time imparting an intense lithia-red color to the flame. Professor Cooke called my attention to this mineral at the time of his observation of its properties, but it was not until I visited the locality in 1863, that I obtained the mineral in sufficient quantity and purity to make further investigations in regard to it.

It is found coating crystals of rubellite, and appears to be a product of the alteration of this variety of tourmaline; in many instances cavities in the rubellite are filled with the nacreous substance. It is also intimately associated with lepidolite, sometimes in extremely minute scales, and not unfrequently in hemispherical aggregations; more rarely it is found in distinct six-sided prisms, which are bent into a vermicular form like some varieties of chlorite. In most cases it occurs so mixed with the tourmaline and lepidolite as to preclude the possibility of its being selected free from these minerals.

Its characters are as follows. Color white, in some cases yellowish-green, in thin scales transparent. Luster pearly, eminently so on the cleavage plane. Structure micaceous. Hardness 2·5. Specific gravity 2·70. In the closed tube, gives off much water, and, on treatment with the blowpipe flame, swells up and exfoliates in a remarkable manner, sometimes bursting the tube. The water which is first given off is neutral, in some cases where the mineral has been weathered it is even feebly alkaline; at a higher heat, however, it affords a small amount of fluorid of silicon, and this on contact with the water deposits a faint ring of silica and gives the water an acid reaction. The tube is also slightly dimmed or etched from the action of the fluorine. Before the blowpipe in the forceps, the mineral exfoliates like vermiculite and colors the flame beautifully carmine-red; it fuses on the thin edges, and with cobalt solution gives a blue color. With salt of phosphorus, gives a skeleton of silica. It is partially, if not completely, decomposed by sulphuric acid.

The limited amount of pure mineral at my command prevented as thorough a chemical examination of it as could be desired; but from a qualitative analysis it proves to be a hydrated silicate of alumina, lithia and potash, with only minute traces of soda. The alumina has some anomalous properties, and at first suggested the presence of some other substance which had escaped identification. When thrown down by ammonia, it seems somewhat less bulky and floculent in its character, and is much more easily washed than is usual with alumina; it, however, reacts blue when treated with nitrate of cobalt, and with the small quantity under examination I have been unable to identify the presence of any other element. It was completely soluble in potash and was insoluble in carbonate of ammonia, and did not react for either fluorine, boracic or phosphoric acids. Its sulphate, when treated with sulphate of potash, yielded octahedral crystals of alum.

The quantitative examination has been made by Mr. Peter Collier, assistant in this laboratory. For analysis, the mineral was ignited, then fused with carbonate of soda to determine the bases, and with carbonate of lime and chlorid of ammonium to determine the alkalies. The lithia was in one instance determined directly, and in the second case by difference, the potash being weighed as platin-chlorid of potassium, and the amount deducted from the total chlorids. The water was determined by igniting the mineral with perfectly dry oxyd of lead, and the difference, between this loss and the total loss on igniting the mineral alone was considered to be fluorid of silicon. Analyses:

	1.	2.	3.	4.	5.	6.	Mean.
Hygroscopic moisture, expelled at 100° C.	·40	·39	·36	....	....	....	·38
Water, - - -	13·89	13·87	13·89	....	....	....	13·41
Fluorid of silicon, -	....	....	....	....	.. .	0·47	0·47
Silica, - - -	35·04	34·05	35·71	....	....	....	34·93
Alumina, with a little iron, - -	45·11	45·28	44·35	....	....	....	44·91
Potash, - - -	....	....	....	2·57	....	....	2·57
Lithia, - - -	....	....	....	2·84	2·81	....	2·82
							99·49

The oxygen ratio of the $\dot{\mathrm{R}}$, $\cancel{\mathrm{R}}$, $\ddot{\mathrm{S}}\mathrm{i}$ and $\dot{\mathrm{H}}$ is 1·93 : 20·97 : 18·51 : 11·91, or approximatively 1 : 10 : 9 : 6, indicating a composition between that of euphyllite and that of margarite. The composition here given is as accurate as was possible to obtain with the small amount of the substance operated upon. The physical and the pyrognostic characters alone are enough to prove the mineral to be a new species, and as such I take pleasure in giving it the name *Cookeite*, after Professor Josiah P. Cooke, Jr., who I believe was the first to discover its remarkable pyrognostic characters.

2. *Jefferisite, a new mineral species.*

In the Ninth Supplement to Dana's Mineralogy, I described a chloritic mineral, which I referred with a query to *vermiculite.*[1] It is the well known brownish chlorite-like mineral from the serpentine quarry near Westchester, Penn., and like the preceding mineral exfoliates in a very characteristic manner when heated. I have recently learned, through Professor Dana, that Des Cloizeaux has determined vermiculite to be uniaxial in its optical characters, and consequently hexagonal in crystallization; and as the Westchester mineral is optically bi-axial, as stated in my first description of the mineral, it must form a distinct species. I propose for it the name *Jefferisite*, after the well known collector, Wm. W. Jefferis, Esq., of Westchester, the original discoverer of the mineral.

I have recently received from Mr. Raphael Pumpelly a similar mineral from Japan, possessing the same property of exfoliating when heated. Mr. Pumpelly informs me that it is found in the mountains of the Peninsula of Kadzusa, southeast of Yedo, and that it is used as an object of amusement by throwing it on coals. The specimens he has sent are small six-sided prisms, two or three lines in diameter. They have a brownish color and are very similar in physical and pyrognostic characters to Jefferisite.

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[1] For the physical characters and chemical composition, see this Journal [2], vol. xxxi, p. 369.

ART. XXXV.—*Note on the Distribution of North American Birds;* by A. E. VERRILL.

ON page 87 of this Journal, Prof. Baird has referred to some observations made by me, in a paper published in the Proceedings of the Essex Institute, vol. iii, page 136, in regard to the division of the Eastern Ornithological Province into Canadian and Alleghanian Faunæ.

Since the publication of those observations they have been confirmed by many additional facts, and the boundaries have been more exactly defined, though not materially changed. In endeavoring to ascertain the *physical* causes which thus influence the distribution of birds in latitude, I have found that the essential limiting cause is the average temperature of the breeding season, which for the majority of our birds may be taken as April, May and June. A line drawn upon the map of eastern North America representing the mean temperature of 50° F., during these three months, will coincide with the southern boundary of the Canadian Fauna, as previously determined from the examination of the birds breeding in that subdivision. Another line representing the temperature of 65° will represent the southern boundary of the Alleghanian Fauna as distinguished from the Louisianian or Gulf State Fauna, which has also been admitted by Prof. Baird and others, from the characteristic birds of the two regions. This line commences on the Atlantic coast near Portsmouth, Va., thence passes up the valley of the James River to near Gordonsville, but on approaching the mountainous region it turns southward through North Carolina and Western Georgia, and, passing along the southern flanks of the Appalachian mountain system, turns to the north again, passing through Tennessee and Kentucky, and up the valley of the Mississippi, probably beyond Cairo, and along the lower part of the Ohio valley. Cincinnati seems to be just north of the line, its temperature varying in different years between 64° and 65°. Beyond the Mississippi valley I have not had data sufficient to determine either of these lines, but that of 50° seems to cross it in the vicinity of St. Paul, Minn. The Gulf State region may be considered, also, as bounded on the south by the line of 80°, which would leave the southern part of Florida as a peculiar subdivision, as suggested by Prof. Baird.

Whether corresponding facts exist in the Middle and Western Provinces can only be determined by future observations, both ornithological and meteorological, but analogous facts would lead us to suppose that the same law will hold in all temperate regions at least, although it may be less apparent. Thus it has been observed both in Europe and America that the temperature of the flowering and fruiting season mainly controls the distribution of plants in latitude. The line of 65°, average temperature during June, July, August and September, indicating the northern limit of the grape culture, at the same time is nearly coincident with the northern range of various other plants. And in this country the same line agrees very nearly with that of 50° determined for April, May and June. It is, therefore, evident that the distribution of the birds may be very similar in some respects to plants, and consequently to insects and other animals dependent upon them for food, even though not depending upon precisely the same season.

The discovery long since made by Prof. Dana that the Crustacea are influenced in their distribution in latitude mainly by the temperature of the winter months is evidently connected with the same law.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the influence of the electro-negative elements upon the spectra of the metals.*—DIACON has published an interesting paper upon the influence of chlorine, bromine, iodine and fluorine upon the spectra of various elements and has confirmed and extended the results of Mitscherlich. The memoir is preceded by a good historical introduction, and is illustrated by four excellent figures of spectra. The author sums up his results as follows:

The chlorids of certain metals which are very rapidly decomposed in the gas-flame are at least partially volatilized in a chloridizing flame and are therefore capable of producing spectra. These spectra in general differ from those which are observed with the oxyds of the same metals in an oxydizing flame.

The chlorid, bromid, iodid and fluorid of the same metal, placed in an oxydizing flame may give rise to bright lines, the position of which is different according to the salt examined. These lines, the duration of which is very variable, are always accompanied by the spectrum which we obtain with the oxyd.

Since the lines which appear with the chlorids belong to spectra which characterize these salts when volatilized in a chloridizing flame, it is proper to consider the new rays which are presented by the bromids, iodids and fluorids, as forming part of the spectra which these compounds would give in flames which do not act upon them. Hence it follows that if it were possible to make with these salts experiments similar to those made with the chlorids, we should have for the same element, barium for instance, five different spectra.

Diacon considers the influence of the electro-negative element upon the spectrum to be placed beyond a doubt by his experiments as by those of Mitscherlich. The spectra given by Bunsen and Kirchoff for the alkaline-earthy metals are mixtures of the spectra which are obtained when the oxyd is ignited in an oxydizing flame, and those obtained by igniting the chlorids in a chloridizing flame. The spectra attributed by Mitscherlich to the chlorids are also in part mixtures of the same spectra. In the first case, however, the spectra of the oxyds predominate, and in the second those of the chlorids.—*Ann. der Chimie et de Physique*, t. vi, 4th series, p. 5. W. G.

2. *On hydroxylamine.*—LOSSEN has succeeded in replacing an atom of hydrogen in ammonia by an atom of peroxyd of hydrogen or hydroxyl. The new ammonia is formed by the action of tin and chlorhydric acid upon nitrate of ethyl. The author employs a mixture of five parts, by weight, of nitric ether, 12 parts of tin, and 50 of chlorhydric acid of spec. grav. 1·124. The mixture becomes strongly heated after a short time, but not much hydrogen is evolved. When the action is over the tin is removed by sulphydric acid and the liquid concentrated by evaporation; large quantities of salammoniac first crystallize out, and afterward the chlorhydrate of hydroxylamine, which is very easily soluble in water. This may be completely separated from salammoniac by dissolving the mixed salts in absolute alcohol and precipitating the salammoniac by bichlorid of platinum, which does not combine with the chlorhydrate of hydroxylamine. Leaving the ethyl out of consideration the formation of hydroxylamine may be represented by the equation

$$NH\Theta_3+6H=NH_3\Theta+2H_2\Theta.$$

The chlorhydrate of hydroxylamine crystallizes from a hot saturated solution in alcohol in needles or in broad leaves; its formula is $NH_3\Theta.HCl$. The sulphate has the formula $2NH_3\Theta.H_2S\Theta_4$. The nitrate could not be obtained crystallized; the oxalate crystallizes in beautiful prisms which have the formula $2NH_3\Theta.\text{Є}_2H_2\Theta_4$. It is not yet decided whether hydroxylamine can be prepared pure in the isolated state. When a concentrated solution of a salt of this base is treated with caustic potash, nitrogen is given off rapidly and ammonia is formed. The decomposition may be represented by the equation

$$3NH_3\Theta=NH_3+2N+3H_2\Theta.$$

In dilute solutions the decomposition takes place gradually. When sulphate of hydroxylamine is precipitated by baryta water a more stable solution of the oxyd is obtained. This may be boiled without rapid decomposition; by distillation a part of the hydroxylamine passes over with the vapor of water. When chlorhydrate of hydroxylamine is rubbed with oxyd of copper a slow evolution of gas takes place, and in this gas deutoxyd of nitrogen may be detected.—*Monatsber. der Berliner Akad.*, S. 359, July, 1865. Quoted in *Chemisches Central Blatt.*, No. 61, p. 970. W. G.

3. *On a new sulphid of Carbon.*—Löw has described a new sulphid of carbon obtained by the action of an amalgam of sodium upon the bisulphid. When semi-fluid amalgam of sodium is shaken with bisulphid of carbon in a well corked bottle the temperature of the mixture rises, and the process is complete when after repeated addition of the

bisulphid heat is no longer evolved. If the mixture be then thrown into water a blood-red solution is formed, which, after filtering, contains much mercury; by passing sulphuretted hydrogen for some time into the solution this may be removed. The dark red solution is then to be poured into dilute chlorhydric acid with constant stirring. A flocky red substance is separated which aggregates to a tough resin, while much sulphuretted hydrogen is given off. The resinous mass is to be washed continuously with hot water as long as it smells of sulphuretted hydrogen. On cooling it becomes brittle, and then yields a violet-brown glistening powder which may be purified by solution in bisulphid of carbon, filtration and evaporation. The new sulphid is but slightly soluble in alcohol and ether, but is readily soluble in bisulphid of carbon with a red color. It dissolves in the pure alkalies, as well as their carbonates, with partial decomposition, but appears to be taken up by alkaline sulphids without alteration. Concentrated sulphuric acid dissolves it with a red color and water precipitates it from this solution. Nitric acid of 1·5 attacks it violently and appears to form a new acid. Heated in a closed tube to 100° the new sulphid melts to a tough resin and remains in this state after the temperature rises to 150°. Sulphuretted hydrogen is then given off. At 200° an amorphous yellow body sublimes and on further heating much voluminous carbon remains. Analysis gave for the new body the formula C_2S_3H. The author explains its formation by the following equations:

$$\text{I. } 2C_2S_4+NaHg=2NaC_2S_3+NaS.HgS.$$

$$\text{II. } 2NaC_2S_3+NaS.HgS+HS=2NaC_2S_3+NaS.HS+HgS.$$

$$\text{III. } 2NaC_2S_3+NaS.HS+3HCl=3NaCl+2HS+2HC_2S_3.$$

Löw regards the body C_2S_3 as a radical analogous to cyanogen or methyl. The compounds of this radical with the alkaline metals are dark-red to black and easily soluble in water; those with the heavy metals are brown or black precipitates.—*Chemisches Central Blatt.*, Nov. 8, 1865, p. 941; from *Wittstein's Vierteljahresbericht*, Bd. 14, S. 483.

W. G.

II. MINERALOGY AND GEOLOGY.

1. *Recent developments with regard to the Geology of California made by the Survey under the direction of* Prof. J. D. Whitney, State Geologist. (Communicated by Prof. Whitney in a letter to Prof. W. H. Brewer, dated San Francisco, Jan. 19, 1866.)—During the past summer, Mr. Remond has traced the belt of Jurassic rocks, first discovered on the Mariposa Estate, as far as the Stanislaus River, finding fossils at several localities, the *Ancella Erringtoni* being the most abundant, although several new species of other genera have been found. It is probable that we shall be able to follow this belt entirely through the Sierra Nevada in the course of our detailed explorations.

The results of Mr. Remond's work in Mexico during the past two years are quite interesting, and will be prepared by him for publication. A synopsis of his principal results will soon be forwarded to the Journal of Science. As one of the most striking facts, may be mentioned his discovery of plants in connection with the valuable beds of anthracite in Sonora. These plants have been examined by Dr. Newberry and are referred by him to the Triassic epoch.

I am pained to have to add that the state of Mr. Remond's health has obliged him to resign his position in our Survey, and that he is about to leave for Chili, where, however, his acquaintance with the rocks and fossils of California cannot fail to stand him in good stead, and if his health allows it, he will, no doubt, be able to add much to our rather scanty stock of information in regard to the geology and mining interests of that extremely interesting country.

Messrs. King and Gardner have been temporarily detached from our Survey and have gone to Arizona, in company with Mr. C. A. Brinley, an amateur photographic artist. These gentlemen have been enrolled in the service of the United States as assistants to the Engineer corps, and are attached to Gen. Mason's staff. They are well furnished with instruments for astronomical and topographical work, and will in all probability have an excellent opportunity to add to our knowledge of the geography and geology of a region which is now attracting much attention, and in regard to which we stand much in need of more light.

Mr. Gabb has been engaged for some time past in working up the invertebrate fossils of the Tertiary rocks of California. The first portion of his work, containing descriptions of about fifty new species, has gone to the printer. It will form the beginning of volume II of the Paleontology of California. The plates, thirteen in number, will also be engraved as soon as possible, having been all drawn. A considerable number of new Cretaceous fossils have been collected by the members of the Survey and others, and a portion of them have been drawn. Mr. Gabb is now engaged in exploring some portion of the Coast Ranges south of the Bay of Monterey which have not yet been visited by any of our corps. This duty will probably occupy him for the next four or five months.

The collection of fossils recently brought to our office from the State of Nevada have added considerably to our knowledge of the geology of the region east of the Sierra. The astonishing development of the Upper Trias in Nevada becomes more and more evident, and it is indeed remarkable that such immense outcrops of highly fossiliferous rocks, extending over so vast an area, should have remained unknown so long, although the country has been so often traversed by exploring parties. We have received from Mr. Blatchley fine specimens of some of the most characteristic species of the Trias of the Humboldt Ranges, and which come from as far east as lon. 117°. Triassic fossils have also been found 150 miles south of Unionville and nearly in the same longitude as the most western Humboldt range. I feel confident that we shall be able to obtain very important additions to our stock of knowledge with regard to the geology of the Great Basin during the coming season, and shall make arrangements to have work done there at some points which promise very interesting results.

The statement made in the newspapers and copied into the Journal of Science, that Mr. R. H. Stretch had been appointed State Geologist of Nevada, is not correct. The requirements of the Legislature that a survey of the State should be made in eight months on an appropriation of $6000, was so manifestly absurd, that the governor declined to make any appointment.

As soon as the Legislature has acted in reference to the continuance of the Survey, I shall take pleasure in communicating our plans for the prosecution of the work during the coming season.

2. *On Native Lead from the Northwest shore of Lake Superior;* by Prof. E. J. Chapman, of Toronto.—As a natural product, lead is well-known to be of exceedingly rare occurrence in the simple or metallic state. On this continent—apart from its occurrence in the meteoric iron of Tarapaca, in Chili—it has hitherto been noticed only at one spot, namely: in a galena vein, traversing limestone (of unstated geological age), near Zomelahuacan, in the Province of Vera Cruz, in Central Mexico. The specimen, from the locality now under consideration, was obtained by Mr. McIntyre, of Fort William, at a spot near the celebrated Dog Lake of the Kaministiquia. The lead occurs in this specimen—the only one, I believe, discovered—in the form of a small string in white semi-opaque quartz. The quartz, which constitutes a narrow vein, does not appear to contain the slightest speck of galena, or of any other substance, except a small quantity of specular iron ore; and the unaltered appearance of the latter is such as to preclude the supposition of the lead having been derived from galena, or other lead compound, by artificial heat. Before coming to my hands, the specimen had been examined by Mr. T. W. Herrick, whose extensive surveys and explorations in this region are so well known, and by him it was looked upon as metallic lead. My experiments fully confirm this determination. The lead, when cut, presents the ordinary color, softness, and ductility of the pure metal. The specific gravity cannot be properly taken, on account of the very small quantity at command, the larger portion of the lead having been used up before the specimen came into my possession. Tested by the blowpipe, however, the substance melts readily, and volatilizes; imparting a blue tint to the flame-border, and forming a yellow ring of oxyd on the charcoal. The fused globule is perfectly malleable. On the cupel, it becomes entirely oxydized and absorbed, without leaving a trace of silver. The cupel-stain, when cold, is of a clear yellow color, showing the absence of copper, nickel, &c. The nitric acid solution yields with reagents the ordinary reactions of lead-oxyd. The substance is distinguished from galena by its ductility, and by yielding no sulphur-reaction with carbonate of soda before the blowpipe. From bismuth, also, it is distinguished by its perfect malleability, as well as by the blue color which it imparts to the outer border of the blowpipe flame. As a further test, it may be stated that a small cutting, placed in a solution of bismuth in nitric acid, produces a black arborescent precipitate of that metal.

This discovery is interesting, not only from the extreme rarity of *Native Lead*, but from the fact, also, that in the few undoubted European localities in which the metal has been found, the latter is generally accompanied by gold. The quartz in which the Lake Superior specimen occurs has, curiously enough, the somewhat waxy aspect and other characters, more easily recognized than described, of the gold-bearing quartz of California and other auriferous districts; and the geological position of the bounding rock, immediately above that of the Huronian strata, is in a measure identical with the horizon of the gold-bearing rocks from which the auriferous deposits of Eastern Canada have been derived. No gold has hitherto been met with, however, in the sands of the Kaministiquia or other streams of Thunder Bay.—*Canadian Journal for Nov.*, 1865.

3. *Notes on Wisconsin Drift;* by J. S. Bliss. (Communication, dated Door Creek, Dec. 4, 1864.)—Recently I took occasion to examine in Lowell, Dodge Co., Wisconsin (lat. 43° 18′, long. 88° 51½′), some large boulders taken from hills or ridges, and in part from only slight elevations above the common level, and I found in them positive evidences of the drift movement. One was rough, for instance, on one side of the more elevated part of the stone, while on the other, it was quite well *smoothed* and *grooved*, the grooves running rather obliquely across. The smooth side was very nearly flat. Another, found in the same excavation, exhibited these traces of grooving and polishing in the central portion, their course being that of the longest diameter of the boulder. Either of them may perhaps weigh a ton.

Still another feature is seen twenty-five miles from the former place, in which the limestone in a railroad excavation, lying between two low tracts of low land, is only covered by perhaps five or six feet of recent deposits, and where this is left bare, owing to the denuding action of the rains, is plainly to be seen the same smoothing and grooving. On both sides, the grooves are exactly in *line*, although the rock is removed four feet below the surface of the lime rock. The polishing is in the direction *southwest by south.* These low tracts have undoubtedly been filled up, having once been very much deeper on either side of the flat rock—a rock that was once the summit of quite a high elevation, and which must have been acted upon similar to the high hills and mountains of New England.

There is still another fact which I will mention. On a recent visit to the Chicago lake tunnel, I saw small boulders which were taken four thousand one hundred and thirty-seven feet (4,137) from the mouth of the tunnel, with the same markings, the grooving being the more prominent feature. Small pieces of copper-bearing stone, like that of Lake Superior, is also found there. It appears, therefore, that small boulders found far down beneath the bed of Lake Michigan bear the same marks as those obtained in our Wisconsin hills.

4. *On Borax in California;* by Prof. J. D. Whitney.—Some explorations have been made around the lower end of Clear Lake, more particularly for the purpose of getting an idea of the very interesting locality of borax, which is found in this region.

Clear Lake is about sixty-five miles northwest of Suisun Bay, and about thirty-six miles from the Pacific. It is believed to be about twenty-five miles long, but has never been surveyed, so that its shape and size are not accurately known. * * *

At the angle where the narrow part of the lake opens out to the west is a high mountain, which comes down with a precipitous front to the water, and which is supposed to be about 2500 feet above the lake-level. It is called the "Uncle Sam Mountain," and, as seen from the opposite side of the lake, it appears to be made up of a closely folded synclinal mass, probably of somewhat metamorphic Cretaceous sandstones. On the southwest side, and to the southeast, volcanic materials and rocks occupy the surface, as is well seen in a crater-like depression on the southwest side of the narrow arm of the lake, called "Thurston's Lake," which is partly covered by water, and surrounded on all sides by high cliffs of volcanic rocks, appearing as if it might have been one of the vents from which the eruptive matter, obsidian, ashes and pumice, so abundant in this region, were ejected. On the eastern side of the narrow arm of Clear Lake, nearly opposite to, and about four miles distant from, Thurston's Lake, is a large accumulation of volcanic materials, with much obsidian and pumice. In fact, all through the chain of the Coast Ranges in this direction, down Grizzly Cañon to Bear Valley, on the trail to Colusi, there are hot springs and the remains of Solfatara action, indicating strongly a cross-fracture in this region, through which the volcanic agencies have made themselves perceptible, and which probably connects on the southwest with the Geysers, thus forming a line of volcanic action nearly if not quite across the chain.

Among the evidences of the former working of volcanic forces in this region, there is nothing more interesting and remarkable than the so-called "Borax Lake" and its vicinity. This lake occupies a depression on the east side of the narrow arm of Clear Lake, from which it is separated by a low ridge of volcanic materials, lying loosely heaped together, and consisting of scoriæ, obsidian, and pumice. The Borax Lake is of variable dimensions, according to the season of the year and the comparative dryness of the season. When examined (September, 1863), the water occupied an area about 4000 feet long, and 1800 feet wide in the widest place, and its shape was irregularly oval, its longer axis being turned in the direction of east and west, magnetic; it has once extended nearly twice as far to the southeast, as the ground is hardly raised above its present level in that direction for nearly a mile. The lake is said to have been entirely dry during the summer before the great rains of 1861–62. In 1863 the water was about three feet deep.

The existence of this lake was first made known to the world by Dr. J. A. Veatch, who examined it in September, 1856, and detected the presence of borax in its waters; but it was not until some months afterwards that the existence of a large bed of crystals of this valuable material in the bottom of the lake was discovered. The land about here has been located by the "California Borax Company," the agents of which have caused explorations to be made, have had the waters carefully analyzed, and were, in 1864, preparing to manufacture borax on a large scale.

The water collected from the Borax Lake, in September, 1863, as analyzed by G. E. Moore, contained 2401·56 grains of solid matter to the gallon, of which about one-half was common salt, one-quarter carbonate of soda, and the remainder chiefly borate of soda, there being 281·48 grains of the anhydrous biborate, equal to 535·08 of crystallized borax to the gallon. Traces of iodids and bromids were also detected. A sample of water taken from the interior of a coffer-dam sunk in the middle of the lake, and which had been allowed to fill by percolation from the bottom upward, was found to be more concentrated, yielding 3573·46 grains of solid matter to the gallon; but it contained nearly the same ingredients, and in the same proportions, as the water of the lake itself. The borax, being the least soluble substance contained in any notable quantity in the water, has in process of time crystallized out to a considerable extent, and now exists in the bottom of the lake in the form of distinct crystals, which are of all sizes, from microscopic dimensions up to two or three inches across. These crystals form a layer immediately under the water, intermixed with blue mud, of varying thickness; as observed in the coffer-dam sunk in 1863, the layer of crystals was about eighteen inches thick, and beneath it was mud without crystals. The thickness, however, of the deposit is undoubtedly very variable, and there are, in places, several layers of them separated by beds of clay or mud. It is believed, by those who have examined the bottom of the lake, that several million pounds of borax may be obtained from it by means of movable coffer-dams, at a moderate expense, and so as to yield a handsome profit to those engaged in the enterprise. How much of a supply of water could be obtained by boring, and what its quality would be, can hardly be settled in any other way than by actual experiment.

Lying about a mile beyond the ridge which borders the Borax Lake on the northeast, and at the foot of a shorter arm of Clear Lake which extends off to the southeast parallel with the longer one, is an interesting locality where solfatara action is still going on, and where a large amount of sulphur has accumulated. This is called the "Sulphur Banks." It consists of a much decomposed volcanic rock, fissured in innumerable places, through which fissures steam and gas are constantly issuing, and all over and through which large quantities of sulphur have been deposited, so as to give the mass, from a little distance, the appearance of being entirely composed of this material. Into some of these cavities a pole may be inserted for several feet, and they are often lined with fine crystallizations and stalactites of sulphur. No doubt a large quantity of this material could be obtained here, and the time will probably come when it will be made available. It is the largest deposit which we have seen in the State, covering several acres of ground; but to ascertain its value and determine the quantity of pure sulphur it contains, it would have to be dug into at various points.

Near the sulphur bank, just at the edge of the lake, is a hot spring, of which the outlet is, even at low water, partly beneath the lake, so that the amount which flows from it cannot be ascertained without some expenditure, to keep out the surrounding water. The flow of this spring seems to be quite variable at different seasons, and probably the amount of materials it holds in solution is far from constant. Dr. Veatch found the area over which hot water was percolating through the sand to be 150 by 75 feet in dimensions; at the time of our visit it was much less; nor was the estimated yield anything like as great as he made it, namely, three hundred gallons per minute.

The water of this spring, as analyzed by Mr. Moore, is found to be of a remarkable character; his analysis is subjoined.

	Grains in one gallon.
Chlorid of potassium,	trace.
Chlorid of sodium,	84·62
Iodid of magnesium,	·09
Bromid of magnesium,	trace.
Bicarbonate of soda,	76·96

Bicarbonate of ammonia,	107·76
Biborate of soda,	103·29
Sulphate of lime,	trace.
Alumina,	1·26
Carbonic acid (free),	36·37
Silicic acid,	8·23
Matters volatile at a red heat,	65·77
	484·35

In this table the constituents are necessarily calculated as anhydrous salts; the biborate of soda, however, contains about 47 per cent of water when crystallized, and the 103·29 grains given above, correspond to 195·35 of crystallized borax. The most extraordinary feature in the above analysis is the very large amount of ammoniacal salts shown to be present in this water, in this respect exceeding any natural spring-water which has ever been analyzed. Mr. Moore thinks that, as in the case of the boracic acid waters of Tuscany, this ammoniacal salt may be separated and made available for economical purposes. This locality is worthy of a most careful examination to ascertain how considerable a flow of water can be depended on.—*From Prof. J. D. Whitney's Geological Survey of California*, vol. i, p. 96.

Additional note.—The San Francisco papers received last Saturday state, in regard to the California borax: During the year they have supplied the local demand of thirty to forty tons and shipped two hundred tons to New York. The borax is collected from the mud at the bottom of the lake, during the dry season, the yield last season averaging about two and a half tons per day. The "crude borax" thus obtained is "so pure that the Mint and assayers of the city use the crude article in preference to the refined brought from abroad."—*Weekly Bulletin, Jan.* 13th.

5. *Gigantic Marsupials of Victoria, Australia.*—A very interesting addition to the National Museum collection of Melbourne, has recently been made through the kind offices of Dr. Greeves, who has on former occasions greatly enriched the museum with fossil bones. The present addition is a small series of four specimens found at Murchill Station (belonging to Mr. John Bell), presented by Mr. Charles Dyson, of Market Square, Geelong, through Dr. Greeves, and giving evidence of two gigantic animals of great rarity in Victoria, and of which the national collection had hitherto no examples. The largest specimen is a fragment of the posterior part of the left ramus of the lower jaw, with the last molar tooth, of the *Nototherium Mitchelli*, an extinct gigantic marsupial herbivorous animal, as big as a bullock in the body, intermediate between the kangaroo and native bear in affinities, not hitherto known to occur in Victoria. Immediately with this specimen were two great canine teeth about the size of those of a tiger, and nearly the same shape of root, which is coarsely sulcated longitudinally, the conical crown being worn down obliquely by use like those of a very old Tasmanian species (*Sarcophilus ursinus*), specimens of which can be seen in the case on the left hand of the entrance to the gallery in the National Museum building at the rear of the university. These teeth are of the highest possible interest to the Australian geologist and zoologist, as they are the first remains of this part of the extinct gigantic carnivorous marsupial, the *Thylacoleo*

carnifex, which have ever been found, and they help to prove the truth of Prof. Owen's suggestion, that at the time when the gigantic *Diprotodons* lived in Australia there was a powerful carnivore large enough to tear them in pieces, and prevent their undue increase, most nearly related in savage disposition and general structure to the Tasmanian species above referred to, but about a third larger than the largest living lion.—*Reader*, *Oct.* 28, from the *Melbourne Argus.*

6. *On Phosphatic Deposits recently discovered in North Wales;* by Dr. AUG. VOELCKER.—An extensive mine, containing several phosphatic minerals, was accidentally discovered early last year by Mr. Hope Jones, of Hooton, Cheshire, whilst he was searching for other minerals in the neighborhood of Cwmgynen, about sixteen miles from Oswestry. Mr. Hope Jones found the phosphatic mine to be continuous for more than a mile, and to come within twelve feet of the surface. It is not far from the clay slate and lead-bearing district of Llangrynag. The strata (slaty shale) contain several beds of contemporaneous feldspathic ash and scoriæ, and the usual fossils of the Llandeilo series are found, but not in great numbers. The strata are vertical, and run east to west, or, more correctly speaking, fifteen degrees north of west (magnetic).

A true vein, or fissure containing vein deposit, partially metallic, divides two phosphatic deposits. One of them is nearly three yards in thickness, and embodies phosphatic limestone beds, containing from ten to upwards of thirty-five per-cent of phosphate of lime. The other, and more valuable deposit is a yard and a-half thick, and consists of a black, graphitic shale, largely impregnated with phosphate of lime. This deposit is free from carbonate of lime, and much richer in phosphate of lime than the first-mentioned deposit. In specimens taken at a depth of about twelve feet from the surface, Dr. Voelcker found from 54 to 56 per cent of phosphate of lime in this phosphatic shale. At a greater depth the shale becomes richer in phosphates, and, consequently, more valuable. In the deeper specimens the proportion of phosphate of lime amounted to 64½ per cent. This phosphatic mine is readily accessible, and naturally drainable to a depth of about 500 yards (?), and contains many hundred thousand, if not millions, of tons of valuable phosphatic minerals. The discovery of this extensive mine in England appears to be of great importance to the English agriculturalist, who at the present time consumes annually many tons of phosphatic minerals in the shape of superphosphate and similar artificial manures.—*Proc, Brit. Assoc.*, *Reader*, Oct. 21.

7. *Observations on Certain Drifts and Ancient River Beds of Siluria and South Wales*; by Mr. SYMONDS.—The nearly total submergence of Siluria and Wales during the marine glacial period the author considered as proved by the position of marine shell-bearing drifts, containing large ice-worn erratics, upon mountain platforms in North Wales. These drifts have been found in several localities at the height of nearly 2,000 feet above the sea. The conclusions arrived at by Sir Charles Lyell, Professor Ramsay, and others, are well known, and they all tend to prove that large portions of Wales and Siluria were submerged during a period of the glacial epoch, which may be denominated as the *glacial marine* period. If this was the history as regards North Wales, Mr.

Symonds contended that it applies also to South Wales, almost the whole of which he believes to have been submerged during this glacial marine period. Accompanied by his friend, the Rev. Jas. Hughes, he had crossed the hill of Craig Turch this summer, where the river Cothi rises, half-way between Llandovery and Tregarron, among the wildest scenery of South Wales. Here he observed large erratic rocks resting on drift similar in position to those of the Maenbras below Snowdon; and he believed these erratics to have been transported from afar by ice-rafts floating over a glacial sea. The hill platform of Craig Turch, like that of Moel Tryfaen, and the Snowdon country, had been elevated in the course of ages to its present height. In the accumulation of the marine drifts of the Snowdon country there could be no doubt about their origin, for they contain numerous sea-shells, and many striated, polished, erratic blocks, which must have been dropped into them by floating ice. The author thinks some of the more elevated mountain platform drifts of South Wales must be attributed to the same origin—viz., a glacial marine origin.

But, while believing that there are unmistakable proofs throughout Siluria of long periods of submergence and of gradual elevation, as proved by the position of marine boulder-bearing drifts at different elevations, the author maintained that the effects of land-ice and snow in transporting great masses of local rocks to long distances had not been sufficiently observed. He always suspected the ice-raft or iceberg theory when applied to the transportation of any erratic which he did not see covered up and lying in stratified marine deposits of sand and gravel, like those on Moel Tryfaen. He had observed immense deposits of transported rocks so peculiarly local that it seemed impossible to suppose they could have been left by icebergs or rafts. No geologist could explore the valleys of the Wye, Severn, Usk, Towy, Tivy, Cothi, Rheidol, Yswith, Teme, and Lugg, without observing that the heads of those valleys were at one time filled with unstratified boulder clay or till, and that through this till the rivers have excavated their channels. This till is entirely unlike the stratified boulder-bearing silts of marine origin. The boulders contained in this till are all local, are frequently elevated above all signs of even the most ancient river action, have never been acted upon by water action of any kind, and, though belonging to rocks *in situ* in the district, have been carried across particular districts and down particular hills; while as regards the erratics borne by icebergs they are mingled and heterogeneous. On many hills in Wales you observe boulders of entirely local origin studding hill sides and resting on rocks to which they do not belong, but they have a local distribution, and have been derived from a local center. He had observed also that in numerous instances the transported rocks never crossed a valley, as in the case of Dean Forest, where masses of millstone grit and mountain limestone are found on one side of the valley, but not one can be found on the hills across the Wye. If these boulders had been moved by iceberg agency it was impossible to understand how the ice rafts moved so peculiarly as always to adapt themselves to the rocks *in situ* on the hills, and did not sometimes depart from one direction and strand large masses somewhere out of the line of the existing valleys and the lines of the hill slopes. The whole tendency of Mr. Symonds's paper was to show that since the elevation of the land into its present condition glacial phenomena were continued long after that elevation, and that although there are evidences of marine glacial action, those evidences have been much obliterated and destroyed by the long-continued and later effect of land-ice and snow. He attributed the transportation of the masses of subangular gravel, which contains large erratics from the Malvern range, and are distributed in patches on the Hanley and Castle Morton plains, to the effect of a mass of frozen snow and ice which in former days stretched from the Malverns down to the plains. The ancient river terraces of Siluria are well marked, and stand out in some instances at a height of 1,000 feet above the existing river channels. In Worcestershire it is difficult to make out where the marine conditions ended and the river conditions commenced. The section at Pull Court, opened up by the funds of the Malvern Field Club, he thought contained subfossil marine shells. These evidences broke down under the investigations of Mr. Gwynn Jeffreys. The specimens were all worn secondary fossils; so whether those high-level drifts were marine or freshwater remains yet to be proved.—*Ibid.*

8. *The Buckler-head Fish.*—Mr. Ray Lankester, of Downing College, Cambridge, read a paper "On the British Species of Cephalaspis and the Scotch Pteraspis." He stated that he had acquired a very large mass of evidence by the assistance of various friends, particularly Mr. Powrie, the laird of Reswollie, Forfarshire. From these specimens he was able to determine that there were only four British species of Cephalaspis, and they were *C. Lyellii*, of Agassiz, confined to Scotland and perhaps the passage-beds of Herefordshire (*C. ornatus*); *C. Murchisoni*, of Egerton, that common in the cornstones, which was a distinct and unnamed species; *C. Asterolepis*, of Dr. Harley, a well-marked form, found in the cornstones; and *C. Salweyi*, of Egerton, also very well characterized.—*Ibid.*

9. *On the occurrence of an internal convoluted plate within the body of certain species of Crinoidea;* by James Hall.—During the investigations upon the Crinoidea of the Carboniferous Limestones of Iowa, there were discovered in the broken bodies of several species, a vertical convoluted plate, filling a large part of the cavity of the body. At that time I showed several of these specimens to Prof. Agassiz, who informed me that he had observed a similar convoluted plate in the body of Comatula.

This convoluted intestinal plate was first observed in the body of *Actinocrinus pentagonus*, and afterwards in *Actinocrinus longirostris*, *Act. erodus*, *Act. Verneuili*, and in a species of the type of *Act. umbrosus*. In several of the specimens, and this is apparently true of all the Actinocrini, the opening into this convoluted sac is wider at the apex, and becomes gradually attenuated below and pointed toward the center of the basal plates where it is attached. The lower portion is twisted not unlike the lower portion of some univalve shells, and this organ, in one specimen, presents a very close resemblance to a small Bulla or similar shell. In *Actinocrinus longirostris* this organ is proportionately very large, the sides straighter and less curved, and very wide at the top.—*Proc. B. S. N. H.*, x, 33.

10. *Researches in the Lingula Flags in South Wales;* a joint report by Mr. H. HICKS and Mr. J. W. SALTER.—The results of these researches have led to the discovery of an entirely new British formation, and the authors propose a new term for the group. The district of St. David's was anciently called "Minevia," and hence, following the example of the best geologists—viz., first to ascertain the position, then the fossil contents of a group, and then to name it—the authors propose the term "Minevian" for the lowest division of the "Lingula flags." Mr. Hicks described five sections north and south of St. David's—the coast affording admirable views of all the beds, from the central syenite through the olive, grey, green, and purple beds of the Lower Cambrians, into the light grey, black, and grey shales of the Minevian group. Some of the sections show a passage from this group into the Ffestiniog group of Professor Sedgwick, which forms the main mass of the "Lingula flags proper," and in Whitesand Bay these are again overlaid by the Skiddaw group and the Llandeilo flags. Each of the sections has shown fossil traces after a long and persevering search. But the section at Porth Rhaw is not only the typical one, but contains all the principal fossil types—trilobites of six or seven genera, and about fifteen species; Brachiopod and Pteropod shells, Cystideæ, and sponges of two or three different kinds. All of them are distinct not only as to species, but usually as to genera also, from the overlying rocks of the true "Lingula flags." And as the history of discovery in the Paleozoic rocks has always been that every group beneath the Old Red Sandstone containing a distinct fauna has received a separate name, the authors hold it of prime importance not to confound this fauna with that of any of the overlying rocks of the Silurian or even Upper Cambrian systems. If Llandeilo, Caradoc, Llandovery, and Wenlock imply distinct periods of creation, much more does the term "Lingula flag" and "Ffestiniog group" indicate a more remote period, in which not even the genera of fossil animals common in the great Silurian deposits are to be found. All is distinct and anterior, lower in point of organization, more limited in point of numbers; the species even, with some exceptions, diminishing in size. We seem to be coming to the zero of animal and vegetable life. As indicative of the value of a close observation of these old faunæ, it may be sufficient to say that by means of this Minevian group we can tell the true horizon of the gold-bearing rocks of Wales; we can identify accurately the oldest fossil-bearing strata of Bohemia and Sweden with those of our own country; and assign them their exact position in the Palæozoic series. The genus *Paradoxides* becomes in this way one of the medals of creation, and the index of a most remote age—so remote, that only a few, and those the humbler members of the invertebrate classes, inhabited the sea before the cuttlefish or the nautilus was created, as these last were long anterior to the very earliest of the fishes. With regard to the distribution of the fossils themselves, the lowest beds, which actually lie among the uppermost coarse beds of the Cambrian grits, only distinguished from them by the want of purple color, contain a species of *Paradoxides* (*P. Aurora*), with which are associated some minute Trilobites, *Agnostus*, *Microdiscus*, &c. Farther up we have *Paradoxides* again, but of a distinct species and larger. The mass of the

fossils then come in, both crustaceans, shells, and sponges; and high up in the series a third *Paradoxides*, so large as to attract general notice—the well-known *P. Davidis*. Specimens of each of them were exhibited on the reporters' table. Mr. Hicks described beds of contemporaneous trap, such as had been previously noticed by his colleague, but also showed their origin and direction; and the faults of the region were touched upon, but could not be fully described. The district is evidently a prolific one, containing a new and most interesting formation; and as St. David's cathedral is now being restored, and as there is an excellent bathing strand close by, it is likely that this remote corner of the island will attract both geologists and non-scientific visitors. The time allotted to the authors was so short, and the President's mandate so urgent, that scarcely even the general facts of the communication could be touched upon.—*Proc. Brit. Assoc., Reader, Nov.* 11.

III. BOTANY AND ZOOLOGY.

1. *Botanical Necrology for* 1864 *and* 1865.—Following a chronological order we have first to mention a botanist whose decease, although occurring in the year 1862, has only recently been known to the world of science:—

Dr. Christian Friederich Lessing,—the author, in 1832, of the classical *Synopsis Generum Compositarum*, in honor of whom and his celebrated grandfather, Gotthold Ephraim Lessing, Chamiso named the little Californian Aster-like *Lessingia Germanorum*—had entirely disappeared from view for the last thirty years. About that time he went to Siberia, with a view to botanical explorations; but engaged in mining speculations, practiced medicine, and finally became a brewer, with ill fortune in all his undertakings, as it appears. These facts seem to have come to light only since his death, which, as stated by von Schlechtendal in the Botanische Zeitung, took place in the year 1862, at Krasnojarsk, a village on the Jenisei, between Tomk and Irkutsk.

Nicolaus Turczaninow, one of the oldest Russian botanists, author of many botanical papers, and of a *Flora Baicalensi-Dahurica*, died at Charkow, in January, 1864. He had suffered, during the last years of his life, by a fall from a ladder in his herbarium. Several years ago his large herbarium was made over to the University of Charkow.

Hermann Crüger, at the age of 45, died Feb. 28, 1864, in San Fernando, Trinidad, where he was the Superintendent of the Government Botanic Garden. He was the author of several interesting papers in the Botanische Zeitung upon vegetable anatomy and morphology; and he had taken up the subject of the fertilization of Orchids by the aid of insects,—a subject on which much was to be expected from his ability and excellent opportunities. A short paper of his, containing his observations on *Catasetum*, *Stanhopea*, &c., communicated to Mr. Darwin, was published, after his death, in the 31st No. of the Journal of the Linnæan Society.

Francis William Junghuhn, a botanist who in former years made considerable collections in the Dutch East Indies, and who returned to Java a few years ago to take charge of a government garden, died at Lembang, on the 24th of April, 1864, aged 52 years.

Ludolf Christian Treviranus, Professor of Botany in Bonn University, the Nestor of botanical professors, and one of the very oldest botanists in Germany, died at Poppelsdorf, May 6, 1864. His age is not mentioned. But the earliest of his numerous works recorded by Pritzel (the best of which are physiological) was published in the year 1806. The latest of any extent was his elaboration of the genus *Carex* for Ledebour's Flora Rossica.

Dr. Hermann Schacht, a distinguished vegetable anatomist and physiologist, and author of several well known works, formerly an assistant of Schleiden at Jena, was appointed to the chair at Bonn vacated by the death of Treviranus. His health, however, had of late years been much impaired; and he had barely entered upon the duties of his honorable position when, on the 20th of August, 1864, he died, at Poppelsdorf, at the age of 50.

Adolf Scheele, pastor at Heersum, near Hildesheim, author of several papers in the Linnæa, died Sept. 7, 1864, in the 57th year of his age. He appears to have been a botanist of considerable merit; which, however, was not greatly shown in his contributions to the Flora of Texas, based upon a portion of Lindheimer's plants and upon a collection made by his friend Prof. Römer, who placed them in his hands.

Johannes Wilhelm Sturm, a name distinguished in German botany for two or three generations, died January 7, 1865, in the 57th year of his age. His latest work was his elaboration of the *Hymenophylleæ* for Martius's *Flora Brasiliensis.*

Dr. Hugh Falconer, who wrote upon botany as well as upon zoology and paleontology, and made very extensive and excellent botanical collections in Upper India (which were mostly destroyed by dampness and neglect in the cellars of the East India House), died in London, January 31, 1865, aged 57 years. Obituary notices of this distinguished naturalist have already appeared in this Journal.

Sir Robert Hermann Schomburgk, who did much for botany in his exploration of British Guiana about 30 years ago, and by whose agency somewhat later the *Victoria regia* was made known and introduced into England, died at Berlin, on the 11th of March, in the 61st year of his age.

Dr. Heinrich Schott, for many years director of the Imperial Gardens at Schönbrunn, died there on the 5th of February, 1865, at the age of 71 years. Although he had written upon Ferns and other departments of botany, his scientific fame rests chiefly upon his works upon the *Aroideæ.* He was the highest authority upon this difficult order, which he had completely mastered. A notice of his principal publications will be found in the third volume of the present series of this Journal.

Sir Joseph Paxton, whose decease, on the 5th of June last, in the 62nd year of his age, has already been recorded in this Journal (xl, p. 140), must also be reckoned among the botanists, having for many years edited the Magazine of Botany, Paxton's Flower Garden, and other popular works. He was an eminent horticulturist, and, after constructing the great glass and iron conservatory at Chatsworth and furnishing the design for the celebrated Crystal Palace in Hyde Park, he removed to Sydenham, and became a distinguished architect and civil engineer.

Sir John Richardson, the well-known Arctic explorer, zoologist and botanist, died on the 5th of June last, in the 78th year of his age. He was born at Dumfries, Scotland, Nov. 5, 1787, completed his medical education at Edinburgh, and entered the navy as assistant surgeon. When he retired, at the beginning of the war in the Crimea, he was, we believe, the senior officer in the medical service, and had held for many years the honorable post of inspector in charge of Haslar hospital. It was while in this position that Richardson, already advanced in years, at his own request, conducted the last overland search for his old friend and companion in earlier Arctic perils, Sir John Franklin. His labors and hardships in these explorations, and the valuable works which he produced upon the geography, climate, and natural history of Arctic America need not be here enumerated. The work by which his name is indelibly associated with American botany is his botanical appendix to Franklin's first overland journey, published in 1823, the most important essay of the time upon Arctic plants, and the precursor of Hooker's Flora of British America.

Hugh Cuming, the renowned collector in natural history, especially of shells, and whose botanical collections in Chili, the Pacific Islands, the Philippines, &c.,—distributed in sets fifteen or twenty years ago, were very extensive,—died in London, on the 10th of August last, at the age of 74 years.

Thomas Bridges, who, as well as Mr. Cuming, made extensive botanical collections in Chili, Bolivia and Peru, beginning more than thirty years ago, but who has for the past eight or ten years resided in California and British Columbia, died on the 9th of November last, on his return to California, from an expedition to Nicaragua.

Sir William Jackson Hooker, as our readers well know, died on the 12th of August last, at the age of 80 years. A biographical notice of this eminent botanist forms the leading article of the present volume. We are informed that the affection of the throat of which he died was not diphtheria, as we had stated.

John Lindley, one of the most renowned botanists of the age, died at his residence near London, on the 1st of November last, at the age of 66 years. A few lines of our January number contained an announcement of this sad event (p. 6, foot-note), with an incidental expression of our sense of the services he has rendered to science. We add some biographical details, compiled from the excellent notice which appeared in the Gardeners' Chronicle, the paper which Dr. Lindley[1] established and edited for a quarter of a century.

He was born at Catton, near Norwich, where his father was a nurseryman, on the 5th of February, 1799; and was educated at the Norwich Grammar School, as was his friend and earliest scientific acquaintance, Sir Wm. Hooker. It was at the house of the latter, soon after his removal to Halesworth, that young Lindley began his career of authorship by translating Richard's *Analyse du Fruit*, which was published in 1819. He appears already to have devoted himself to botanical and horticul-

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[1] Mr. Lindley received the degree of Doctor of Philosophy from the University of Munich, in the year 1832.

tural pursuits, and, it is said, had arranged to visit Sumatra and the Malayan Islands; but for some reason—perhaps connected with his father's reverses in business,—the project was abandoned. At this juncture, he was introduced by his friend Hooker to Sir Joseph Banks, who employed him as his assistant librarian. Sir Joseph recommended him to Mr. Cattley, for whom he edited the folio *Collectanea Botanica*, illustrating some of the new and curious plants cultivated in Mr. Cattley's collection. He had already published his Monograph of Roses (1820), and his Monograph of Digitalis (1821), the latter illustrated by plates from Ferdinand Bauer's drawings. The next year (1822) began his connection with the Horticultural Society, as Garden-Assistant Secretary, when he took charge of the laying out of the garden at Chiswick. In 1826 he became sole Assistant Secretary, Mr. Sabine being Honorary Secretary until 1830, and then Mr. Bentham until 1841; nearly the whole active charge of the establishment falling upon Dr. Lindley. Then, as Vice Secretary he conducted the operations of this great and most prosperous society, with almost undivided responsibility until 1858, when, dropping the laboring oar, he became Secretary and Member of the Council, and took a leading part in the reorganization of the society, until, fairly broken down by overwork, in 1862 he was obliged to retire from the management. Besides his work in the Horticultural Society, sufficient of itself to task any ordinary powers, Dr. Lindley was Professor of Botany in University College from 1829 to 1861, giving elaborate courses of lectures every year, and also Lecturer at the Apothecaries Garden at Chelsea for nearly the same period. He conducted the Botanical Register from about 1823 (although his name does not appear upon the title-page until somewhat later) down to its close in 1847; he did the principal botanical work in Loudon's Encyclopedia of Plants, and wrote the botanical articles for the Penny Cyclopedia, down to the letter R; contributed to the Transactions and Proceedings of the Horticultural Society, and edited its Journal; prepared the later volumes of Sibthorp's magnificent *Flora Græca*, &c., &c.,—besides writing and often re-editing his numerous classical botanical works, which, with his lectures to successive classes of pupils inspired by his own ardor, have made his name so famous wherever botany is cultivated. Of these numerous works we can mention only the principal. His Synopsis of the British Flora arranged according to the Natural Orders, first issued in 1829, has only a local and historical interest, as a part of his successful endeavors to introduce and popularize the natural system in England, where it had peculiar obstacles to contend against. His Genera and Species of Orchidaceous Plants, with his *Sertum Orchidaceum* and, later, his *Folia Orchidacea* (which he was able only to commence), embody a portion of his labors upon an important and curious family of plants, upon which he became the paramount authority. His Introduction to Botany, which ran through four editions, his Outlines of the First Principles of Botany, at length expanded into his Elements of Botany, and his School Botany, from a series of introductory works which have done much more for botanical instruction than any others in the English language. By his *Flora Medica* he supplied to medical students a good botanical account of all the more important plants used in medicine. By his Theory of Horticulture, explaining the principal operations of gardening upon physiological principles, in connection with his articles upon the subject in the Gardeners' Chronicle, he may almost be said to have raised this branch of knowledge "from the condition of an empirical art to that of a developed science." And, finally, in his Introduction to the Natural System of Botany, the first edition of which, published in 1830, was the earliest systematic exposition of the natural system in the English language, or fairly available to English and American students, and his further development of this work into his classical Vegetable Kingdom,—the one book which may take the place of a botanical library, —Dr. Lindley made his most important contributions to the advancement of systematic botany. The coming generation of botanists cannot be expected to appreciate the vast influence exerted by the earlier of these works in its day; the latter, however open to adverse criticism in particulars, is still unrivalled and is probably "that by which his name will be best known to posterity." Physiologist, morphologist, and systematist, he displayed equal genius in all these departments of the science, but he worked too rapidly to do himself full justice in any of them. "His power of work was, indeed astonishing; whatever he undertook [and his undertakings were wonderful in amount and variety] he did with the utmost conscientiousness, never flagging until he had done it; and he was a splendid example of what can be accomplished by a man of strong will, habitually acting up to his oft-repeated saying, that to method, zeal, and perseverance nothing is impossible." "Until he had passed 50 years of age," it is stated, that "he never knew what it was to feel tired either in body or mind." Such persons are sure to be overtasked. The Great Exhibition of 1851, adding protracted and onerous duties to his ordinary work, prostrated him with serious illness; the second Exhibition, in 1862, in which he took charge of the whole colonial department, fatally injured his bodily and mental powers, and cut short his scientific career. He was able, however, to enjoy the society of his immediate friends and to keep up an interest in his favorite pursuits quite to the close, which occurred from an apoplectic attack, on the morning of the first of November last.

Dr. Lindley was a man of marked character. While his biographer declares that "he was hot in temper and impatient of opposition," he no less truly adds that, "on the other hand, he had the warmest of hearts and the most generous of dispositions." He seemed as incapable of cherishing a resentment, as of repressing the expression of indignation for what he thought wrong; and if at times he made enemies, he was almost sure in time to convert his enemies into friends.

Dr. John Leonard Riddell, the only American botanist of this list, died in New Orleans,—where he had resided for the last thirty years,— on the 7th of October, 1865, in the 58th year of his age. His biography, written by his friends and associates in the New Orleans Academy of Sciences, is given in the January number of this Journal, p. 141.

Dr. Jean François Camille Montagne, the venerable and distinguished Cryptogamic Botanist of Paris, we have just learned, died on the 5th of January, having nearly completed the 82d year of his age. Near the close of the last century he was a master's mate in the French Navy, was in the French expedition into Egypt, where he was transferred to the civil service. After the capitulation at Alexandria he returned to Paris, studied medicine, became an army surgeon, remained in the service until 1830; and then, indulging a long-cherished fondness for Botany, he began the career as a Cryptogamist in which he has been so useful and eminent. A. G.

2. *Essay on the Trees and Shrubs of the Ancients; being the substance of four Lectures delivered before the University of Oxford, &c.;* by C. Daubeny, M.D., F.R.S., Professor of Botany and Rural Economy in the University of Oxford. Oxford and London, 1865, 152 pp., 8vo.—An interesting little volume, collecting with considerable research and good judgment what is known or may be reasonably conjectured in the way of identifying the principal trees and shrubs mentioned by Greek and Roman authors, or described by Theophrastus, Dioscorides, Pliny, &c. As to these primitive naturalists, Dr. Daubeny well remarks that, in consequence of the vagueness of their descriptions he has been unable, except in the case of a few conspicuous and important species, to do more than point out with some degree of probability, the natural family or at most the genus, to which the classical designation appeared intended to apply. Moreover, unavoidable ignorance has often been turned into confusion by the mis-appropriation of classical names of plants by modern botanists, and the adoption of these without enquiry by lexicographers. At the close of the fourth lecture Prof. Daubeny alludes to, and recapitulates the points of, a paper which he read to the British Association at Bath, in 1864, in which he suggests that, irrespective of changed conditions, "each species, like every individual belonging to it, has its days numbered, and that the period assigned to its duration may be extended, indeed, by favorable, and abridged by unfavorable external conditions, but in no case can transcend certain definite limits." This view has been propounded more than once before, and under close-breeding assumes a certain probability. But the external influences to which every species is subject, and the irrepressible struggle among them will probably sufficiently account for the observed facts.

A Catalogue of the Trees and Shrubs indigenous in Greece and Italy, with their ancient Greek and Latin synonyms, is appended to the volume, and will be useful for reference. For an Oxford-University book, too many Greek names are printed with wrong accents. The Birch is said not to be a native of Greece; but we have excellent authority for saying that it is indigenous to the mountains, to Pelion, for instance. By some unaccountable oversight, the second lecture contains a circumstantial repetition of the story which some bewildered penny-a-liner contributed to the Edinburgh Review two years ago, about the Cedar of the *Jardin des Plantes* having been brought from the Holy Land by Bernard Jussieu, potted in his hat, and supplied with his own short allowance of water, &c., &c.—a story which we exposed at the time in this Journal, though thinking it hardly worth the while to give so much attention. A. G.

3. *New Fluid for preserving Natural History specimens;* by A. E. Verrill.—In consequence of the high price of alcohol, a series of experiments were undertaken by me last year, with the view of finding a substitute for it in preserving the soft parts of animals. Among the various solutions and liquids tested were nearly all that have ever been recommended, besides many new ones. Chlorid of zinc, carbolic acid,

glycerine, chlorid of calcium, acetate of alumina, arsenious acid, Goadby's solutions, and various combinations of these and other preparations were carefully tried, and the results made comparative by placing the same kind of objects in each, at the same time. Although each of these, under certain circumstances, have more or less preservative qualities, none of them were found satisfactory, especially when the *color* and *form* of the specimen are required to be preserved as well as its structure.

As a test for the preservation of color, the larvæ of the tomato-worm (*Sphinx quadrimaculata*) was used. These larvæ are difficult of preservation with the natural form and color, nearly always turning dark brown and contracting badly in alcohol and most other preparations.

As a result of these experiments the following solutions were found highly satisfactory in all respects when properly used. By their use the larvæ and recent pupæ of the tomato-worm were preserved and still retain their delicate green colors, together with their natural form and translucent appearance, while the internal organs are fully preserved. Fishes, mollusks, various insects, worms, and leaves of plants have also been preserved with perfect success and far better than can be done with alcohol. In the case of mollusks, especially, the preparations are very beautiful, retaining the delicate semi-transparent appearance of the membranes nearly as in life, with but little contraction. Another great advantage is the extreme simplicity and cheapness of the solution.

To use this fluid I prepare first the following stock solution, which may be kept in wooden barrels, or casks, and labeled:

SOLUTION A. I.

Rock salt, ...	40 oz.
Nitre (nitrate of potassa), ...	4 oz.
Soft water, ...	1 gal.

This is the final solution in which all invertebrate animals must be preserved. A solution with double the amount of water may be kept if desirable, and called A. II. Another with three gallons of water will be A. III.

In the preliminary treatment of specimens the following solution is *temporarily* employed, and is designed to preserve the object while becoming gradually saturated with the saline matter, for in no case should the specimen be put into the full strength of solution A. I, for it would rapidly harden and contract the external parts and thus prevent access to the interior. Even with alcohol it is far better to place the object for a time in weak spirits and then transfer successively to stronger, and for some objects, as Medusæ, no other treatment will succeed.

SOLUTION B. I.

Soft water, ...	1 gallon.
Solution A. I, ...	1 qt.
Arseniate of potassa, ...	1 oz.

Another solution with double the amount of water may be made if desired, and called solution B. II.

To preserve animals with these solutions they are, if insects or marine invertebrates, ordinarily placed first in solution B. I, but if the weather be cool it would be better in many cases to employ first B. II, and in the case of all marine animals washing first in fresh water is desirable, though not essential. If the specimens rise to the surface they should be kept under by mechanical means. After remaining for several hours, or a day, varying according to its size and the weather, in the B. I. solution it may be transferred to A. III, and then successively to A. II, and A. I, and when thus fully preserved it may be transferred to a fresh portion of the last solution, which has been filtered clear and bright, and put up in a cabinet, when no further change will be necessary if the bottle or other vessels be properly secured to prevent the escape of the fluid by crystallization around the opening. To prevent this the stoppers, whether of cork or glass, together with the neck of the bottle or jar, may be covered with a solution of paraffine or wax in turpentine or benzole, which should be applied only when the surfaces are quite dry and clean. The length of time that any specimen should remain in each of the solutions is usually indicated by their sinking to the bottom when saturated by it. In general the more gradually this saturation with the saline matter takes place the less the tissues contract or change in appearance. In many cases, however, fewer changes than indicated above will be effectual. I have in some cases succeeded well with but two solutions below A. I. For vertebrates, except fishes, the solution A. II. will usually be found strong enough for permanent preservation, especially when the object is small or dissected. If the entire animal be preserved, when larger than two pounds in weight, it should be injected with the fluids, especially B. I. and the final A. I. or II, or an incision may be made in one side of the abdomen in vertebrates, or under the carapax of crabs, &c., to admit the fluids more freely. In preserving the animals of large univalve shells an opening should be made through the shell at or near the tip of the spire. Mammals, birds and reptiles, should be placed first in solution B. II. to obtain the best results. In cases where the use of the B. fluids would be objectionable, on account of their highly poisonous nature, a fourth dilution of solution A. I, corresponding in strength with B. I, but without the arseniate of potassa, may be substituted, and in many cases will do nearly as well, if the weather be not very hot, but the specimens in this case should be carefully watched and transferred to the stronger solutions as soon as possible, so as to avoid incipient decomposition while in the first fluids.

New Haven, Feb. 12, 1866.

4. *Researches upon the Hydrobiinæ and allied forms; chiefly made upon materials in the Museum of the Smithsonian Institution;* by Dr. WILLIAM STIMPSON. 55 pp. 8vo. 1865; with 29 wood-cuts. From the Smithsonian Miscellaneous Collections.—The great difficulty of studying the anatomy of the Hydrobiinæ, owing to their diminutive size, has, with few exceptions, caused conchologists to classify them merely from the form and other characters of the shell, and such parts of the animal as can be seen protruded when in motion. Hence, rather widely different views have been entertained in regard to their generic relations, some referring a part of them to the genus *Paludina*, others to *Melania*, *Leptoxis*, *Cyclostoma*, &c., while other authors have more properly proposed for the reception of certain types, the genera *Amnicola*, *Pomatiopsis*, *Soma-*

togyrus, &c. Even those who have admitted these new genera, however, still differed in regard to their family affinities, some placing certain of them in the *Melaniidæ*, others in the *Rissoidæ*, *Viviparidæ*, *Littorinidæ*, &c., while still other conchologists proposed to establish for their reception a new family, *Amnicolidæ*.

After a thorough and searching investigation of the whole subject, particularly of the structure of the softer parts and the dentition of many of these types, Dr. Stimpson arrives at the conclusion that these little snails all belong to the *Rissoidæ*, to which they had in part been referred by H. & A. Adams; though he also includes in the family the genera *Lithoglyphus* and *Paludestrina*, (referred by those authors to the *Littorinidæ*), as well as several new genera he finds it necessary to establish. He likewise suggests that *Pyrgula*, *Tricula*, *Cecina*, and *Blanfordidia* probably belong to this group; while he excludes from it the genus *Barleea*, which had been included by H. & A. Adams.

After thus eliminating the extraneous genera, and including others not previously known to belong to this family, he gives a full and clear diagnosis of the group, by which it can readily be distinguished from the families *Littorinidæ*, *Viviparidæ*, *Truncatellidæ*, *Melaniidæ* and *Valvatidæ*, with which it is more or less nearly allied, or has in part been confounded. He then defines the following six sub-families, into which the group is found to be naturally divisible:

1. *Bythiniinæ*, including *Bythinia* Gray.
2. *Rissoininæ*, including *Ressoina* D'Orb.
3. *Rissoinæ*, including *Rissoa* Frem., *Cingula* Flem., *Alvania* Risso, and *Onobia*, *Setia*, *Ceratia* and *Fenella* H. & A. Adams.
4. *Skeneinæ*, including *Skenea* Flem.
5. *Hydrobiinæ*, including *Hydrobia* Hartm., *Littorinella* Braun., *Amnicola* Gould & Hald., *Bythinella* Moq. Tand., *Stenothyra* Benson, *Tricula* Benson, *Pyrgula* Christ. & Jan, *Paludestrina* D'Orb., *Tryonia* Stm., *Potamopyrgus* Stm., *Lithoglyphus* Muhlfeldt, *Fluminicola* Stim., *Gillia* Stim., *Somatogyrus* Gill, and *Cochliopa* Stim.
6. *Pomatiopsinæ*, including *Pomatiopsis*, Tryon.

The memoir is mainly devoted to the subfamilies *Hydrobiinæ* and *Pomatiopsinæ*. Of the genera belonging to the former, extended descriptions, and excellent outline cuts illustrating the shell, animal, dentition, &c., are given of the typical species of *Amnicola*, *Bythinella*, and the new genus *Fluminicola*. Similar illustrations, and a good description are given of the type (*Amnicola lapidaria* Say.) upon which the genus *Pomatiopsis*, and the subfamily *Pomatiopsinæ*, were founded. The latter type, although a true air-breathing mollusk, living habitually out of water, is shown to breath by gills, and not, as would naturally be expected, by lungs. He remarks, however, that "it may be said to be amphibious, but only in the sense that *Succinea* and some other terrestrial mollusca are so; that is, it is capable of living for a long time under water." The foot of this type is also shown to be adapted by a peculiar construction, to a gliding mode of progression in water, and to a stepping motion, aided by the rostrum, when on land.

Farther on, he gives an extended description of the sub-family *Hydrobiinæ*, with accurate diagnoses of each of the included genera, full references, synonymy, citations of types, &c. Of these genera, the following are new: *Tryonia* Stim., founded upon a new species, *T. clathrata* (probably extinct) from the Colorado Desert; *Potamopyrgus* Stim., founded upon *Melania corolla* Gould.; *Cochliopa* Stim., founded upon *Amnicola Rowellii* Tryon; *Gillia* Stim., founded upon *Melania altilis* Lea; and *Fluminicola* Stim., founded upon *Paludina Nutalliana* Lea.

It is worthy of note that the author has not, as is too often done, gone on to refer by guess, to his new genera, all the little shells that might be supposed to belong to them, but leaves that to be done by others who may have an opportunity to study thoroughly their softer parts, dentition, &c., and determine whether or not they really possess all the characters of the newly founded groups.

Another commendable feature in this memoir is, that the author has in each instance *distinctly stated what species he regards as the types of the new genera.* Every naturalist must be aware that much of the confusion in the nomenclature of natural history has arisen from the neglect of this simple rule in the subdivisions of the group which may afterwards take place, some retaining the original name for one group of the species, and others for others, with no chance for agreement. Many, perhaps the majority, say that, in such cases, the old name should always be used for the group including the first species, or in other words, that the first species mentioned or described under the old name, should be regarded as its type. Others, however, insist that the original name should be retained for the group including the majority of the species first described, or included; while others contend that the type most nearly agreeing with the diagnosis, or which has its characters best expressed in the name itself, should be regarded as the type of the original genus. Still others say that the first author who divides and properly restricts a genus originally founded upon heterogeneous materials, has the right to determine, arbitrarily which shall retain the old name, and which shall receive new ones. Now all such confusion is avoided by simply stating which species is recognized as the type in founding a new genus.

The work under review bears throughout marks of great care and thoroughness. The Smithsonian Institution is doing a good work for the advancement of science in publishing the results of such investigations.

M.

5. *On the method of flight of the Flying-fish;* by HORACE MANN (in a letter to F. W. Putman).—I have been watching the flying-fish to-day. They are very abundant, and though you may know all about them from persons more competent to see and describe than I, yet I venture to send you a few notes on them in my journal. I had supposed that they must acquire some considerable momentum below the surface before rising above it, and for that reason wished to see if the motion of the fish immediately after leaving the water was more accelerated than during the later portions of its flight (for it is obviously a true flight). I think that I have been able to discover some slight differences in the rates of motion immediately after leaving the water and later in their course; but I also think their motion is kept up by the fins, and also that the weight is sustained by them. They do not appear to leave the

water at a large angle, but otherwise; as near as I have been able to judge about 5° or 6°. They plainly have the power of altering their course of flight, so far as rising and falling, as I have seen them go over the rising surface of a not very high wave, and their flight is also almost always slightly dipping. I have also thought they sometimes altered their course to the right or left without touching the surface of the water, but it may have been owing to the wind. They will often barely touch the surface of the water and rise again, keeping on in the same or an altered course. There went a school of a dozen or twenty this very minute, rising and falling slightly, and entering the water and issuing from it again and again, and altering their course for the distance of seventy-five to one hundred yards. The motion of the fin is *not always* steady, as I have seen when they rose near the ship and the sun struck favorably upon them, for in those cases the motion was intermittent in velocity, though kept up all the time, and might be represented by a line more or less shaded. I have observed them fly thirty or forty yards without touching the water, though I should say usually they would not go more than half that distance. They do not usually rise much over a foot above the surface of the water, often much less, though one was said to have come on board the other day, and to do that I should think must have risen at least eight or ten feet.—*Proc. Boston Soc. N. H.*, x, 21.

6. *Dodo.*—On the 9th of January, Professor Owen read a paper before the Zoological Society of London on the osteology of the Dodo (*Didus ineptus*, Linn.). The materials upon which Prof. Owen's researches were based consisted of about one hundred different bones belonging to various parts of the skeleton which had been recently discovered by Mr. G. Clark, of Mahéberg, Mauritius, in an alluvial deposit in that island. After an exhaustive examination of these remains, which embraced nearly every part of the skeleton, Prof. Owen came to the conclusion that previous authorities had been correct in referring the Dodo to the Columbine group, the variations presented, though considerable, being mainly such as might be referable to the adaptation of the Dodo to a terrestrial life and different food and habits.—*Athen., Jan.* 20, 1866.

IV. ASTRONOMY.

1. *Observations of Shooting Stars on the nights of Nov.* 12–14*th*, 1865.—To the accounts given in the last number of this Journal, pp. 58–61, there may be added,

(1.) *Detroit, Michigan.*—Mr. O. B. Wheeler saw on the night of the 12th–13th, between one and two o'clock, 77 meteors, and between the hours of three and four, 63. On the next night only 23 were seen between one and two o'clock. Both nights were very clear, and his eyes were kept constantly directed, during these hours of observation, toward the heavens in the general direction about 30° N. of E., and 45° high.

On the first night about one-third were of the common sort, such as are visible on every clear night. Nearly all the remainder were "cigar" shaped, and radiated from the sickle in the constellation Leo. On the next night only four of the 23 were "cigar" shaped.

(2.) *In England.*—From a report in the Royal Astronomical Society

Notices (pp. 54–57), of a verbal communication to the Society by J. Glaisher, Esq., and of a subsequent conversation, we take the following.

"On the night common to the 12th and 13th of November a watch was kept up at the Royal Observatory, Greenwich, from the hour of 6. Between this hour and 8^h two meteors only were seen; from 8^h to 12^h the sky was cloudy and no meteors were seen. At this time six observers (viz., W. C. Nash, A. Harding, F. Trapaud, E. Jones, T. Wright, and Lieut. Rikatcheff, R. I. N.) were located on an elevated part of the observatory. At 12 minutes after midnight the clouds began to break, and at 20 minutes to 1 the sky was free from clouds. At 1 o'clock the paths, zones, color, and other particulars of 29 meteors, were recorded. By 2^h A. M. the same particulars of 70 additional were noted; and by 5^h A. M. the positions, &c. of nearly 280 meteors had been secured. Before this time we knew that we had abundance of observations to determine the radiant point or points; and for a space of nearly a quarter of an hour the paths of the meteors among the stars, &c. were not noticed, but their number was simply counted. The result was that at this time the meteors of the first class were appearing at the rate of 250 per hour. Now for every meteor observed, there were at the lowest estimation two or three whose positions were not recorded; so that at least 1000 meteors were visible during the hours of 1 to 5 o'clock.

At the hour of 5 the moon was shining brightly, and many meteors were seen close to her.

Mr. Alexander Herschel was observing at Hawkhurst till nearly 3^h A. M., and he noted the positions and paths of 68 meteors, which he has laid down on a diagram, indicating very clearly a well-marked, radiant point in *Leo*.

Many of the Greenwich meteors are laid down on this diagram, and by comparing the two diagrams together it will be seen that the Hawkhurst diagram indicates the radiant point in *Leo*, within narrower limits than the Greenwich diagram. Also it will be seen that more than one radiant point is indicated in the Greenwich diagram; but they are in the same right ascension, viz., about 10^h. Now the great interest connected with this part of the results, in relation to astronomy, is that this position in *Leo* is the part of the heavens toward which the earth was moving at this time; and apparently, as soon as the earth approaches this part of the heavens, those bodies situated there become luminous. This adds another link to the sciences of astronomy and meteorology.

I think there is no doubt that the meteors observed this night were those of the November period. At Greenwich, for more than twenty years, a good lookout has been kept for the annual display of shooting-stars at the November period, but this is the first time we have seen them. It is very likely that on several occasions we have closed our watch too early. It was the knowledge of this fact that made me say, at the beginning of these remarks, that I was not surprised at gentlemen giving up watching at 12 o'clock; for it is no joke, as I know by experience, to stand motionless on a clear, cold night, hour after hour, staring, as it were, at vacancy, with perhaps one or two observations only as a reward. It is also likely that on some occasions the shower has taken place during the day, and therefore has not been visible at Greenwich at all.

Speaking of radiant points, I may remark that there are 56 already determined and well marked. Many of these determinations have been materially influenced by isolated observations of meteors observed on the same day in different years being brought together, thus indicating the same point of the heavens as the origin of the meteors. I know nothing in physical research which seemed so unpromising as isolated observations of shooting-stars did a few years ago, yet how well a patient and painstaking record of such phenomena has been repaid.

The next step in the reduction of the observations of these meteors will be to ascertain those which have been doubly and trebly observed, so as to determine their heights and velocities.

The only information I can give to-night in these respects is that with which Mr. A. Herschel has furnished me. It appears that 15 meteors observed on that night by Mr. Herschel at Hawkhurst were simultaneously observed by Prof. Adams at the Cambridge Observatory. The distances from the earth, at the beginning and end of the apparitions of five of these doubly-observed meteors, were as follows:—75 miles and 54 miles; 72 miles and 55 miles; 68 miles and 44 miles; 89 miles and 57 miles; and 114 miles and 86 miles.

These distances are somewhat greater than usual. I consider it of great importance to get simultaneous observations of other meteors; and I hope that our knowledge of the distances, &c. of these bodies will be much increased by the observations of this night."

Prof. Challis said: "What Mr. Glaisher has said confirms my experience at the Cambridge Observatory. I often looked out for the November meteors, but could not see them. I had seen the August meteors very regularly with no very great disproportion as to the numbers; but I cannot say that I saw anything more on the 12th November than on other nights. Prof. Adams has given me the particulars of his observations last 12th November. He began at 12 o'clock, and went on to about 20 minutes past 1, and during that time I think it was 120—at all events, above 100, that he saw. My experience of the August meteors has been this, that I never at that hour of the night got that number; so that it is quite clear, from the experience of the Cambridge Observatory, that the appearance of this last November is exceptional—a kind of shower such as we have not noticed before. I may also, perhaps, state that Prof. Adams told me that he found fourteen coincidences—I think twelve certain—by comparing with Mr. A. Herschel's observations; and that the average height of the meteors they ascertained was 83 miles. I mention this because, in the year 1862, I took observations myself in the August period, and compared them with observations made at Hawkhurst on that occasion, and we got an average height of 82 miles. The number of coincidences is ten; and I think the coincidence of heights at the two periods is remarkable and worthy of notice."

Mr. Prideaux said that on the night in question he had gone with two companions to the top of Primrose Hill, and that in the forty minutes they remained there they saw seventy-two meteors. His friends were perfectly inexperienced in the matter. They arrived there about 3 o'clock in the morning. During the whole of the time that they were out, somewhere about an hour and a half, they saw nearly 120 meteors.

2. *Meteoric Explosion near Charleston, S. C.*—The inhabitants of Charleston were much surprised by an unusual phenomenon, that occurred at about half past eight last evening. The air at the time was still, and a slight shower was falling. Suddenly a vivid flash of light, considerably different in character from ordinary lightning, everywhere prevailed; and after an interval of about one minute came a very heavy explosion, producing in many instances a jarring of windows, similar to an earthquake. Various conjectures of the cause were expressed; some supposing it to be lightning, others this agency, followed by the explosion of a powder magazine in one of the forts in the harbor, as the sound seemed to proceed from the southeast. On inquiry this morning, I learn from an intelligent gentleman, who, at the time, was standing upon one of the wharves, that the light was so dazzling that he involuntarily covered his eyes with his hands, and was thereby prevented from observing whence it proceeded; but that the report, after an interval of rather more than a minute, came from the south. He noticed also that the explosion was followed for some seconds by a peculiar rumbling sound, more monotonous than is usual in the reverberations of thunder. A colored sentinel before the Roper's Hospital described it as a falling star, and pointed to the southern heavens as the region from whence he saw it descend. C. U. S.

Medical College, Queen street, Charleston, December 10, 1865.

Since writing the above but little additional information has been obtained, the most important being that afforded by Capt. Boutelle of the United States Coast Survey, whose steam-cutter, the Bibb, was at the time lying off the south end of the city. He estimated the interval between the light and the report at 30 seconds; and supposed the explosion occurred in a southeasterly direction, at a distance of about 7 miles, making the fall of the body to take place over the water. As affording some evidence concerning the duration of the light, Capt. B. mentioned the circumstance, that the sentinel on deck, hearing something like the movement of a small boat under the bow of the steamer, was led to suspect an attempt at escape by some of the crew. The flash occurring at the same moment, he discovered two men in a boat just making off in that direction, whereupon he leveled his piece, as if with the intention of firing upon the refugees, who observing their peril immediately commenced their return to duty,—an instance which has perhaps never before occurred where the light of a meteor has lent itself for the support of military discipline.

An observer in the city has stated to me that the sky was much overcast at the time, so as to have concealed the path of the meteor. He noticed, however, what he called three waves of light, and also stated that the flashes revealed the outlines of the clouds in several places. Still another observer thought the light had a bluish tint. All concur in its want of resemblance to lightning. Even children in the streets were alarmed by it; and in one instance several of them ran into a shop and secreted themselves until after the explosion.

A conductor on a South Carolina railroad observed the light of the meteor at a place 75 miles north, or north-by-west, of the city; from which it would seem that its course was from N.W. to S.E. C. U. S.

3. *On the Heat attained by the Moon under Solar Radiation;* by Mr. J. P. Harrison.—On the assumption that the moon's crust is constituted geologically like the earth different parts of her surface would not attain the same degree of heat. Nearly two-thirds of the hemisphere turned toward us is honeycombed with gigantic craters, and covered everywhere with the *débris* of stupendous volcanic eruptions. That region, should, therefore, absorb less heat, in proportion to its reflecting properties. On the other hand, the greater portion of the dark surface of the moon would absorb and radiate heat in the inverse ratio to their non-reflecting surfaces. The whole surface of the moon being exposed in turn for from about thirteen to rather more than sixteen days to the solar rays, in speaking of the heat which our satellite attains it must not be considered that equal surfaces illuminated—e. g., at the first and third quarters—are equally *heated* because so illuminated, or without reference to the duration of the sun's radiation upon them. On the contrary, at the day of first quarter, the region of the moon which has received the rays of the sun for a mean period of nearly three and three-quarter days, after being subjected to the most intense cold during the moon's long night, has been gradually warming up to the time it completes its first quarter; the region opposite the earth having received the heat of the sun's rays for only about four and twenty hours—a period manifestly insufficient for any surplus heat to have been absorbed, even if the region had been favorable for storing radiant heat. At the period of last quarter, on the other hand, the surface illuminated will have been heated twice as long as at the first quarter—namely, for a mean duration of seven and a half days—and not only so, but at the time when the moon completes her third or last quarter, a similar surface to that at first quarter will have received the heat of the sun's rays for 360 in place of 24 hours, with this additional peculiarity, that the surface generally will be a good absorber of heat. The heat of the moon at the last quarter might, on like grounds, be shown to be greater, or certainly not less, than at the full. It will be sufficient, however, to point out that at the period of maximum heat, that portion of the moon's fully-illuminated hemisphere opposite to us, and which radiates heat directly toward the earth, is not heated so intensely at the full as at the last quarter, or for a day or so after that phase; the ratio in favor of the latter portion being nearly two to one, whilst the ratio in favor of the last quarter compared with a corresponding region in the first quarter is rather more than fifteen to one; the measure being the duration of solar radiation, without reference to the surfaces on which it falls.

The author exhibited a curve of the mean temperature at Greenwich for fifty years, showing that the period of the greatest heat of the lunar surface synchronized with the period of greatest monthly cold in the terrestrial atmosphere, and conversely.—*Proc. Brit. Assoc., Reader, Oct.* 7.

4. *Elements of the asteroid* (85).—The following elements are given by Dr. Peters for the asteroid (85).

$$\begin{array}{ll} \mathrm{M}=334^\circ\ 10'\ 43''\,7, & i=11^\circ\ 55'\ 35''{\cdot}4, \\ \pi=321\ \ 45\ 18\ {\cdot}7, & \varphi=11\ \ 10\ \ 56\ {\cdot}1, \\ \Omega=203\ \ 50\ 42\ {\cdot}4, & \mu=818''{\cdot}16574, \end{array}$$

$$\log.\, a=0{\cdot}4247769.$$

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the Manufacture of Cast Steel; its Progress and Employment as a substitute for Wrought Iron;* by H. Bessemer.—This important paper, which will be printed *in extenso* in the annual volume, opened with a review of the inventions which had finally resulted in the establishment of "Bessemer" ironworks throughout the country. It pointed out at some length how the disadvantage of the old fixed converting vessel was remedied, and other improvements introduced. In 1839 the trade of Sheffield received an enormous impulse from the invention of Josiah Heath, who patented in this country the employment of metallic manganese, or, as he called it, "carburet of manganese;" the addition of a small quantity of this metal, say from half to one per cent, rendered the inferior coke-made irons of this country available for making cast-steel. It removed from these inferior qualities of iron their red shortness, and conferred on the cast-steel so made the property of welding and working soundly under the hammer. Mr. Heath, supposing himself secure in his patent, told his licensees that if they put oxyd of manganese and coal-tar or other carbonaceous matter into their crucibles along with the blister steel it would do as well and be much cheaper than the carburet of manganese he was selling them; in effect it was the same thing, for before the steel was melted the carbon present reduced the oxyd of manganese to the metallic state, so that the patent carburet of manganese was formed in the crucible in readiness to unite with the steel as soon as it became perfectly fused. But the law decided that this was not Heath's patent, and so the good people of Sheffield, after many years of litigation, were allowed to use it without remuneration to the inventor. Manganese had now been used for many years in all cast-steel works in Europe. It mattered not how cast-steel was made, since manganese added to it necessarily produced the same beneficial changes. No one appreciates the fact better than the unfortunate Mr. Heath, as evidenced by his patent of 1839, in which he declared that his invention consisted in the use of "carburet of manganese in any process whereby iron is converted into cast-steel." Had Heath seen in his own day the Bessemer process in operation he could not have said more. With this patent of Heath's expired, and become public property, coupled with the universal addition of manganese and carbon to cast-steel, it would naturally be supposed that the author, in common with the rest of mankind, would have been allowed to share the benefit which Heath's invention had conferred on the whole community, but it was not so. The reading of the author's paper on the subject, at Cheltenham, in 1856, led to great expectations as to the value of the new process, and licenses to manufacture malleable iron, under the patent, were purchased by ironmasters to the extent of 25,000*l.* in less than twenty-five days from the reading of the Cheltenham paper. Great excitement existed at the moment in the iron trade, and many persons seemed to covet a share in an invention that promised so much. There was consequently a general rush to the Patent-office. Some of the gentlemen who applied even repatented some of the writer's own patents, while others patented things in daily use, in order that they might be considered new, when added to the products of the new pro-

cess. The paper described the features of the numerous patents applied for within six weeks of the reading of the paper at Cheltenham, and remarked that if that long series of patents could have been sustained in law, it would have been utterly impossible for the author to have employed manganese with steel made by his process, although it was considered by the trade impossible to make steel from coke-made iron without it.

Soon after the reading of the Cheltenham paper, several rough trials of the Bessemer process were made privately, by persons in the iron trade, and defects discovered which were supposed by practical men to be wholly fatal to the invention. The press then spoke of the utter impractibility of the process, and of regrets that the high expectations originally formed were so fallacious; but the storm gradually subsided, and the process and its author were soon entirely forgotten. Imperfections in the process there certainly were, but the author had had the most irrefragible proof of the correctness of the theory on which his invention was based, and also of the fact that the reasoning on which it was condemned by the trade was in itself wholly fallacious. He therefore decided not to argue the question against a hundred pens, but energetically to prosecute his experiments, and to remain silent until he could bring the process to a commercial success. When, at the expiration of three years of incessant labor on the part of himself and his partner, Mr. Longsdon, and an expenditure of more than 10,000*l.*, the process was again brought before the public, not the slightest interest was manifested by the trade. This was discouraging, and one of two things became imperative; either the invention must be abandoned, or the writer must become a steel manufacturer. The latter alternative was unhesitatingly accepted, and Messrs. Henry Bessemer & Co. determined to erect a steel works at Sheffield, in the very heart of the stronghold of steel making. At these works the process had ever since been successfully carried on; it had become a school where dozens of practical steel-makers received their first lessons in the new art, and was the germ from which the process had spread into every state in Europe, as well as to India and America. By the time the new works at Sheffield had got into practical operation, the invention had sunk so low in public estimation, that it was not thought worth paying the 50*l.* due at the expiration of three years on Mr. Mushet's large batch of manganese patents. They were consequently allowed to lapse, and become public property. The author had therefore used without scruple any of the numerous patents for manganese without feeling an overwhelming sense of obligation to the patentee. At the suggestion of the author, works for the production of manganese and alloys were erected by Mr. Henderson at Glasgow, who now made a very pure alloy of iron and manganese, containing from 25 to 30 per cent of the latter metal, and possessing many advantages over *Spiegel Eisen*, which it would doubtless replace. (Specimens of iron manufactured by this process and afterwards bent and tested in every way were exhibited.)

The paper proceeded to notice some of the more important applications of steel as a substitute for wrought iron. In no case, it was pointed out, was this change of material more important than in the construction of ships, for in no instance were strength and lightness more essential. Bessemer cast-steel ship-plates were then described, and their advantages illustrated by facts and statistics. The advantages had not escaped the attention of Mr. Reid, the Constructor of the Navy, and they would doubtless soon have substantial proof of what might be effected by the employment of steel in the construction of ships of iron. The application of steel to projectiles was next considered. Next its uses for railway purposes, such as the manufacture of engine cranks, axles, tires of wheels, and even rails. The paper described successful experiments which had been made in the use of cast-steel for these purposes. The paper concluded by stating that cast-steel was now being used as a substitute for iron to a great and rapidly increasing extent. There were now seventeen extensive Bessemer steel works in Great Britain. There were at present erected and in course of erection in England no less than sixty converting vessels, each capable of producing from three to ten tons at a single charge. When in regular operation, those vessels were capable of producing fully 6,000 tons of steel weekly, or equal to fifteen times the entire production of cast-steel in Great Britain before the introduction of the Bessemer process. The average selling price of this steel is at least 20*l*. per ton below the average price at which cast steel was sold at the period mentioned. With the present means of production, therefore, a saving of not less than 6,240,000*l*. per annum might be effected in Great Britain alone, even in the present infant state of the steel manufacture.

In the discussion which followed, in reply to Mr. Bramwell, Mr. Bessemer said they had proof that they could produce malleable iron, but at the same time the bulk of iron ores were so impregnated with phosphorus and sulphur that it was extremely difficult. They, however, were now using hematite ore at the rate of 4,000 tons weekly. As regards waste, taking the average of the last 10,000 tons made, he found that there was 12¾ per cent difference between the weight of pig-iron put into the furnace and the cast-steel ingots obtained. But from this should be deducted 5 per cent of impurities, and 5 per cent the usual waste of pig-iron in melting, so that only 2½ pr. ct. of iron was wasted in the process.

Mr. Lloyd said, as a practical ironmaster, he could bear testimony to the value of Mr. Bessemer's process. He had tried it for three years, and had accomplished all that Mr. Bessemer had stated.

Dr. Fairbairn said there could be no doubt that a great change would sooner or later take place in the manufacture of iron. Hitherto the great difficulty in the manufacture of steel had been the want of uniformity. If Mr. Bessemer by his process could always secure uniformity in the quality of his manufacture, the probability was that steel would take the place of wrought iron in all large works, not only on account of its greater brightness, but of its increased strength.

Dr. Price stated that the introduction of the sulphur was due in a great measure to the fuel employed; and as it has been proved by careful research that all the phosphoric acid in the materials melted at English works was reduced to phosphorus, which combined with the iron, it would be of great value to the ironmaster if Mr. Bessemer could state what was the maximum amount of phosphorus that pig-iron might contain to be available for conversion by his process, as it could then be predetermined whether the iron would suit for this purpose.

Mr. Bessemer said, 0·1 pr. ct. of phosphorus might be present in the pig. —*Proc. Brit. Assoc.*, *Reader*, *Oct.* 21.

2. *Chicago Academy of Sciences.*—We have received the first Bulletin of this new institution, in the form of a neatly printed pamphlet of sixty-three pages. It contains the Act of Incorporation, Constitution and By-Laws, and Lists of Officers, Members, and Correspondents; together with a lucid historical sketch of the establishment and progress of the Academy, by Dr. Andrews, the President; also, a very full and complete report on the condition of the Museum and Library, by Dr. Stimpson the Secretary and Mr. Frost the Librarian.

The following gentlemen are the Officers of the Academy: Dr. Edmond Andrews, President, Daniel Thompson and Benjamin F. Culver, Vice-presidents; Dr. William Stimpson, Secretary; and George H. Frost, Librarian. The officers of the Board of Trustees are the following: I. Young Scammon, President; William E. Doggett, Vice-president; George C. Walker, Secretary and Treasurer; and Robert Kennicott, Director of the Museum.

From the Report of the efficient Secretary, Dr. Stimpson, we learn that there are already in the Museum nearly forty thousand specimens of Mammals, Birds, Birds-eggs, Reptiles, Insects, Crustacea, Annelids, Mollusca, Echini, Corals, Plants, Fossils, Minerals, &c.; and Mr. Frost's Report shows that the Library, though yet small, contains a number of valuable works on various departments of Science.

Mr. Kennicott, the energetic Director of the Museum, is now with a corps of young naturalists, in Russian America, attached to the party exploring the route for the overland Russo-American Telegraph; and will doubtless bring back from that distant and little known country, large accessions to the Museum of interesting objects of Natural History.

We learn that the Academy will soon commence the issue of liberally illustrated Transactions and Proceedings; and that during next summer a fine fire-proof building will be erected for the reception of the Museum and Library, on a valuable block of ground given for that purpose.

The establishment and liberal support of such Institutions as this and the Chicago Astronomical Observatory are facts that speak well for the intelligence of the citizens of Chicago. They have already shown us that they possess the energy, the capital, and the skill to build up a great and flourishing city in an astonishingly brief space of time, and now they seem to be equally in earnest when they speak of soon making their city "the scientific as it is already the commercial center of the west."

3. *On a Second Journey into Western Equatorial Africa;* by P. B. Du Chaillu.—Mr. Du Chaillu stated that he left London on the 5th of August, 1863, and on the 9th of October in the same year he reached the mouth of the Fernand Vaz River, on the African coast, immediately to the south of the equator. The ship in which he had sailed had to land its cargo in native canoes, and in going ashore himself with his scientific instruments he was capsized, and the most valuable part of the instruments lost. A new set from England was ordered, but it did not reach him till August in the following year—a delay which he employed in making collections of Natural History, and transmitting them to England. He then advanced eastward to the Ashira country, where he had been on his former journey, and where he was well remembered and kindly received. The country from the coast eastward rises by successive

steps. First, there is a belt of low land near the sea, then a succession of hilly ranges running northwest and southeast, with valleys between, the ranges increasing in altitude toward the interior, and the passes over them ranging (by aneroid and boiling-point) between 1,864 and 2,400 feet. The greater part of the country is covered with dense forest, through which are narrow paths leading from village to village; but from the Ashira country eastward there are three main lines of path—one to the northeast, another to the east, and the third to the southeast. The tribes are divided into clans, and each village has its own chief, the inhabitants always belonging to the clan of the mother. The villages are more populous and larger than those near the coast. In reading the works of Grant, Speke, and Burton, he observed many words which were identical with or which closely resembled words used in the district he had traversed, and he had no doubt that the tribes of Western and Eastern Africa had formed originally one people. After he and his party had been about three weeks in Ashira, a visitation of small-pox ravaged the country. Misery and destruction were spread on every side, and he was himself reduced to a most dejected and prostrate condition. To increase his difficulties, the chief, Olenda, his old and tried friend, died of the disease, and the traveller was accused of causing his death by witchcraft. He was, moreover, prohibited from continuing his march eastward through the Apingi country (the route which he had followed on his former journey), owing to the Apingi king having died soon after his visit, and his death being attributed to the white traveller, who was believed to have wished to carry the spirit of the chief back with him to his own country. He was ultimately enabled to continue his journey eastward by the Otando country. In the course of the journey he met with a singular diminutive wandering tribe, a kind of negro gypsies, of lighter color than the negroes, and having shorter hair on the head and hairy bodies. The average height of the women, a few individuals of whom he measured, was only from 4 feet 4 inches to 4 feet 5 inches. After he had advanced 200 miles farther than any European had yet penetrated, his undertaking was brought to an unexpected termination by an accident. This was at the village of Mooaoo Kombo, 270 miles from the mouth of the Fernand Vaz. One of his men fired off a gun accidentally, and two of the natives—a man and a woman—were unfortunately killed. The villagers became at once excited, and attacked himself and his party with their spears and poisoned arrows. He could not blame them for the suspicion and irritation under which they acted, and he, therefore, forbade his men to fire on them. He then ordered his followers to retire, which they did, at first in good order, while he himself remained in their rear, as he believed he was in a less degree than they an object of resentment to the excited natives. A panic, however, soon seized his party; he found it impossible to check them; they threw away all the articles which they carried; he himself felt compelled to join them in their flight and to part with many of the most valuable things which he had in his possession. The result was that, although his men energetically rallied, he lost all his instruments as well as his ammunition, and all that could have enabled him to continue his journey with advantage. He lost also the whole of the Natural History collections he had made in the interior, and a fine series of photographs of the scenery and natives. He saved, however, his chronometers, which he himself carried, and his journals, with one set of his astromomical observations. He at once, therefore, retraced his steps westward, and immediately afterward made his way back to England.—*Proc. Geograph. Soc., Jan.* 8.

4. *On Beef and Pork as sources of Entozoa;* by Dr. Cobbold, F.R.S.—This paper brought together all the evidence bearing on the question as to the source of tapeworms in the human body, and especially controverted an opinion recently enunciated in the columns of the *Natural History Review*, in which journal it was maintained that the *Tænia* would cease to infest us if the pig was deprived of the privilege of acting "the part of a communicating medium." It was shown that beef was a much more fertile source of tapeworms than pork; this conclusion being drawn not only from data furnished by the author's experimental researches, but also from the fact of the much greater prevalence of the hookless tapeworm (*Tænia mediocanellata*) as compared with that of the hooked species (*Tænia solium*). An animated discussion followed, in which Professor Van der Hoeven, Professor J. H. Bennett, Dr. Fleming, Dr. Crisp, Dr. Anderson, Dr. Patterson, Messrs. Turner, Power, and others took part.—*Proc. Brit. Assoc.*, *Reader*, *Sept.* 30, 1865.

5. *Illumination under the Microscope.*—At the late *soirée* at University College, two forms of Mr. Smith's (of the United States) illumination for opaque objects under high microscopic powers were exhibited. One was constructed by Messrs. Smith and Beck, of Cornhill, and the other by Messrs. Powell and Lealand. The first form closely resembles the American contrivance—so closely, indeed, that it is difficult to know in what the difference between the two consists. A brass box intervenes between the end of the microscope tube and the objective. This is pierced at the side by an aperture opposite which a table lamp is placed; within the box is a small silvered mirror, which receives the light from the lamp, and throws it down through the objective upon the object. This contrivance, though it works admirably with such a power as the one-fifth inch, is objectionable, from the fact that it cuts off half the pencil of rays proceeding to the eye of the observer. The second form —that exhibited by Messrs. Powell and Lealand—is superior to that of Smith and Beck, and differs from the American plan in having a reflector of plain glass. The result of this alteration of the original plan is that whilst sufficient light is thrown down to illuminate the object, the rays proceeding from the latter are not partially cut off. This modification applied to the one-twelfth inch gave splendid results, and the makers allege that it may be used with one-twenty-fifth or one-fiftieth inch glasses with equal advantage.—*Reader, Dec.* 23.

OBITUARY.

Lovell Reeve, the publisher, died on the 18th instant at his house in Henrietta street, after thirteen months' severe suffering, aged fifty-seven. Mr. Reeve was well known, not only as a publisher, but also as an author, his contributions to the natural history of the Mollusca being both numerous and valuable. They are to be found in the volumes of the "Proceedings of the Linnean Society," of which body Mr. Reeve was a fellow.

He was also the author of "The Conchologist's Nomenclature," 1845; "Conchologia Systematica," 1841–3; "Conchologia Iconica," 1842–5; and "Initiamenta Conchologia," 1846.—*Reader, Nov.* 25.

Prof. FORCHHAMMER, of Denmark, distinguished in the departments of geology and mineralogy, and Secretary of the Academy of Sciences of Copenhagen, died in December last.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *Mineral Oil. Prospectus of the Indian Creek and Jack's Knob (Cumberland and Clinton counties, Kentucky) Coal, Salt, Oil etc. Company, with a Geological Report on the Lands;* by Dr. J. S. NEWBERRY. 20 pp. 8vo. Cincinnati: 1866.—Dr. Newberry, as early as 1859, in a paper on the Rock Oils of Ohio, published in the Ohio Agricultural Report for that year, gave an excellent review of the subject of mineral oil, including views on its nature and origin. He pointed out the rocks in the United States affording it, referring the oil of Ohio to the Waverly sandstone as its principal repository, but to the Hamilton shales beneath as probably its original position, the same rock which he states affords the oil of Canada West.

In the Report whose title is above given he makes observations on the geological structure of the Cumberland Oil Region (Kentucky) from which we take the following facts. The "oil-belt" seems to cover an area on the line of the great anticlinal axis which runs parallel with the Appalachians, and separates the eastern and western coal-fields of Kentucky, bringing the older Silurian rocks over a large region in Kentucky and Tennessee to the surface. The great wells of the Cumberland Valley, "from which tens of thousands of barrels of oil have flowed," descend two hundred feet into the Lower Silurian Blue Limestone formation. There are here bituminous shaly strata overlaid by sheets of thin-bedded compact limestone; and these are covered by 500 feet of shales of the Devonian and Subcarboniferous formations, the whole much upheaved, folded or contorted and faulted. These features prevail from Lincoln and Casey Cos., on upper Green River, through Adair and Russell, Cumberland and Clinton Cos. in Kentucky, and Overton and Jackson Cos. in Tennessee; and over this area at numerous localities oil has been found; but whether all parts will be productive in oil remains to be demonstrated. The region about Burksville, Cumberland Co., is one of the proved oil centers. It is supposed that the Obeys river region, in Overton Co., will be productive. To the north, in Lincoln and Casey Cos., the old salt wells, known as the Alford, the Shanks and the Evans, are flowing oil wells, and seem to point out this also as a center of production.

2. *Geological Survey of California.* J. D. WHITNEY, State Geologist. PALEONTOLOGY, Volume II, Section I, Part I. *Tertiary Invertebrate Fossils;* by W. M. GABB. 38 pp. 4to. February, 1866. Published by Authority of the State of California.—This first part of the second volume of the Paleontology, just issued, contains descriptions of about fifty new species of fossils, besides also of others before known that were imperfectly described, or were not figured. The species are all referred to the Miocene and later Tertiary, no beds having been recognized by Mr. Gabb as positively Eocene,—who observes, however, that future

researches may modify much present conclusions. The plates are not yet quite ready for delivery. There are on hand for description in the continuation of the Paleontology, additional Tertiary species, besides fifty or more new Cretaceous, a few Jurassic and Triassic, some Vertebrate, and many Plants.

3. *Geology of Arisaig, Nova Scotia.*—A paper on the Geology of Arisaig, Nova Scotia, by the Rev. Dr. Honeyman, F.G.S., is contained in the Quarterly Journal of the Geological Society of London, for November, 1864. The strata of the region are Silurian, and have a striking resemblance in fauna to the British Upper Silurian. The whole thickness, as estimated, is 870 feet.

4. *An Outline Geological Map of Tennessee, including portions of Mississippi, Alabama and Georgia;* by NELSON SAYLER. Published by E. Mendenhall. Cincinnati, Ohio. 1866. Price $2.00.—This map is mainly a copy of that published by Prof. James M. Safford in his Geological Report of Tennessee. It gives by means of lines and colors a general idea of the areas occupied by the several formations, with less of detail than in the original by Mr. Safford, and is accompanied by a section of the state stated to be "arranged from J. M. Safford's Geological section." The map will prove a useful one to all interested in the geology of Tennessee, or in the general geology of the United States.

5. *Die Steinkohlen Deutschlands und anderer Länder Europa's;* by Prof. Dr. H. B. GEINITZ, Prof. Dr. H. FLECK, and Dr. E. HARTIG. Vol. I, Geologie, 420 pp. 4to, with a thick 4to volume of 28 plates. Munich, 1865. (B. Oldenbourg. Price for the volume 12 thlr.)—The first of the two volumes of which this great work is to consist has just been issued in two parts, the first including the text, the second the plates. This volume completes the Geological part of the work, and is prepared by Dr. Geinitz; the second will take up the subjects of History, Statistics, and Applications to the Arts, and is the work of Prof. Fleck and Dr. Hartig.

The Geology treats of the Coal regions and formations of Germany and the rest of Europe. It takes up, in order, the different positions of fossil coals commencing with the Azoic beds, and the kinds of coal; the stone coal formation of the Kingdom of Saxony; of the Prussian province of Saxony, the southern border of the Harz, the Thuringian Forest, the Bavarian Oberpfalz, and the Schwarzwalde; in Saarbeck and Rheinpfalz (contributed by von Rönne); of the vicinity of Aachen (by Dr. von Dechen); of Westphalia, and near Osnabrück in Hanover; the Silesian, continued in Bohemia and Moravia (by Bergmeister Schütze); the Brown coal of the Alps, in the Keuper and Lias; and of Austria, in the Cretaceous and Tertiary; the stone coal of Switzerland, Savoy, Italy, Portugal and Spain; of Belgium and France; of England and Scotland; Sweden; Denmark; Russia. Dr. Geinitz treats his subject in a masterly manner, it being a department in which he has long labored and with many original results and publications. Sections are given of the beds; descriptions of the rocks, and of the intersecting dikes when they occur; comparisons of fossils; sections of mines and the associated rocks; and whatever, in fact, is of interest and importance connected with the geology of coal. The volume of plates includes geological maps of the various countries or regions that contain coal, and profile sections of coal beds; and are prepared and engraved in a style of great perfection and beauty. Some of the folded plates are six times the size of the quarto page.

The 2nd volume, treating of practical and economical subjects connected with coal, is soon to be issued at the price of 9 thalers.

6. *Revue de Geologie pour les années*, 1862, 1863; by M. DELESSE, Ingenieur en Chef des Mines, etc., and M. LAUGEL, Ancien Ingenieur des Mines, etc. 412 pp. 8vo. Paris, 1865. (M. Dunod.)—A portion of this work appeared in the Annales des Mines, and was noticed by us in volume xl, at page 272. The volume will be welcomed by geologists, as it is an excellent general review of the progress of the science for the years mentioned, and the only one accessible to them. It commences with a preliminary notice of periodicals and works issued during the period, and then takes up the different departments of the subject in the following order: Recent Changes; Systems of Mountains; Rocks; Metamorphism; Geogony, or the origin of metalliferous deposits, changes of level, etc.; Facts relating to the successive formations and their fossils, commencing with the Paleozoic; Geology of particular regions or localities, and geological maps. An extensive circulation of the volume would tend greatly to the progress of geological science. This is the third volume in the series issued by MM. Delesse and Laugel, the *first* covering the year 1860, and the *second* 1861.

7. *Om de i norge forekommende Fossile Dyrelevninger fra Quartæperioden, et Bidrag til von Faunas Historiæ;* af Dr. MICHAEL SARS (Prof. in the Christiania University). 136 pp. 4to, with 4 lithographic plates. Christiania. 1864.—This memoir is a description of the Post-tertiary of Norway and its fossils, especially of southern Norway, where there are no Tertiary or Mesozoic strata. No Tertiary exists, in fact, in any part of Norway. At one period in the Post-tertiary the land about Christiania was 500 feet below its present level, so that a deposit of clay was formed containing a fauna of arctic character. Previous to this, as the marks of erosion and groovings over the rocks beneath the clay show, the land was covered with ice to a height of 5000 feet above the sea; and the ice is stated to be the ice of an icy sea. Subsequently to this glacial epoch, there was another in which the seashores were about 150 feet above the present level, and then a fauna of a milder climate, more southern in character, existed along the coasts. The author distinguishes consequently, two epochs in the Post-tertiary (Quarternary) of Norway; a Glacial and a Post-glacial [corresponding, apparently, to the Glacial and Champlain of North America.] The fossils of both of these eras are described in the memoir.

8. *Materialen zur Mineralogie Russlands;* von NIKOLAI V. KOKSCHAROW. Fourth volume. St. Petersburg, 1861.—This continuation of the great work of von Kokscharow, on Russian Mineralogy, treats of the species Æschynite, Euclase, Magnesite, Brucite, Epidote, Orthite, Planerite, Rutile, Melanochroite, Xanthophyllite, Beryl, Pyrrhotine, Chalcopyrite, Kotschubeite (variety of Clinochlore), Karelinite, Linarite, Talc, Volborthite, Silver, Graphite, Rhodonite and Samarskite.

9. *Mind in Nature, or the origin of Life and the Mode of Development of Animals;* by HENRY JAMES CLARK, A.B., B.S., Adjunct Professor of Zoology in Harvard University, etc. 322 pp. 8vo, with over 200

illustrations. New York. 1865. (D. Appleton & Co.)—The title of Mr. Clark's work claims more than he or any author can at the present time fulfil. The work however contains the results of much original observation and is a valuable contribution in illustration of the nature of life and animal development. The author is one of the few investigating microscopists of the country, and has labored with great thoroughness and success among the lower forms of life, and also in the department of embryology, in both of which directions the work gives details of structure of great value. Some of his conclusions will be questioned by other zoologists, and among them, with much reason, his raising the Protozoa to the rank of a distinct Branch or Subkingdom coördinate with the four distinguished by Cuvier, and his views on spontaneous generation. But in a brief notice we cannot properly discuss these points, or any of the many of deep importance which the work brings forward. It contains some personalities which we think had better have been omitted. The illustrations are numerous and excellent.

10. *The Record of Zoological Literature.* 1864. Volume First. Edited by ALBERT C. L. G. GUNTHER, M.A., F.Z.S., etc. 634 pp. 8vo. London. 1865. (John van Voorst.)—This Record contains a general review of the Zoological works and memoirs published during the year 1864. It has been prepared with care, and should be in the hands of all who desire to keep up with the progress of Zoological Science.

11. *On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay;* by W. KITCHEN PARKER, F.Z.S., and Prof. T. RUPERT JONES, F.G.S.--From the Philosophical Transactions, 1865. A memoir both of great zoological and geographical interest.

12. *Principes de Thermodynamique;* par PAUL de SAINT-ROBERT. viii and 210 pp. 8vo. Turin, 1865. (J. Cassone et Cie.)—The author of this volume has brought together into one view the elements of the new science of Thermodynamics,—the science that treats of the mechanical effects due to heat, and of the heat produced by mechanical agents. Those who have read the papers of Carnot, Mayer, Joule, Thomson, Rankine, Clausius, Helmholtz, Hirn, &c., will find little that is new in this volume. The only portion for which the author claims novelty is the seventh chapter, which treats of the motion of balls in the bore of fire-arms. To those who wish to find the mathematical principles of Thermodynamics in a single volume, developed in an exceedingly lucid and simple manner, we commend this book of Saint-Robert. H. A. N.

13. *Musée Teyler. Catalogue Systématique de la Collection Paléontologique;* par Dr. T. C. WINKLER. 2nd and 3d Livraisons. Harlem. 1864, 1865. (Les Héritiers Loosjes.)—These two parts carry this work from the 125th to the 394th page, and are devoted to the Mesozoic era, that is, the Triassic, Jurassic and Cretaceous periods. The work is a model for such catalogues, being quite perfect in its method, very full in its synonymy and references, and of remarkable beauty and distinctness in its varied typography. The Physical Cabinet (Cabinet de Physique) of the Teyler Museum at Harlem is under the direction of Dr. V. S. M. van der WILLIGEN; and the Cabinet of Paleontology, Geology, and Mineralogy under that of Dr. T. C. Winkler, to whom all offers of exchange in

these three departments should be sent. The Teyler Museum contains the remarkable head of the Mosasaurus from Maestricht, the various specimens of Icthyosaurus described by Bronn, several species of Pterodactyl described by H. von Meyer, etc.

14. *The Birds of North America.*—D. G. Elliot of New York (27, W. 33d st.) proposes to publish a work to contain all the new and unfigured birds of America, to be issued in Parts, 19×24 inches in size, containing each five plates colored by hand, with a concluding part of text; price for each part, ten dollars. Only 200 copies will be published. Mr. Elliot is author of a Monograph of the Pittidæ or Ant Thrushes, in one volume imperial folio, with 31 plates, and a Monograph of the Tetraoninæ, Grouses, one vol. royal, with 25 plates; in each the birds, with two exceptions only, are represented of life-size. Subscriptions are requested.

15. *Chambers's Encyclopedia*—a Dictionary of Universal Knowledge for the People; illustrated by wood engravings and maps.—Parts 100 and 101, carrying this Encyclopedia to the word *Saxon*, have just been issued by the American Publishers, J. B. Lippincott & Co.

C. F. Gauss' Werke;—a reprint of Gauss's works, by the Royal Society of Göttingen.

British Conchology; by John Gwynn Jeffreys, F.R.S., &c. Vol. III. Marine Shells. London, 1865. (Van Voorst).

History of the Mathematical Theory of Probability from the time of Pascal to that of Laplace; by J. Todhunter, M.A., F.R.S. London, 1865. (Macmillan & Co.)

British Hemiptera, vol. I; by John W. Douglas and John Scott. London, 1865. Published by the Ray Society. (R. Hardwicke).

Prehistoric Man: *Researches into the Origin of Civilization in the Old and New World*; by Daniel Wilson, LL.D. 2nd edition. London. (Macmillan & Co).

Chart of Fossil Crustacea; by J. W. Salter and H. Woodward, with a descriptive catalogue: 490 figures. London. 1866. (J. W. Lowry & Tennant).

Comparative Anatomy of the Vertebrate Animals; by Professor Owen. Announced as to consist in three volumes. The first has been issued, the second will appear in March, and the third before summer.

The Animal Creation: a popular introduction to Zoology; by Thomas Rymer Jones, F.R.S., Kings College, London.

Reliquiæ Aquitanicæ; being contributions to the Archeology and Palæontology of Périgord and the adjoining provinces of Southern France; by Edouard Lartet and Henry Christie. London, 1866. (H. Baillière, Regent St.)

Meteorologiske Jagttagelser, par Christiania Observatorium. 1864. Christiana, 1865.

Meteorologische Beobachtungen aufgegeichnet auf Christiania Observatorium. I. Band, Letzte Lieferung. 1837–1863. Christiania, 1865.

Norges Ferskvandskrebsdyr. Förste Afsnit, Branchiopoda; I. Cladocera, Ctenopoda (Fam. Sididæ and Helopedidæ); by G. O. Sars. 72 pp. 4to, with 4 lithographic plates. Christiania, 1865.

Annals of the Lyceum Nat. Hist., N. York, Vol. VIII, Nos. 6 and 7, November, 1865.—Page 155, Notes on some terrestrial mollusca, with descriptions of new species; *T. Bland.*—p. 174, List of birds from New Grenada, with descriptions of new species; *G. N. Lawrence.*—p. 178, List of birds from Nicaragua, with descriptions of new species; *G. N. Lawrence.*—p. 185, On the Mineralogy of New York Island; *S. C. H. Bailey.*—p. 194, Catalogue of the Mollusca of Little Gull Island, Suffolk Co., N. Y.; *S. Smith.*—p. 195, Remarks on the Spongidæ of Cuba and Description of a new species of Ambulyx from Brazil; *A. R. Grote.*—p. 207, Descriptions of new species of Pupadæ; *E. S. Morse.*

Field Notes retouched, embracing observations upon the Geology, Minerals, and Physical Geography of the States on the waters of the Upper Lakes, by Col. Chas. Whittlesey, of the late Geological Surveys in Ohio, Michigan, Wisconsin and Minnesota, with maps and illustrations.—A work in 8vo, with the above title, is in the press at Cleveland, Ohio.

U.S. COAST SURVEY

A.D. BACHE Supdt.

CURVES OF EQUAL ANNUAL CHANGE OF MAGNETIC DECLINATION

In the eastern part of the United States, for the period 1860 to 1870

+ indicates increasing west declination.

Constructed by CHAS. A. SCHOTT

Assist. U.S. Coast Survey.

Oct. 1865.

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XXXVI.—*On some of the Mining Districts of Arizona near the Rio Colorado, with remarks on the Climate, &c.;* by B. Silliman.[1]

Itinerary and characteristics of the Mojave Desert.—In July, 1864, I visited the Colorado river for the purpose of seeing some of the mineral districts near Fort Mojave. The route followed was from Los Angeles in California by the Cajon Pass and Mojave Desert to Fort Mojave. After leaving the vineyard of Cocamunga the journey is made by encampments. The distance from Los Angeles to the Colorado is about 250 miles, which we made in nine encampments. Few of the stations on this route are laid down on any of the published maps, and are generally watering places only, the whole distance being an uninhabited wilderness, nearly destitute of the means of supporting life. The Mojave desert is entered at the summit of the Cajon Pass, where the road passes through a dug way in masses of sandstone, upturned beds of, probably, Tertiary age. The highest point of this pass is (by barometer) about 4000 feet above tide, and is distant about 25 miles from Cocamunga vineyard. The Mojave river is passed at the 'upper crossings,' about 20 miles from the 'Toll Gate' of the Cajon Pass, and at an elevation of about 2650 feet. The Mojave river, as is probably pretty well known to most readers, is a river in name only, existing, so far as it has water at all, as a series of lagoons with long intervals where not a trace of water can be found. At the so-called

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[1] Read before the National Academy of Sciences at Washington, D. C., January, 1866.

'Upper Crossings' it is seen a few inches deep, flowing with a gentle current eastwardly over a pebbly bottom, but disappearing in a short distance, and never appearing again as a running stream. At the Fish Ponds, Camp Cady, and the Caves, the water re-appears but only in stagnant or torpid pools. The line of the river is however perfectly well marked by rounded boulders and smooth river shingle, and along its dry banks grow some shrubs of which the the so-called willow (a bignoniaceous plant with narrow willow-like leaves) is the most conspicuous, and more rarely the Mezquit bean of the Mojave Indians (*Cercidium Floridium*).

The rough road, often very difficult for an ambulance, follows the dry bed of this so-called river, the grade being pretty steadily downward from the 'Pass' to Soda Springs, 150 miles or thereabouts from the Toll Gate.[3] At Soda Springs the barometer stood at 29·355 inches, being the lowest point in the desert of the Mojave, and differing, by the mean of my observations, only 0·195 in. from the level of the Rio Colorado at Fort Mojave.

Soda Springs marks the site of an ancient lake, the surface of the saline plane being as level as the sea. A powerful spring of calcareous water breaks out on its western margin, charged with sulphate of lime, and bearing, among the ignorant guides of these desert regions, the reputation of containing arsenic or some other deadly metallic poison. We drank freely of it, however, with no ill effects to man or beast, and were very glad to obtain so potable a water after several days of great dearth of this essential of comfort.

The term 'Soda Spring' is a misnomer, as the water is destitute both of carbonic acid and alkalinity (it did not affect reddened litmus); has doubtless received its name from its bright sparkling appearance, so much in contrast with the green stagnant water of the 'government holes,' or wells, dug by the roadside for the supply of travellers.

A gigantic fly abounds at Soda Springs and Marl Springs. They were such an annoyance to our animals as to compel us in each case to move on before we were ready, to avoid the torments they inflicted on the poor beasts with their sharp lancets, drawing blood every time when, with a droning sound like that of a humble bee, they struck the skin. They seem to attack the animals in preference to men, as none of our party suffered from them.

From Soda Springs—"the sink of the Mojave"—the road, going toward the Colorado, rises in 25 miles to "Marl Springs"

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[3] An adventurous pioneer on the outskirts of civilization has erected a toll gate just before entering the Cajon Pass, where he exacts a fee of all passers in return for some labor bestowed upon the road at that point; this 'black mail' is cheerfully paid to the self-constituted supervisor.

nearly 3000 feet, and thence in 18 miles farther, at 'Rock Springs,' it reaches an elevation of nearly 3800 feet above Soda Springs. From this point it rapidly descends again in 23 miles to Pah Utah creek, about 1800 feet, and from that point the grade is rapidly descending to the Rio Colorado at Fort Mojave, falling in 24 miles a little over 2000 feet.

Climate at Fort Mojave and vicinity.—Dr. John Stark, Post-surgeon at the military station, Fort Mojave, has kindly furnished me with a copy of his record of temperatures kept at the fort for one year, from Nov., 1863, to Oct., 1864. The following table of monthly averages, prepared by me from Dr. Stark's observations, for the three daily periods of observation, is of interest in this connection.

Table showing the mean monthly temperatures for one year, and also the maxima and minima at Fort Mojave, Arizona, very near Lat. 35°.

	MEANS.			MAXIMA.			MINIMA.		
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.
1863.	°	°	°	°	°	°	°	°	°
November,	48 96	72·50	58·76	63	85	76	38	54	46
December,	42·02	65	53 96	57	77	62	36	58	49
1864.									
January,	40·97	68·58	58·38	62	80	70	31	56	43
February,	52 31	78·48	63·06	69	90	77	28	56	43
March,	52·12	80·00	64·35	58	90	75	41	70	57
April,	69 83	90·11	80 01	83	102	87	52	73	60
May,	73·64	89·29	78·64	85	102	92	62	70	60
June,	77·40	99·10	87·10	88	106	98	63	88	72
July,	84·23	106·09	96·38	94	111	102	73	101	91
August,	87·35	106·67	97·48	95	115	104	79	99	87
September,	76 30	100 80	88 03	88	108	97	65	90	72
October,	62·09	86·22	72·29	74	100	83	45	70	59

From this table December is seen to be the month of lowest mean temperature, although the minimum degrees of heat are seen in January and February.

The greatest heats are found in July and August, when the temperature is seen to be most remarkably uniform, the maximum being in fact almost identical for the three daily periods of observation respectively throughout, while at 2 P. M. the minimum temperature reaches the remarkable extreme of 101° in July, and 99° in August.[3]

In the San Francisco District, Arizona, the maximum temperature observed by me in August was 101°.

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[3] "No rain of any consequence," says Dr. Stark, "falls at this post except during the months of July and August, though heavy rains are of very frequent occurrence in the surrounding hills. The rain guage has not been regularly kept at this post, but I estimate the mean amount of rain for the years of observation to be about four inches.

"At Fort Yuma, near the mouth of the Rio Colorado, accurate observations show only three inches of rain for the year. Snow has not fallen in this valley since I have been here, now two years.

"The atmosphere, of course, is very dry, dew never being seen. In view of this

The barometer (aneroid) at Fort Mojave was noted in my journal as 29·55 to 29·75. At Allen's Camp, San Francisco District, it was 28·193, average of twelve observations between July 26th and Aug. 1st, the greatest difference being ·055.

The highest temperature noted in the sun was 120° F., at San Juan Camp, (bar. 27·65), Aug. 6. In the sand the mercury rose to 136°, and eggs are coagulated by burying in the sands in 20 or 30 minutes exposure.

The wet-bulb thermometer, which was observed thrice daily during our journey out and back, indicated all through the Mojave Desert and the Colorado regions a remarkable dryness of the air. A few examples will serve as illustrations.

July 21, Mojave Desert, 2 P. M.,	air 104°,	wet-bulb 66,	dif. 38°
" 22, " "	" 104	" 70	" 34
" 26, Fort Mojave, "	" 108	" 75	" 33
" 28, Allen's Camp,	" 101·5	" 70	" 31½
Aug. 1, 10 miles south of Fort Mojave,	" 109	" 73	" 36

Even at night this difference was very remarkable, sometimes as much as 20°, thus:

Aug. 13, Forks of Mormon Road, 9½ P. M.,	air 82°,	wet-bulb 60°,	dif. 22°
" 14, Cottonwood, 9 P. M.,	" 76	" 59	" 17

The 2 P. M. observation rarely gave less than 20° difference between the wet- and dry-bulb thermometers.

Hot wind storms, or sirrocos, are not unfrequent in the desert and on the Colorado. I find this mention of one of these sand storms on the desert in my notes of the journey. "Soon after we had spread our blankets at a 'dry camp' on the plain, about 9 P. M. we heard a roaring sound coming up from the south like the sound of breakers on the shore. As the noise came nearer the resemblance to the roar of the ocean increased, and presently the blast struck us hot as the wind from a furnace, bearing along with it a blinding and almost stifling hurtle of sand, pelting the skin like hail. In vain did we seek to shut it out by covering the head with our blankets. It sifted through all our defenses, filled the hair, was inhaled by nose and mouth and gritted in the teeth, making the skin feel like sand-paper, while the oppressive heat was made ten-fold worse by our efforts to exclude the sand by burying our heads under blankets. It seemed for a time as if we should be buried alive under the

fact I hazard nothing in saying that a more healthful and healing climate for those laboring under that great destroyer, phthisis, could not be desired. These cases seldom present themselves, and then only among emigrants. With simple remedies nature immediately restores good health. I should be glad if this fact were more generally known to those suffering from this disease in eastern cities. * *

"I am now stationed here about two years and have not had a death among the troops during that period; evidence that good health is our epidemic."

drifting sands, but in about an hour the violence of the storm abated, vivid lightening and powerful thunder to the east of us succeeded, and, an hour later, a dash of rain for a few moments, just the outer skirt of the thunder storm, but enough to drive me to seek the shelter of the ambulance.

At Fort Mojave we experienced another similar wind-storm with the temperature over 100°, occasioning more annoyance from the scorching effects of the powerful hot wind.

The officers at Fort Mojave assured us that these hot wind-storms blow sometimes with great violence for a whole week, when it is impossible to go abroad; men and animals being liable to be lost if overtaken on the open desert, as it is then no longer possible to observe the way, gain a shelter, or find water, the latter difficult enough under the best circumstances."

Any notice here of the geology of the Mojave Desert, would extend this paper beyond its proper limits.

SAN FRANCISCO DISTRICT.

Situation and approach.—The San Francisco Mining District is located upon the eastern side of the Colorado river, Allen's Camp, about the center of the district, being stated as 11½ miles from Fort Mojave. Allen's Camp is situated upon Silver Creek so called, a dry arroya which divides the San Francisco District into two nearly equal parts. Measured upon the course of the river, this District extends about twenty miles, or ten on each side of Silver Creek, from north to south. In the other direction, from east to west, the District extends about ten miles, the eastern limit being the first range of mountains, of which the most conspicuous point is known as Boundary Peak.

General Features and outcroppings of the Mineral Veins.—The observer is struck, upon entering this District, with the singularly wild and fantastic outline of its bounding mountains and intermediate ridges; he learns with surprise that the bold and serrated peaks stretching from east to west, and rising, now in delicate needles, and again prolonged in acute ridges, are the outcrops of gigantic quartz lodes, among which are seen conspicuously the Moss lode on the north,—the Skinner and Parsons on the south. The general aspect of these outcrops is different from that of those seen in any other portion of the Great American Desert that I have had the opportunity of examining. Whether from the influence of volcanic heat or of atmospheric causes, or,—which is more probable—of both combined, the aspect of these great quartz ridges is more rugged than any others which we have observed. The general course of the lodes in this District is that of pretty strict parallelism to the east and west magnetic equator, the deviations from this course seldom exceeding 4° or 5° by the compass.

This is true of by far the greater number of all the outcroppings in the District. There is another set of lodes, however, much less numerous than the first, whose general direction is northwest and southeast, or more exactly N. 20° W.: these lodes, if prolonged, must obviously intersect, at certain points, some of the east-and-west lodes. They differ not only in their course and direction, but essentially in their mineralogical constitution. The first series, the east-and-west, are quartz lodes, characterized by the presence of feldspar and fluor spar as the peculiar associate minerals; showing also rather rarely at surface metallic sulphurets and free gold. The second set of lodes may be called calcareous, being composed to a great extent of magnesian carbonate of lime or dolomite, flanked in some cases by quartz linings with polished walls, and as a general rule quite barren and unpromising in their outcrop. The Virginia, Olive Oatman, and Buffalo are conspicuous examples of the calcareous lodes. A third class of lodes is observed in the San Francisco District whose main direction is northeast and southwest. This class is very small, not including more than three or four, namely, the Pride of Mexico, Triumvirate, Wright, and Morning Star.

Resources in timber and water.—San Francisco District, like all the neighboring regions of the Colorado, is entirely destitute of timber, and at present is very imperfectly supplied with water. Timber is said, however, to exist in considerable abundance,—cotton-wood, cedar, pitch-pine, and nut-pine,—on or near the banks of the Colorado, within 100 miles of Silver Creek; at points from which it can be brought at a moderate cost for the supply of fuel and mining timber to meet the future demands of this district.

When we remember the experience in Nevada, especially the dearth of water on Mt. Davidson, in the early history of mining on the Comstock lode in Virginia City, and its present comparative abundance there as the result of mining operations, we are encouraged to believe that a similar result may be expected in San Francisco District, especially since the very limited explorations which have been carried out here have resulted in the discovery of water even in the driest situations.

This region is liable, like all the adjacent semi-desert districts, to sudden and violent storms of rain and wind, which may, as we had occasion to observe during our residence at Silver Creek, in a single hour, convert the dry arroya into a broad and roaring torrent, sweeping everything before it; while a few hours after scarce a trace of the inundation remains beyond the sand bars and pools of slime which a few days sun reduces again to the condition of dust. Wells sunk along the line of these dry water courses find an abundant supply of water at a few feet from the surface, which although hard, becomes reasonably good if constantly used.

Saline or alkali incrustations.—Like all other regions of the Great American Desert the surface of this District is abundantly charged with saline substances familiarly known as "alkali;" salts derived from the decomposition of the alkali minerals of the porphyritic and volcanic rocks which characterize the region. It is the solution of these substances in the drainage waters which gives most of the springs in this section those deleterious properties known as alkalinity. It is to be observed that the water which will flow from tunnels and shafts, excavated here in the processes of mining, will possess little or none of the qualities belonging to the surface waters which dissolve away from every rain-fall the soluble saline matters that capillarity, aided by the powerful evaporation of a semi-tropical sun, concentrates upon the surface of the earth. This evil of bad water may therefore be expected to disappear with the active prosecution of mining enterprises.

Climate and healthfulness.—Under a previous head the climate of the Colorado has been characterized. The San Francisco District, being elevated some 1500 feet above the river, is less fervid during the hot months, the temperature averaging about ten degrees less than at Fort Mojave. The months of June, July, and August, are, however, extremely hot, and all active work in the open air, unless in the early morning or at evening, is interdicted, the temperature ranging in the neighborhood of 100° F. The air is extremely dry, 30° to 40° at times marking the difference between the wet- and dry-bulb thermometer. This circumstance favors exertion by lowering the temperature of the human body. Deep mining will, however, offer a refuge from the tropical summer heats, rendering labor agreeable and supplying also water of a lower temperature and better quality than can be found at the surface.

In point of healthfulness no region can be more free from diseases than this. I ascertained by enquiry from the physician at the military post that there were literally no climatic diseases known on that portion of the Colorado.[4] Malaria is unknown, and fevers equally so; chronic diarrhea occurs rarely, and then is traceable to causes independent of climate. This healthfulness may be considered as nature's compensation for some of the privations incident to this fervid region. The effect upon the urinary organs, due to the use of the saline waters of the desert, disappears immediately upon the use of the river water or any other pure water, and is always under the control of vegetable acids and of moderate doses of alcoholic stimulants.

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[4] See note (3), page 291.

Cost of transportation and labor—The important elements of cost in mining upon the Colorado river and its adjacent district are labor and freight. The former is found to be about the same as in Virginia City and Nevada territory generally, viz., from $4 to $5 per day. So far as present experience justifies an opinion—no considerable amount of active mining having been done here—there is no dearth of labor. Most of the miners who have gone to this country have gone in the capacity of "prospectors" or adventurers, and are to a great extent owners of claims as well as laborers. This is in accordance with the general experience of all new mining districts on the Pacific coast. These bold and adventurous men have often been the pioneers of discovery, and subsequently the authors of the laws and regulations of the mining districts which their own sagacity and industry have developed, and in the organization of which they become officers as well as co-laborers.

Freight, by sea from San Francisco, costs now about four cents the pound, or eighty dollars a ton. The cost by land over the Mojave Desert is much greater; and nothing but the saving of time will justify the use of the Los Angeles route, and then only for the lighter descriptions of freight such as food and the smaller mining supplies. The time by sea up the Gulf of California is about three, not unfrequently four months. Over the Desert the time by government teams is 78 days from Wilmington or San Pedro to Fort Mojave. The navigation of the Colorado is continually improving, especially by the introduction of a class of steam vessels better adapted to this service. The shifting sands of the river, and the high tides—about 25 feet at its mouth—will, however, always make this navigation difficult and uncertain; and the low water of the river in the winter months occasions not unfrequent interruptions in the navigation. All these causes continue to render it highly desirable to improve the Mojave desert road by the establishing of more frequent watering stations, a thing believed to be quite feasible,—and by the improvement of the road itself by the removal of obstructions.

The agricultural capacities of the bottom lands of the Colorado remain to be developed. The Indian tribes now resort to them for the growth of corn, wheat, beans,—of most excellent quality,—yams or sweet potatoes, melons and pumpkins. The native Mezquit bean (*Cercidium Floridium*), and the 'screw bean' (*Strombocarpa pubescens*), furnish excellent food for animals, and is largely consumed by the native tribes for their own support. There can be little doubt that both corn and other grains for stock can be raised here for the wants of a considerable population, as well as all the esculent vegetables and most important fruits. At present the best lands are occupied by the

Indians, from whom, by purchase or treaty they can soon be obtained. In respect to agricultural capacities this region is more favored than most of the mining districts of Nevada, and may be in a good degree rendered self-supporting.

General features of the Geology of the District and successive epochs of eruptive rocks.—The rocks of this District are exclusively porphyritic or volcanic. The porphyry consists for the most part of the feldspathic variety, the crystals of feldspar being implanted in a violet or lavender-colored paste of various shades. Like most of the porphyries observed in the great American desert, for example at Virginia City and at Esmeralda, at Bodie and in the Mojave desert, these rocks yield to atmospheric influences, either crumbling into incoherent masses or breaking away into acute and fantastic cliffs. The porphyries in the San Francisco District are of at least two distinct epochs. Along the right-hand branch of the arroya of Silver Creek for the distance of a mile or more, occurs an olive-green, sometimes leek-green porphyry, in which are imbedded—like boulders in a conglomerate—large masses or fragments of the violet-colored porphyry and of other associated plutonic rocks; for example masses of basalt and diorite. This fact leads us to the conviction that the greenish porphyries are of more recent age than the violet-colored ones whose fragments they contain; fragments identical in character with the violet-colored porphyries which constitute the main mountain masses of the district. As the quartz lodes of this region,—for example those gigantic dikes known as the Moss and Skinner lodes,—contain imbedded in their mass, especially at their surface, fragments of scoriaceous lava, and present in general a burned and roasted appearance, I am led to the conclusion that not long subsequent to the time of their separation from the masses of porphyry through which they cut, there was a general and violent volcanic action resulting in the upheaval or injection of many dikes of basalt, diorite and olive-green porphyry imbedding fragments torn from the older rocks as already described. That this period of activity was general and simultaneous for this region, seems almost certain from the fact of the parallelism of the east and west lodes, as well as from their mineralogical and metallurgical identity, so far as present observation and exploration justify an opinion.

A second period of eruption appears to be clearly indicated by the existence of the second class of lodes already noticed, namely, the calcareous lodes, whose main course is northwest and southeast, and the mineral constituents of which are entirely unlike those of the east-and-west lodes. There is evidence also in this district, as well as in the country at large, of volcanic eruptions of a much more recent date than those which have given origin to the mineral lodes. This evidence is seen in the cappings of basaltic lava which surmount many of the hills with plane tables, or which occur in parallel bands, interstratified with masses of volcanic tufa, sometimes of enormous thickness. We have no data for fixing the epoch of this third class of volcanic phenomena, but it seems clear that like the two others it was sub-oceanic; and in this respect all three are distinctly separated from a fourth and extremely well-marked group of similar phenomena which were plainly sub-aerial, and which occurred, geologically speaking, at a very late period, after the surface topography had assumed its present features. To this fourth class of volcanic phenomena we refer those extinct cones, so conspicuous just east of the Organ cañon of the Mojave,—cones whose lava streams now stretch their rugged course in long and regular inclined planes to a distance of eight or ten miles from the craters, standing with vertical basaltic walls ten or twenty feet above the plain, capped with scoria whose surface still speaks of the sluggish nature of the once molten mass.

Characteristics of the Mineral Veins.—The first thing which arrests the attention of the mineralogical observer in the San Francisco lodes, as compared with those of most other regions, is the general absence of the metallic sulphurets, and of the carious or porous character so common in the outcroppings of quartz in most auriferous regions. In this respect the San Francisco outcroppings are not unlike those seen in some portions of Nevada. There is reason to believe, so far as our own observations have extended, that this character of the outcroppings of the quartz lodes in San Francisco District is common to most the outcroppings in the porphyritic or plutonic rocks of other mining districts in Arizona; as in the districts of Eldorado Cañon and the Wauba Yuma. The larger lodes of the San Francisco District, such as the Moss and Skinner, are characterized also at surface by a cross structure at right angles to the general course of the lodes, breaking them up into a series of subdivisions or headers which include often large masses of the adjacent porphyry walls, or of other rocks more or less distinctly volcanic. Whether it is due to the volcanic action to which the surface of these lodes has been subjected, or to some other less probable cause, it is a fact that most of the lodes in this district show an absence of the fringe or lining of fluccan or clay material, generally found in softer rocks. The lodes of this district are in general glued fast to the adjacent walls of porphyry, but that this characteristic is only superficial seems probable from the fact that the Allen shaft, sunk upon the Moss lode, intersecting the line of its southerly or hanging wall shows a distinctly marked fluccan or fringe, separating the vein from the adjacent porphyry at a few feet depth from the surface,—although at the surface no such structure was visible. The surface of the quartz also, at this portion of the Moss lode has the appearance of having been burned, looking like quartz containing pyrites which has been roasted in the fire and then quenched in water, leaving the surface deeply stained with red oxyd of iron; this stain penetrating by numerous rifts and fissures to a considerable depth from the surface. It was in quartz of this description that the extremely rich samplings of gold were taken which have rendered this lode famous. In similar quartz from this portion of the Moss lode, I found it still easy to obtain rich specimens. The inference is that the surface of these lodes has been subject to the action of heat, probably through hot waters, dissolving or decomposing the metallic sulphurets and leaving the superficial portion of the lodes in a hardened and changed condition, unpromising for metallic value, but giving place in depth to vein stuff of a softer character, and more charged with metallic sulphurets. This change is very conspicuous in the Techatticup lode in Eldorado cañon which has been open to a depth of 140 feet, and shows, as I am informed by Henry Janin, a gradual increase to this depth of metallic sulphurets, from a condition at surface of a quartz lode destitute of these compounds. On the Moss lode a shaft of 52 feet has shown a similar change in the relative hardness of the including walls of porphyry, and the gradual softening of the contents of the vein. As yet the explorations in the San Francisco District are quite too limited in depth to enable us to apply this reasoning with certainty to any number of the lodes, and it is by analogy only that the conclusion is reached which seems to warrant this probability.

Mineral contents of the lodes.—The Moss, Skinner, and in general the larger lodes of the San Francisco District, are characterized by the presence of an abundance of white feldspar, forming sometimes the mass of the vein; the quartz existing then as a subordinate vein in the feldspathic and porphyritic gangue.

The mineral most characteristic of the east and west lodes in the San Francisco District, next to the quartz and feldspar which form the great mass of the lodes, is *fluor spar*, a mineral frequently seen elsewhere in the world as an associate in silver-bearing lodes—as, for example, in Freiberg in Saxony—but which is of rare occurrence in this country in a similar association. This mineral is found abundantly in the Skinner lode, the Dayton, the Knickerbocker, and the Quackenbush; and has been observed also in the Moss and several others. It is associated in them with free gold, horn silver sometimes in distinct dodecahedral crystals, and iron gossan.

Description of some of the veins of the San Francisco District.—In general the lodes in San Francisco District are remarkably vertical, rarely deviating more than 30° from the perpendicular; and their outcroppings are commonly very strong and well marked, forming, in the case of the larger lodes, conspicuous features in the topography of the country—landmarks seen for many miles.

To describe all the lodes in this district would be tedious and unprofitable. The amount of work performed on them has in general been no more than is essential to conform to the easy conditions imposed by the laws of the district upon claimants; and has in most cases been too little to furnish important data for the guidance of the judgment. I shall therefore confine myself to those which are best developed or of the most general interest and importance, commencing with the Moss lode, which has received more attention than any other one of the San Francisco lodes.

Of the Moss lode.—The outcroppings of the Moss lode form a most conspicuous feature in the landscape, being seen, standing up in bold crests and pinnacles, from a long distance. The observer who enters the Colorado valley from the Mojave Desert has his attention arrested by the crests of the Moss lode, as soon as he emerges from the valley of Pah-Utah creek, at a distance of at least twenty miles in an air line. This lode stretches in a continuous line for at least 7,800 feet, and is 'claimed' for double that distance. Its distance north of Silver creek is about two miles, and its course is about W. 5° N., or nearly at right angles to the river, from which it is distant about five miles. This vein shows at surface about fifty feet of thickness, as well as can be judged in its present state of development, while its croppings rise to a height of from fifty to one hundred feet or more above the arroya or wash, sinking at times to the surface and then towering away again in bold peaks and crests. Its height above the Colorado must be at least 1500 feet. Its dip is southerly 65° to 70°, or 15° to 25° away from the vertical. The weathered aspect of this vein is reddish and rich brown, but on breaking away the weathered surfaces it is found to be composed of whitish compact feldspar and quartzose porphyry, intersected by veins of very red, often marbled quartz, at times violet-colored, and rich in free gold. There are included in this vast mass, not merely numerous sets of feldspar, hornstone, and quartz veins, but also masses of gray porphyry and lumps of tufaceous and vesicular lava, indicating the action of heat, either of thermal waters or of direct volcanic agency. Some masses of a cellular structure have the vesicles filled with hyaline quartz or hyalite,—possibly also with some zeolite—and these masses so resemble the siliceous sinter of Steamboat springs in Washoe valley, as to recall at once the probability of a thermal origin. This probability is further strengthened by the occurrence of veined and marbled jaspers and hornstones. Drusy surfaces of crystalline quartz are also seen abundantly in all the "shuts" or closures of the vein.

The hanging wall of the Moss lode is an ash-gray feldspathic porphyry, often intersected by thread veins of quartz and hornstone, but barren of metallic sulphurets, and showing at the surface no clay wall or fluccan, separating it from the vien. The absence of this character of permanent and well defined lodes at the surface of the Moss ledge is in analogy with the character of many veins in Nevada, which, however, at moderate depths acquire this feature, as the Allen shaft shows to be the fact for the south or hanging wall of the Moss lode. The entire outcrop on the Moss lode has a burnt up, dried and hardened aspect, as previously explained; and this character is shown now by very moderate explorations, to be quite superficial.

The characteristic veinstone of the Moss lode is feldspar with veins of chert or hornstone, in which matrix occur veins of highly ferruginous quartz, sometimes almost an iron jasper of various colors, sometimes compact and again cellular. The surfaces of closure are drusy, not separated from the gangue by any parting, but cutting it with a dip usually more highly inclined than the dip of the vein itself. These intercalated or subordinate veins of quartz appear to maintain a course quite parallel with the main vein. Too little work has however been done on the lode to justify this generalization in any more than a limited sense, as far as can at present be seen.

The rich specimens of free gold in quartz, of which over a ton weight were taken at one time in 1864, were obtained on one of these subordinate veins of deep red iron-stained quartz, just behind the point on the so-called San Francisco claim where Allen's shaft is now being sunk. I caused some blasts to be put in at this point and was able to obtain a considerable amount of quartz of similar character, highly charged with gold. That the gold is not confined to this point I found by breaking some specimens at several points along the face of the outcrop for a distance of 250 feet; and it is easy to detect minute particles of the precious metal along a line of 500 feet, by careful observation.

The Moss lode has been opened by a shaft called Allen's shaft, sunk on the San Francisco claim, ten or twelve feet in front of the spot where the first lot of rich ore was obtained, to a depth, in Aug. '64, of 42 feet. This shaft was set to cut the hanging wall of the lode and pass through its entire thickness in an estimated depth of about 100 feet. Where it cut the southern edge of the lode ore was found from which an assay was obtained, showing $4,200 per ton of precious metals.

I ordered this shaft cleaned up, to exhibit the nature of the section it has furnished of this side of the lode. The result was interesting: the "pay streak" or productive ore ground is seen to be here about three feet wide in two nearly equal divisions, separated by about one foot of soft yellowish and reddish material, which prospects well for gold. This softer seam has come in on sinking and is not seen at all at surface. It is increasing in width as the shaft descends and is easily worked by the pick alone. Its dip is such that it passes out of the shaft in twenty-seven feet, the shaft being eight feet wide. The hanging wall is perfectly definite and shows smooth "slickensides," with a clay lining between them in places from three to four inches in thickness. The upper-rock is a reddish feldspathic porphyry, with thread veins of quartz. The vein stuff shows very little sulphurets and the porphyry comes in between the walls. The quartzose ground increases as the shaft descends, until at its present bottom it is nearly all quartz.

The bullion obtained from this vein contains silver enough to give it a pale yellow color. The gold appears in beautiful polished scales, the flat surfaces often embossed with crystalline lines. The precious metal is sometimes imbedded in a compact red jaspery quartz, presenting, when cut and polished, beautiful graphic goldstone. This rich gold-bearing mass of ferruginous quartz it will be understood formed the outcrop of this gigantic vein at only isolated points. Subsequently having an opportunity of comparing the physical features of the Moss vein with the surface show upon the "Comstock lode" in Nevada, I was forcibly struck with the great resemblance of these portions of the Moss vein with that portion of the Comstock which is still seen at Gold Hill, south of Virginia City, where similar rich deposits of low grade gold in the quartz outcrop gave its name to the town which has since sprung into such wonderful activity as the result of the development of the mines which have been opened upon this remarkable silver vein. The inference seems probable that the explorations of the Moss lode will likewise develop a silver mine, and if the magnitude of the outcroppings afford any just ground of comparison, the future of the Moss lode should not suffer in the contrast. But there is this important feature of difference, the rich sulphids of silver associated with native silver which were found in such remarkable abundance in that part of the Comstock, now known as the Ophir ground, has never been seen on the Moss lode.

I am permitted to copy the following certificate of assay and experiments with sodium amalgam made by Dr. Torrey & Son on a sample of ores taken from the rich 'chimney' of the Moss lode. The sample in question was collected in the summer of 1863 by Mr. Chas. W. Strong, who is now engaged in an active exploration of this interesting locality on behalf of a party of New York capitalists:

U. S. Assay Office, New York, Feb., 1866.

Sample of ore from Arizona Territory.

Weight of sample 34 lbs. 14½ oz. Bullion obtained $59·04.
By assay the bullion contained in 1000 parts,

Gold,	682
Silver,	308
Copper,	010
	1000

The value per ton by assay is $3,572.00

a. After treating the ore by *panning* to remove the coarser portions of the free gold, the remainder was subjected to a series of experiments to test the comparative value of amalgamation by ordinary mercury and the Wurtz process with sodium amalgam.

First the tailings of *a* were assayed and gave,

Gold per ton,	$1072.00
Silver "	60.00
	$1132.00

b. 8 lbs. of the ore (tailings) were amalgamated with ordinary mercury, and the bullion obtained weighed 2 dwt. 14 grs., which assayed as follows:

Gold,	706·5
Silver,	291·0
Copper,	2·5
	1000

Value of Gold obtained from *b*: $1.88=45 pr. ct. of fire assay.
" Silver " " .04
$1.92

c. 8 lbs. ore (tailings) were treated with sodium amalgam, (Wurtz process) and the button obtained weighed 4 dwt. 11½ grs., which gave by assay

Gold,	705
Silver,	146
Copper,	149
	1000

Value of Gold obtained from *c*: $3.26=78 pr. ct. of fire assay.
" Silver " " .04
$3.30

The total quantity of gold in 8 lbs. of ore by fire assay is $4·19.

Jno. Torrey & Son.

The assays of samples of the ore of this vein collected by myself and others, show a value of from $70 or $80 to several thousand dollars to the ton of 2000 lbs. But all such results are of little value compared to the actual reduction of large quantities of the ores in working processes.

Other lodes of this district.—My notes contain mention of over fifty lodes or veins, most of them probably distinct, which I visited in the course of my explorations of the San Francisco district, and which belong to the east-and-west system. The parallelism between the lodes of this system is almost exact, and there is a great similarity in their mineralogical character.

The 'Skinner,' on the south side of Silver Creek, is one of the most conspicuous, forming like the Moss lode bold and fantastic crests, rising sometimes in slender needles to a remarkable height. The boldest outcrop is called the "center claim," of 1600 feet. But those portions called the Rochester (1800 feet) and the San Francisco (2400 feet) are nearly as bold. This lode shows drusy quartz, both compact and cellular and ferruginous with numerous cavities where fluor-spar has been weathered out. Hornstone is also seen frequently. Very small traces of sulphids show at surface, which is much stained by black oxyd of manganese, rendering portions of the outcrop quite black.

This vein varies from 50 to 150 feet in thickness. Its walls of ash-colored feldspathic porphyry are seen in places beautifully polished on the line of the dip 70° N. It appears glued first to the porphyry, without a lining of clay, (fluccan), but this is so commonly the case in the outcrops of Nevada that it is no proof of the absence of this important character of a true vein at a moderate depth.

An exploratory shaft has been sunk near the center of this claim on the foot wall, at a point designed to cut the lode at the depth of 100 feet, but at a depth of 50 feet the resources of the explorer gave out. Eighteen feet of water in this shaft confined my observations to the materials thrown out, showing the correctness of a statement made to me, that a branch vein or offshoot of the main vein had been cut, carrying green and purple fluor in octahedrons in a quartzose and feldspathic gangue, with occasional gray spots of minutely diffused sulphid of silver. Three assays of the ore from this shaft proved the presence of silver to the value respectively of \$25, \$74, and \$83 to the ton of 2000 lbs. From a second shaft sunk on the N.E. side of the wash, in the body of the vein, to a depth of 25 or 30 feet, I obtained beautiful octahedral crystals of green, white, and purple fluor spar. The gangue and the whole mineralogical character of this vein, so far as explored, is of the most promising character, and it offers a most legitimate field for judicious exploration, with a reasonable expectation of the discovery of silver ores in remunerative quantity. At the same time it must be remembered that such an exploration is sure to be costly and its result is always doubtful.

The Parsons, Hurst and Leeland are other gigantic lodes, south of the Skinner and of generally similar character, but, at the time I saw them, almost completely unexplored.

Some of the smaller lodes of this district appear to me to offer the hope of a much less costly exploration, and with the promise of quicker returns. Of this class I may mention the Caledonia and Dayton, a few hundred feet south of the Moss lode, and the Quackenbush and Knickerbocker, some distance south of the Skinner and Parsons. These veins are from three to ten feet in thickness, well defined, and showing at surface all the characters of true metalliferous veins. Besides well characterized and abundant iron gossan in cellular quartz, I observed in them fluor spar, feldspar, green carbonate of copper, horn silver, and free gold. Samples from these outcrops, collected by myself, yielded when worked in an experimental mill, from forty dollars to two hundred and fifty dollars per ton of two thousand pounds.

In no other mineral district which I have seen are there so many remarkable outcroppings of quartz veins carrying the precious metals, crowded into so small an area and on a scale of such magnitude in development as in the San Francisco District. In the vicinity of Austin, (Reese River) Nevada, the veins are more numerous, probably, but are also much smaller and quite inconspicuous, having, in fact, almost uniformly no outcrops to attract the attention of the explorer.

Both districts are situated in a desert and inhospitable region, but the fervid heats of the Arizona summer are fully counterbalanced by the severe cold and snows of the more northern locality. Supplies can be brought with tolerable certainty by sea and river to Hardy's Landing, immediately in front of the San Francisco District, and within five miles of the Moss lode.

With these facilities for development we ought not to remain long in ignorance of the true character in depth of these very remarkable mineral veins, nor is it too much to hope that they will, with an honest and prudent use of capital reward the adventurers with handsome returns for the capital employed in the exploration.

Of neighboring mineral districts.—My observations extended east of the San Francisco District to Trout Creek, a branch of Bill Williams' Fork of the Rio Colorado, where there is a mineral district called the Wauba Yuma, about 60 miles east of the Colorado, and in a region entirely beyond the present limits of civilization. Passing the range of Boundary Peak, over a crest of volcanic tufas and red porphyry rocks of some 1500 feet elevation at the point of crossing, above Allen's Camp, or over 3000 feet above the river,[5] the traveller descends eastwardly in

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[5] The peaks on either side of the pass are, however, much higher, but I had no opportunity to measure them by the barometer.

a dry valley, called Massacre Valley, from the sad tragedy of the murder of a large party of Texan and Arkansas emigrants in 1857 by the Mojave, Wallupi and Pah Utah Indians. We found the melancholy evidence of this catastrophe scattered along the line of Beale's Road for several miles, over seventy persons with their teams and baggage wagons having been destroyed. The bleaching bones of the oxen, half burned remnants of waggons, with cooking utensils and household furniture scattered about or lying as they fell, attest the savage ferocity of these treacherous tribes. About twenty miles beyond the easterly margin of the San Francisco District, there is an entire change in the geological character of the country. The porphyritic and volcanic rocks give place to metamorphic schists, gneiss, and granitic rocks abounding, with numerous veins of white quartz. From the Rio Colorado to the eastern limit of the Massacre Valley, 30 miles or more, the rocks are entirely porphyritic or volcanic. The same rocks which are seen on the west side of the Colorado are repeated here. The mountains possess a fantastic, almost grotesque outline, due, probably to their peculiar mode of decomposition. Many needle-shaped porphyritic masses adorn the ridge and are thrust through horizontal and gently inclined beds of volcanic tufa and cement of various striking colors, usually light, sometimes almost white, variegated by zones of brown, red, chocolate, and yellow. Large blocks and irregular fragments of volcanic or basaltic rocks, usually black or deep brown, are seen implanted in the overhanging and undercut cliffs of tufa and cement 250 to 300 feet high along the narrow gorge through which the trail crosses the crest, near "Meadow Springs." These volcanic beds appear to be of sub-aqueous origin. All the loose river drift and boulders on the plane are cemented into a firm concrete with a white cement derived probably from these beds.

The change in the geology of the region is very marked in the transition from volcanic rocks to those of the granitic family, and is accompanied by a corresponding change in the character and direction of the mineral veins, and the commencement of a region better wooded and watered than that previously described. Near the western margin of the Wauba Yuma District occurs a considerable vein of auriferous quartz, accompanied by ores of copper and sulphurets of iron. It first appears in a pretty high granitic mountain to the northwest, and its course has been traced about three miles to the southeast. This lode, which has been called the "Pride of the Pines," appears to be about ten feet wide, and possesses promising characteristics. The sample collected by me, although showing no free gold, yielded $30 to $50 to the ton of assay. It possesses the characteristics common to the auriferous lodes of the Sierra Nevada, and the same general N.W. and S.E. direction, while, it will be remembered, the silver veins of the San Francisco District are nearly east and west in direction.

The granitic range in which the "Pride of the Pines" vein occurs extends for at least fifty miles, in a line nearly north and south, and forms a mountain mass of no mean proportions. Its altitude I could only conjecture, having sent my barometer in another direction, and crossing the ridge only at subordinate points. Its crests, however, may be from five to six thousand feet above tide.

Immense drift deposits of angular fragments without arrangement occur upon the flanks of this range, and so greatly resembling in their character glacial moraines as to command my careful notice. In a dry arroya which had been cut by torrents through this ancient drift, I saw for two and a half miles a section, averaging perhaps one hundred feet in depth, of the mass of one of these moles of glacier-like materials, chiefly angular fragments of granite, some of quite large dimensions, mixed with smaller angular fragments, sand and mud, with no trace of arrangement or stratification whatever. These moraines (if they are such) are of all dimensions, from one mile to eight miles in length, some of them as regular as a rail-road embankment and forcibly recalling those of unquestionably glacial origin jutting out upon the American Desert from the eastern escarpments of the Sierra Nevada near Mono lake, Aurora, and between Wellington's and the Palmyra districts.

These Arizona mounds run southeast from the main mountain mass, in lines seemingly parallel but really radii of the mountain valleys or gorges, between which they occur, falling away in gently inclined planes from the ridge. On their outer edges some traces of stratification appear, as in river drift, but this appearance seemed plainly a partial rearrangement of the materials by the torrents to the course of which they are limited. I record the observation with the impressions made at the time. My field notes contain the remark "true glacial drift." The latitude was about 35°, lower than true glacial phenomena have been recognized, if I am correctly informed. There were no exposed surfaces of rocks to show glacial scratches, and the exigencies of travel in this difficult region did not permit me to ascend the rocky peaks in search of them.

These alluviums, whatever their origin may be, cover an area ten miles to fifteen miles in width, going east of Pine Mountain ridge to the next and parallel ridge, which I have in my notes called "Castle Ridge." The recurrence of volcanic rocks and wide spread sheets of basaltic lava, as a capping to the mountains and hills, gives it a character entirely in contrast with the familiar features of the metamorphic and granitic mountains just noticed. These features are especially seen in a lofty table mountain of the 'Castle Ridge' on the traveller's left, as he leaves

Pine Mountain ridge behind him. This bold land-mark I named in my notes "Mount Brewer." "Fortress Rock," on Trout Creek, is another fine example of the same kind, but the valley north is filled with similar table mountains from a few hundred to a thousand or twelve hundred feet above the surrounding country. Here the same horizontal and gently inclined beds of light colored tufas already noticed as occurring near Silver Creek, fifty miles or more west of this, recur and are capped in a like manner by basaltic columns.

Enormous dikes or reefs of quartz and of coarse quartzose feldspathic granite cut through the reddish gneissoid granite which forms the basement rock over a large part of the Wauba Yuma District, rising in one case 100 to 150 feet above the cañon which cuts the vein at a point where I examined it, and where it is 50 feet thick. I could not discover in those gigantic veins much evidence of any metallic value, nor had there been any exploration upon them.

The Sacramento District, about 45 miles N.E. of Fort Mojave, I did not visit, but inspected a large collection of argentiferous galena from its veins, made chiefly by soldiers of the Post. These lead veins occur in metamorphic rocks, and are such in size and metallic value, so far as I could learn, as to lead to the belief that they will one day be worked when labor and supplies are cheaper and more abundant, and they may furnish a most important auxiliary to the treatment of the silver ores of adjacent districts.

The Irataba district, south of Fort Mojave, comprises a number of veins carrying copper, but few of them, in the opinion of my assistant, Mr. Frank Sample, who visited them, are worthy of exploration.

ART. XXXVII.—*A method of Giving and of Measuring the angles of Crystals, for the determination of species, by the use of the Reflecting Goniometer;* by JOHN M. BLAKE.

IT seems desirable that more general use should be made of angular measurements of crystals for the purpose of determining species, than the ordinary methods of measurement and comparison will allow.

The time and study required to understand the various forms of symbols adopted by different authors, and then to locate the planes on the given crystal before making the measurements, make the pursuit of the subject in this way a difficult matter, even to those who have spent considerable time in the study.

Now it is possible to describe a crystal, giving measurements which will locate every plane occurring upon it, without the use of symbols having reference to any system of crystallization. By thus making the measurement of a crystal, simply a mechanical operation, this description will be sufficient to determine again the same species, so far as it can be done by angular measurement of the planes.

The method consists in taking advantage of the existence of certain natural laws, which determine the arrangement of the planes upon a crystal into zones; and noting the angular distance of each plane in a zone, from one of them fixed upon as the starting point; this to be done by simply giving the goniometer-reading for each plane; and, further, binding all of the measured zones together by noting a sufficient number of their points of intersection.

Since a zone is a number of planes making parallel intersections with each other, if we adjust any two of the planes for measurement, we have at the same time adjusted all, and can readily go on and record the reading of the instrument for each plane.

We thus preserve the relative position of the planes, which gives the measurements a value which cannot be attained by the ordinary method of separate measurements, for the location of which we have to depend upon our knowledge of certain symbols.

It can be seen that there is thus a saving of labor, and of space in recording, if we consider that the object in view is to get a *complete* measurement of a crystal.

This measurement of zones may be carried to an extent which convenience will determine for each species. Four or five zones will often include nearly all the planes on a crystal, perhaps all that would be actually needed for the determination of species. To bring in the remainder, to complete the description, it may be best to make separate measurements; or to give only portions of zones, where to give the complete zone would be an unnecessary repetition of what had already been well noted.

To show what can be done by this method, suppose in the case of sulphate of copper, ($CuOSO_3+5HO$) each plane to have its opposite, there will be more than twenty-eight planes upon a complete crystal.

All of these planes can be brought into three zones intersecting in a common plane (*b*, of Rammelsberg).

It will be necessary to add a fourth zone, crossing the others, to bind them together and make the description complete. The species, sulphate of copper, is selected, because it belongs to the triclinic system of crystallization, and therefore it might be considered more difficult of description than the average of species, and the remeasurement of a crystal for comparison, an operation requiring considerable patience, to say the least; but by the use of this method it becomes in either case a comparatively easy operation.

If, from the description, the angle be required between any two planes lying in one of the measured zones, it can be readily obtained by subtraction. But if the planes do not both lie in one of the measured zones the angle can be found by means of spherical trigonometry, without taking into consideration symbols or axes.

The prismatic zone in elongated crystals would be the first to measure, because best developed.

We can start with the zero of the instrument opposite the largest plane if we have no other guide.

The other zones may be taken in the order in which they appear best developed. Some order is desirable to facilitate the use of the description for future comparisons.

In using the description for determining species, after measuring the most obvious zones on the crystal, we can plot them on paper and turn the protractor until the readings coincide with the description.

The plotting is necessary only when there is difficulty in making the comparison, on account of the zero of the instrument not having been brought opposite the plane used in the description.

When we have found a coincidence of readings for a zone we have determined all the planes in the zone; also the symbols, if given in the description.

In this way, with a description in this form, we can speedily determine all of the given planes which occur upon the crystal before us; also if there are any new planes.

Care should be taken not to confound right and left hemihedrism, or similar non-superposable forms, which is liable to be done if we do not note the relative position of at least three planes, not in one zone. In case a drawing is given, this will not be necessary.

The use of this method gives us a great advantage in detecting and measuring accurately very small planes and cleavages, which, were it not for the fact that they come into the zones, could not be adjusted for measurement on account of the feeble reflection which they give.

Note.—Direct sunlight is of great value in detecting and measuring small planes: the light may be tempered by means of smoked glass.

For convenience in approximate adjustment when using a Wollaston's goniometer of the usual form, and to make it possible to measure entirely around a crystal, it will be found an advantage to mount the crystal at the extremity of a lead wire, of three or four centimeters in length, and for most crystals one millimeter in diameter.

A method for the rapid and easy adjustment of a crystal for measurement, in the Wollaston goniometer is, first, to bring one plane parallel to the motion of the joint between the two L's, so that motion of this joint will not affect the reflected image, and then to use for adjusting this plane only the motion of the rod carrying the crystal, while, for adjusting the other plane, motion of the joint only is to be used. By observing these points, from two to four movements only will be required to obtain perfect adjustment; while if we neglect them there are certain positions in which the planes may lie with reference to the adjusting motions, which will make the adjustment a tedious operation.

New Haven, Dec. 14, 1865.

ART. XXXVIII.—*On the Quaternary Formations of the State of Mississippi;* by EUG. W. HILGARD, Ph.D., State Geologist of Mississippi.

IN my Report on the Geology and Agriculture of Mississippi, printed in 1860, I have given my observations on the Quaternary formations of the state. (See pp. 5 to 46, and 194 to 201, incl.) I now desire to present some general considerations on this subject, which in the place referred to could find but a brief mention or discussion. In so doing I shall not reiterate in detail the facts and observations recorded there, but in mentioning them will refer the reader to the corresponding paragraphs of the published volume. Having been for several years past deprived of all scientific intercourse, I desire to enter beforehand a disclaimer as to any intentional plagiarism, should some of the views and questions here presented have been meanwhile discussed and perhaps settled by others.

I have stated (§ 326) that, aside from the Alluvium proper, attributable to causes still in action, there are four distinct stages of the Quaternary recognizable in Mississippi, to wit:

1. The "Orange Sand."
2. The Bluff or Loess.
3. The "Yellow Loam."
4. The "Hummocks," or Second Bottoms, which I shall consider in the order of their age.

The Orange Sand.—I am not aware that a formation of precisely the same *ensemble* of character as this, exists outside of the States of Mississippi, Alabama, Tennessee, and small portions of Louisiana, Kentucky and Arkansas. Its existence in the latter two states is apparent from observations recorded in various places in the reports of the geological surveys of Arkansas and Kentucky; more especially does the description given by Dr. Owen of Crowlegs ridge, Greene county, Ark., agree closely with the usual facies of the formation as observed by myself in Mississippi, and by Prof. Safford in West Tennessee. In Alabama it is characteristically developed in the northwestern portion of the state, on the waters of the Buttahatchie, Looxapalila, and Sipsey. It is not specially so described in Tuomey's Alabama reports, from the accidental circumstance of his never having personally visited that portion of the state, which afforded no prospect of important practical discoveries; but I have traversed the region in 1856, on a visit to Tuscaloosa, a few months before Prof. Tuomey's untimely death.

Prof. Safford, in his First Biennial Report of the Tennessee Survey (p. 162), classes his "Orange Sand Group" as a member of the Cretaceous formation; without, however, claiming as final results, this as well as other opinions derived, as he himself states, from a mere reconnoissance. Having been unable to procure a copy of his later report, I am not aware whether or not, on reëxamination, he has changed his views on this point, as I have no doubt he would upon a fuller investigation of the facts of the case, such as they force themselves upon the attention of a geological observer in Mississippi.[1] From the few data given by him *l. c.*, though they can leave no doubt as to the identity of the formation, I am unable to judge whether the "bed of greensand" mentioned by him, together with the underlying lignitic clays, are referrable to the Ripley and Eutaw Groups, or to the "Northern Lignitic" of my report, which as there stated (§ 166), is sometimes glauconitic in its highest member. The greensand of McNairy Co., Tenn., is unquestionably Cretaceous; Safford's Lignite Group is, doubtless, the continuation of my "Northern Lignitic"; but he has failed to identify the Orange sand with the "Drift series" underlying the Bluff formation on the edge of the Bottom. Considering the highly complicated relations often existing between the Orange Sand and the underlying Cretaceous strata (as exemplified §§ 33 to 40, *et al.*), the occurrence of Cretaceous fossils in the ferruginous sandstone capping the hills, and the appropriation of Cretaceous material, almost unchanged to the formation of strata most unequivocally connected with the Orange Sand, the misapprehension of Prof. Safford is extremely natural. It requires, indeed, all the closeness of research which necessity imposes upon the geologist in Mississippi, to convince one's self of the identity of this capricious formation under all its forms, the knowledge of which I am even now far from satisfied of having exhausted.

The Orange Sand, as my observations show, overlies in Mississippi formations reaching from the lowest Sub-carboniferous slate (Saff. 1st Rept., p. 158) through the Cretaceous and Tertiary to a group of deposits on the Gulf coast, which so far I have found to contain only living species, and am therefore inclined

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[1] Prof. Safford refers the beds to the Tertiary in this Journal, xxxvii, 361, May, 1864, in an important paper treating of the "Cretaceous and Superior Formations of Tennessee."—Eds.

to consider of Pleistocene (or Quaternary?) age (§ 247, and ff.). All over this area, it contains, more or less, the fossils of the underlying formations, mostly *waterworn*; while the closest scrutiny I have bestowed on hundreds of extensive exposures, has failed to detect any fossil apparently peculiar to the formation as such. This might seem paradoxical enough to any one acquainted with the frequent occurrence of silicified wood in these strata; but it soon becomes quite obvious to an attentive observer, that the regions of frequent occurrence of this fossil in the Orange Sand, are coëxtensive with those in which fossil wood, either silicified (when imbedded in siliceous sands) or lignitized, occurs in the underlying lignitiferous (Cretaceous or Tertiary) strata. It is not at all unusual to find trunks of silicified wood imbedded partly in the unchanged lignitic strata, partly in the Orange Sand; the portion contained in the latter being nearly or wholly deprived of carbon, while the part imbedded in the lignitic material is, if at all silicified, of an ebony tint, and often contains pyrites (§ 26, *ad finem*).

While, therefore, I admit the possibility of a further specific determination of these silicified trunks assigning to the Orange Sand some peculiar species, I am convinced that the greater part, if not all of this fossil is derived from the underlying strata, and will be found represented in their flora. Wherever silicified wood does occur at a distance from lignitiferous deposits, it forms waterworn pebbles; and not unfrequently, layers of comminuted fragments of the same, form the line of contact between the older strata and the Orange Sand. (See for example, § 169, section 17.)

The lithological and stratigraphical characters of the formation, however (which in the absence of proper fossils must form our landmarks), are strongly marked, and the correspondence of many of its prominent features with those of the deposits of the Drift proper in the northwestern states, as described by Dr. Owen, Profs. Hall, Swallow and others, is manifest at a glance. The materials are essentially correspondent, and disposed in a similar manner; proving the action of violent currents and their concomitants—extensive denudation of the more ancient formations, appropriation and re-deposition of their materials with the irregularity of arrangement consequent upon the alternate existence of currents, eddies, slack water and counter-currents, in one and the same place.

The geographical distribution of this formation, as well as the total absence of any observable dips, where its strata are sufficiently continuous to admit of such determinations, clearly prove its deposition posterior to the epoch of upheaval which has given a sensible dip even to the latest Tertiary (if Tertiary it is) of the Gulf coast (§§ 250, 869). The main body of the formation seems to represent an immense delta, whose apex is in the neighborhood of the junction of the Ohio and Mississippi. Its *eastern* outline descends along the ridge of Carboniferous rocks skirting the Tennessee valley on the west, and passing along the western outline of the Coal-measures of Alabama, reaches the Warrior river at or above Tuscaloosa. Thence the formation extends southeastward toward the Coosa, but the pebble belt, which generally so far has marked the eastern outline, seems to follow rather the course of the Warrior and Tombigby, coastward. In Alabama, however, as in Mississippi, it is but thinly represented on the territory of the "Rotten Limestone."

The extreme western outline of the delta is, doubtless, to be sought in Arkansas, skirting on the east the high lands of that state. That the great channel of the Mississippi, however, was already impressed upon the surface at the time of the deposition of this formation, is rendered obvious by the existence in it, parallel to that channel, of a belt of pebbles and coarse shingle, which at present reaches but a short distance (ten to fifteen miles) inland from the "bluff" or edge of the great bottom. It was deflected westward by the Tertiary ridge of the "Walnut Hills," abutting at Vicksburg upon the Mississippi, the latter having almost entirely cut away the pebble deposit; it reappears, however, below Grand Gulf, and thence again has spread southeastward across the state, so as to reach, in Marion Co., Miss., the waters of Pearl river.

While the Mississippi river is thus the legitimate modern representative of the great ancient current which was capable of transporting such coarse material, no *one* channel now remains to represent the corresponding stream (or bayou, as it would now be termed) on the eastern edge of the delta, whose existence in times past is certified by a similar band of pebble deposits now crossed in several directions by the drainage of the country it traverses. Unlike the loose beds of the western band, those of the eastern stream are often, if not prevalently, cemented into solid pudding-stones by a cement of brown iron ore; which circumstance may give some clue to the deflection of the waters from the ancient channel which now, on the contrary, forms a dividing ridge between the waters of the Tennessee and upper Tombigby.

Such being the general disposition of these deposits, we are led to inquire into the origin of the great inundation of water apparently devoid of organic life, by which they were formed. What traces of its existence has it left north of the latitude of the Ohio, whence the rush of waters evidently came? The northern geologist may pertinently retort: "What became of that rush of waters whereof our Drift furnishes the evidence, after it left our latitudes?"

Given, the Northern Drift: it appears to me that the *Southern Drift* is a postulate, so far as the surface conformation of the United States would admit of its deposition. And here we have a formation possessing, as we shall see, all the main features of the northern Drift, the differences being quantitative rather than qualitative—its age later than the latest Tertiary, yet anterior to the Loess. There are but two essential features to distinguish it from the beds of the northern Drift proper. These are, first, the absence, or at least, great scarcity of "erratic blocks" proper, *i. e.*, of fragments of rocks derived from distant localities and not, or but slightly, waterworn; secondly, the great prevalence, to the extent of characteristic feature, of limited deposits of ferruginous sandstone or conglomerate, which, however small their local extent, have by their resistance to denudation controlled the surface conformation of by far the greater portion of the State of Mississippi (§ 11 and ff.).

As regards the former point, it would seem to find a ready explanation in the *lower latitude* in which these deposits are situated. Whatever may have been the precise nature of the "Drift agencies," it cannot be doubted that arctic ice, whether icebergs proper, or shore-ice floes, were instrumental in the transportation of the sharp-angled fragments we find imbedded in the northern Drift deposits, innocent equally of the rounding action of water, and of the grinding and scratching one of glacier transportation. It is but rarely that, at the present time, the floating ice of the Mississippi river passes much beyond the latitude of Vicksburg; and it is difficult to conceive how even the largest berg should not, before reaching a latitude so low, have performed so many evolutions through the successive changes of its center of gravity, as to have dropped every vestige of moraine material. Yet some stout floe of shore-ice might be supposed to be capable of reaching this latitude without dropping all its passengers, some of which might be therefore expected to occur amongst the (otherwise invariably waterworn) materials of the southern Drift. And such in fact is the case, for, however rarely, a few large angular boulders *have* been found in the Orange Sand of Mississippi (§ 21). The block of milky quartz in the collection of the University of Mississippi, shows a surface almost as sharply angular and splintery as if freshly broken from its original place.

As to the second point, it amounts to a mere quantitative difference as to the extent of the process which, from Minnesota to the Gulf coast, forms ferruginous sandstones, claystones and conglomerates of various degrees of hardness, in the deposits of the Drift period. While in those of the northwest, the ferruginizing process has played but a subordinate part, and within the limits of the Drift itself, in Mississippi its action has frequently extended beyond the Orange Sand, into the underlying formations.

It has thus, for example, metamorphosed the white, leaf-bearing clays of the Tertiary, into the fine-grained ferruginous shales whose species have been in part determined by Mr. Lesquereux (§170, Sec. 18). Where the clays are less siliceous and consequently less pervious, the ferruginous solution, unable to penetrate, has aggregated into nodules of limonite ore (§42). On the territory of the Carboniferous, the ferruginous conglomerate of hornstone pebbles (which passes through all gradations of fineness into the common ferruginous sandstone of the hilltops) is underlaid by a singular hornstone breccia, whose adjacent angular fragments mostly fit each other, as though produced by the contraction in drying, of a gelatinous mass. The cement of this breccia is brown iron ore which fills the interstices and has colored to the depth of one-tenth to one-eighth of an inch, the substance of the hornstone fragments. (See also §72, and note.)

These phenomena when considered in connection with the abundant occurrence of ferruginous sands and sandstones in the upper members of the group, seem to be characteristic of the *end* of the period of its formation; for no such tendency to ferrugination is observable in the overlying formations of the Bluff and Yellow Loam, whereas the principal deposits of ferruginous sandstone or pudding stone invariably occur at the *highest* levels, both geologically and hypsometrically of the Orange Sand deposits.

As to the occurrence of silicified wood, its presence in the beds of the Drift of Iowa is repeatedly mentioned by Prof. Hall; it also occurs, I believe, in the southern counties of Missouri, and in Arkansas, though not, as far as I am aware, to the extent it does in Mississippi, where in some regions, entire logs of this fossil (sometimes with part of the roots and branches) are of common occurrence. They are, however, always prostrate. I have attempted to trace to its origin the report mentioned by Prof. Wailes (First Rept. on the Geology of Miss., p. 282) of a silicified tree found standing upright with its roots in place; but it has always receded before me and vanished like a mirage. I have myself found trunks imbedded in the Orange Sand at a considerable angle with the horizon, a fact as easily explained as the discordant stratification of the formation, but which to inexperienced eyes might seem the next thing to seeing them growing there.

Yet it is hard to believe that even the violent currents and eddies, of which the irregular stratification gives evidence (see *e. g.* Pl. II, fig. 2), should have been able to transport, or elevate to the summits of the highest ridges at times, bodies of such enormous weight; even though those same agencies have doubtlessly tossed up to similar elevations the limestone fragments containing Cretaceous fossils, whose calcareous ingredients have since been replaced by brown iron ore (§ 33). The conclusion seems inevitable that, when transported, these logs were either in a fresh, or semi-lignitized condition, such as we now find them in the subjacent lignitic strata; and that their silicification took place within the Orange Sand after its deposition. In my Report (§§ 15, 16, 44, 45,) I have given facts sufficient to prove that an abundant supply of silex has been active in this formation, which has given rise to the hard, non-fossiliferous sandstones found in it, and even to the silicification of beds of lignite *in situ* (§ 45).

That this process is still in progress seems to be proved by the disintegration, not only of hornstone pebbles (§ 32), but also of silicified wood itself; the inside of the trunks consisting frequently of translucent hornstone, while the outside is opaque, porous and sometimes (§ 44) asbestiform or pulverulent. One of the results of this process is, necessarily, the formation of siliceous solution, which in its turn may be active in effecting pseudomorphoses.

As regards the existence of the southern Drift in other southern states besides those mentioned, the subject is discussed at some length in Tuomey's second Report on the Geology of Alabama, pp. 144 to 147; elsewhere, so far as I know, it is but incidentally mentioned. He refers to the existence of a long ridge of similar accumulations parallel to the Atlantic coast, apparently upon the margin of the ancient Tertiary (Pliocene?) sea; and he identifies the detrital strata upon which the cities of Baltimore, Washington, Richmond, Petersburg, Va., and Columbia, S. C., are situated, with the Tuscaloosa beds—which in their turn, are most unequivocally connected with the Orange Sand of Mississippi. With the latter formation he was acquainted only through my verbal communications, nor was I myself, at the time, aware of the features of the formation on the large scale, or of the existence of the great delta whose apex reaches the confines of the northern Drift in Illinois and Missouri. Tuomey's doubts as to the connection between the two great divisions were therefore natural, but cannot now, I think, be sustained. Even though the waters of the northern Drift period were able to surmount, or rush through the passes of the Alleghany upheaval, they would not transport any materials beyond it; those forming the Drift of the eastern cotton states must, of necessity, be derived from the southern slopes of that barrier itself, as Tuomey states is the case in Alabama, and as I have found it to be in the eastern, and smaller, pebble belt of the Orange Sand delta in Mississippi. But where, as in the main channel of the Mississippi, those waters might rush southward unchecked, through the gap between the Alleghany and Ozark upheavals, we might expect to find traces of rocks derived from higher latitudes. Such are furnished by the rare, small, and well-worn pebbles of greenstone, porphyry, trappean rocks and even mica schist, which close observation will detect among the shingle of the Mississippi-band; the direction of whose currents alone seem to forbid the derivation of these rocks from any point as far south as the eruptive and primary region of Arkansas. It remains for future comparisons, however, to settle this point.

As to the finer materials of this formation, it is significant that while the *sharpness* of the sand of the northern Drift deposits is often mentioned by writers on the subject, the sandgrains of the Orange Sand proper—that which forms the rocky hill-tops and the main body of the formation, are always very much *rounded*, as a proof of their transportation from a long distance. Whether or not the same is true of the Atlantic ridge of detritus mentioned by Tuomey, I am not aware; but it does not seem to have struck that observer.

Dr. D. D. Owen repeatedly mentions lignites and leaf-bearing clays of *quaternary* age, as underlying these deposits in Kentucky and Arkansas. Without calling in question the determination of that eminent observer, I will state that I have found no reason to suspect any more special connection between the Orange Sand and any of the lignitic beds of Mississippi, than is afforded by the obvious appropriation of the materials of the latter by the former formation—a relation existing equally where other formations underlie.

According to Mr. Lesquereux's determination, the lignitic of North Mississippi is certainly not newer than the Miocene; while some marine shells occurring in its highest strata, would seem to place it even below the lowest marine Eocene of the state (§ 162, ff.). While so far as my observations reach, I find no reason to suspect that all the lignitic strata occurring north of the marine Tertiary in Mississippi and Alabama, are not of the same age, I have nothing to urge against the occurrence of quaternary lignites elsewhere. Some of the lignitic beds of the Mississippi bluff (§ 181), of which I cannot speak from personal observation, may be of that age, as well as the small basin mentioned (§ 27) as occurring in a section of Orange Sand in Tennessee. In the absence of pretty *numerous* determinations of fossil plants, however, it must be difficult to decide upon the age of such strata, when not seen in juxtaposition with the marine Tertiary.

The Bluff, or Loess Group.—This stage of the quaternary formations does not offer, within this state, any features requiring special remark. From Vicksburg southward, it skirts the left bank of the Mississippi river, with a width, inland, of twelve to fifteen miles. It caps most of the high points visible from the river, the maximum thickness observed being about seventy-five feet. It is usually underlaid by some member of the Orange Sand, and this in its turn by the sandstones or clays of the Grand Gulf group (§ 236 *et al.*). The chief difference between the Loess of Mississippi and that of Indiana, is the greater fineness of the material, and the total absence, as far as observed, of any but terrestrial fossils.

Apart from a few scattered sandgrains and calcareous concretions, it is a mouse-colored or buff, almost impalpable siliceous silt, but very lightly cemented by from 6 to 10 per cent of carbonate of lime. Like the Loess of Kentucky, it contains, also, a large amount (5 to 7 per cent) of carbonate of magnesia.

Helix, Helicina, Pupa and Achatina are the genera thus far found in it. As to the mammalian bones, they are here, as in Kentucky, found chiefly not in the usual material of the formation, but in a "blue clay," which, however, I have not thus far had an opportunity of examining in place. I should here state that the Mastodon bones mentioned by Tuomey as having been found in the "Drift" of the lower Tombigby and Alabama, were by himself, upon reëxamination, referred to the Bluff, and *not* to the Drift or Orange Sand age.

Above Vicksburg, the Loess deposits appear along the edge of the bluff, skirting the bottom, in irregular patches or narrow strips, such as would be exhibited below Vicksburg, were the main body of the formation, riverward, to be cut away. Such undoubtedly has been the case here, for in Tennessee, according to Safford, it is again found regularly skirting the bottom, many miles in width. It seems also that, as we advance northward, the color and fineness of the material changes, so as to resemble more and more that comprising the Loess of Indiana and Ohio.

No other river exhibits, within the state, any traces of the Loess along its course, so far as the latter is independent of the Mississippi river. The Big Black simply crosses the Loess region; the Tallahatchie and Yazoo simply touch it by accident, as it were. Neither Pearl river nor the Pascagoula, show any signs of it; while according to Tuomey, both the Tombigby and the Alabama river exhibit it characteristically, in the lower portion of their course. It would be interesting to study the circumstances which determine this apparently capricious selection. From the predominant horizontality of the lines of contact between the Orange Sand and Loess, it would seem that the deposition of the latter was not preceded by any very extensive denudations into the surface of the former; the Loess thus indicating, apparently, those channels which during the Drift period, formed the main outlets of its waters.

The Yellow Loam.—Next in the upward order, and as distinctly superimposed upon the Loess where it exists, as it is elsewhere upon the Orange Sand,[1] we find a deposit consisting usually of a mellow brick clay, or loam, more or less ferruginous, and subject to inconsiderable variations in accordance with the character of the underlying materials. It might in some regions, therefore, be accounted a mere surface disintegration of older strata, but for the fact that in others it is distinctly developed as an independent stratum; its maximum thickness observed being about twenty feet, while the average lies perhaps between five and ten.

As to its geographical distribution, it is not a little remarkable that, while the preceding and succeeding stages, viz., the Bluff and the Hommock deposits, show a very obvious relation to the drainage of the country, such is the case only to a very limited extent with the Yellow Loam itself, which seems originally to have overspread the country very evenly, with on the whole a slightly increasing thickness toward the larger channels, such as the Mississippi, lower Tallahatchie, Yallabusha, Big Black, and Tombigby. The local uniformity of its material, the absence of stratification-lines in its own mass, and the horizontality of its lines of contact with underlying formations seem to be incompatible with the existence of strongly denuding currents during its deposition; while at the same time, its distribution and other characteristics render equally inadmissible the supposition of its being either a lacustrine or marine deposit.

The extensive denudations which *succeeded* its deposition render it extremely difficult to determine, in *all* cases, where this stratum is in its original place. It has disappeared, and unfortunately is still disappearing rapidly from many ridges, which according to their level as compared with adjoining regions, have been capped with it. Yet while it doubtless never was deposited upon some of the highest ridges of the state, which were above water even then, it is found manifestly *in situ* both on plateaus elevated above the general surface, and in regions a hundred or more feet lower, immediately adjoining the former. And since in all cases its character varies more or less in accordance with that of the underlying material, which enters into its composition and therefore testifies of a certain amount of denuding action, it would seem that the conditions of its deposition could be satisfied only by the assumption of the submergence of the surface under water locally deep, but always gently flowing—not sea-water, for the deposit is void of fossils—nor for the same reason, precisely such as that which deposited the Bluff formation. On the same ground, and on that of its inconsiderable thickness, we must also conclude that but a short space of time was occupied in its deposition.

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[1] Or rather, upon an amorphous and ill-defined transition stratum of "hardpan," usually one to three, but locally as much as fifteen feet in thickness (§ 335).

It may be premature to attempt to define more precisely the nature of the events which attended the formation of this deposit. It may have been the result of the expiring efforts of the Drift waters to find their way over the delta, whose surface, after deeply eroding it, they had elevated by flooding it with detritus. But there is one point requiring mention as intimately connected with the subject; I refer to the peculiar constitution of the *prairies* of Mississippi and Alabama.

These differ in several essential features from the prairies either of Illinois or of the Plains. They are not usually altogether treeless, but possess a sparse growth of stout, well formed, compact Black Jack and Post Oak, with occasionally a Red Cedar; except where the Cretaceous limestone is within a foot or two of the surface, causing "Bald Prairies" with only scattered clumps of Crab Apple, Wild Plum, Persimmon, and Amorpha. Usually, the Cretaceous rock ("Rotten Limestone") is overlaid by a stratum five to twelve feet in thickness, of a material differing from the Yellow Loam of adjoining ridges only in the amount of lime and clay contained in it, and showing unequivocal transitions into the Loam stratum proper on the edge of the prairies, where on the hillsides similar material is formed, wherever the Cretaceous rock is in a corresponding position. Hence I consider the underclay of the prairies as the equivalent of the Yellow Loam, modified in its composition by the subjacent rock; just as, on broad sandy ridges, the Loam is sometimes represented by an extremely sandy "hardpan" (§ 651); or by the intractable "Hog Wallow" soil, where it is underlaid by certain stages of the lignitic Tertiary (§ 746).

As to the hypsometrical position of the Cretaceous prairies, it is not a very definite one. Locally they are surrounded by, and lower than adjoining ridges, but this is by no means the rule. Large bodies on the contrary seem rather to occupy the position of dividing plateaus, on a level, or nearly so, with the hill-tops of adjoining uplands. Their position, no less than their material, seem, therefore, to forbid attributing to them a lacustrine origin; while a comparison of the composition of the prairie underclay (§ 548) and of the Rotten Limestone (§ 149) will dispose of the idea of "surface disintegration."

There is another facies of surface conformation which seems to be parallel, not only geographically, but geologically and genetically, to the prairies, viz., the level belt of land timbered prevalently with Post Oak, and popularly known as "the Flatwoods" (§ 561, ff.). North of Ocktibbeha county, Miss., they are separated from the prairie belt by intervening ridges, but farther south the two trails coalesce, the difference of soil alone marking, in some degree, their confines. That difference is manifestly owing to, and parallel with, that between the subjacent materials; which in the case of the flatwoods, is the heavy gray clay of the lignitic (§ 165), resisting denudation equally as much as the Rotten Limestone.

It seems to me that in this resistance to denudation is to be sought the cause, both of the absence of the Orange Sand deposits from both tracts (§ 6), and of their levelness, their surface being, as it were, parallel to that of the strata of the underlying older formation. (See profile, Pl. I, fig. 2, in Miss. Report.)

Wherever water can make little impression on the surface over which it flows, its motion is, *caeteris paribus,* more rapid, and its tendency to form deposits much less, than where a roughened bed gives rise to eddies and counter-currents, and every initial deposit induces the formation of others around it in a geometrical ratio of increase.

Whether we suppose the Orange Sand never to have been deposited on the prairies and flatwoods, or that it has subsequently been removed; its absence is to be accounted for. We cannot for a moment suppose that the waters which deposited the Orange Sand did not visit the region, since the ridges which divide the prairies and flatwoods are thickly capped with it (§§ 122, 137), and bands of Orange Sand frequently divide from each other adjacent patches of prairie land. When this is the case, although the surface may be on a level with the prairie, the Cretaceous limestone is always much deeper underground. And it is equally obvious, in passing westward from the flatwoods, that they disappear as soon as the stratum which has served to form their characteristic soil dips too low, and is overlaid by the more easily denuded materials of the lignitic (§ 587).

Considerations quite analogous to these apply also to the Tertiary prairies of South Mississippi, and the adjoining "Hog Wallow" or "Post Oak" prairie—the latter possessing no better claim to the title of prairie than the flatwoods of North Mississippi. There are but few cases in which (as in some of the prairies of Scott Co.) the subsoil can be considered a mere surface disintegration, if we confine the meaning of that term to the changes attributable to atmospheric influences alone, as should be done. Whenever the material has been transported from its original place, breaking up its structure and stratification, it must be considered a distinct deposit, no matter whether or not its chemical composition has undergone a change.

How far similar considerations may apply to the prairies of Illinois, in connection with the Carboniferous strata, those better acquainted than I am with the facts of the case must determine. It would seem to be a postulate of the ingenious theory of Mr. Lesquereux on this subject, that the Drift period should have left them greatly more level than we now find them, and if my memory serves me, the deposits of the Drift proper are but feebly represented in the level portions, the material covering the Carboniferous rocks being analogous, apparently, rather to the Yellow Loam of Mississippi and Alabama.

The sparseness of the timber on the prairies of Mississippi does not, as it seems to me, present any difficulty of explanation. All over the state, the Black Jack and Post Oak are the chief denizens of upland soils of extreme physical conditions; hence their prevalence on the heavy prairie soil. Owing to the luxuriant growth of grass, etc., on the prairies, but a small percentage of the most vigorous seedlings can escape the annual fires. These, however, from the fertility of the soil and the free scope for development afforded by their sparseness, can naturally become exquisite specimens of their species (§ 545).

In the "Flatwoods," *per contra*, while the species of trees selected would be the same, the exceedingly scant growth of grass would not seriously impair, in burning, the abundance of young trees. Hence we find on them a dense growth of lank, poorly clad trees, the very type of their species when occupying an illiberal soil (§ 568). Precisely the same relations, as regards their timber, existed in the uplands of the Yellow Loam region (§ 606) between the Black Jack ridges and the fertile Table-lands (611, 616), when both were regularly burnt by the Indians. The former possess a dense growth of gnarled, tattered trees, the latter had the appearance of artificial parks—now marred by the dense undergrowth which the omission of burning, or burning at the wrong season, has allowed to spring up (§ 796).

The "Hummocks," or Second Bottoms.—While the period marked by the Yellow Loam and its equivalents must have presented features not now exemplified, called forth by causes which have ceased to act, the formation next in upward order differs from those now in progress only in the quantity or intensity of the action which produced them.

The Second Bottoms form part of the valleys of all the larger streams of the state, and in some districts even of the "creeks." They are in general most extensive where the material of the adjoining uplands was most easily denuded (without being too pervious, as in the Pine Hills of the south (§§ 32, 77), and has therefore permitted the excavation of wide valleys; while, where that material resisted denudation, the contraction of the valley and consequent greater swiftness of the stream have either prevented the formation of these deposits, or caused their subsequent removal.

There are two points of difference between these "second bottoms" and the "first bottoms" of the present era, which enable the observer to distinguish them even when either is entirely absent. In the first place, the "hummock" is always out of reach of the highest water within the memory of the "oldest inhabitant," and in many cases the first bottom is as distinctly cut into the second bottom deposits, as the water channel is into the first bottom, there being a *sudden* ascent of from three to as much as ten or more feet, while by a more gradual slope, thereafter, the difference of level often amounts to twenty feet and more. In the second place, not only is there almost always a decided difference between the materials, and consequently the soils and natural vegetation, of the first and second bottoms of one and the same stream (for example, § 809), but the nature of the latter soil shows a certain correspondence all over the state, so as to be mostly recognizable at a glance by an experienced eye. It is only in the lower portion of the course of the larger streams, that this distinction is lost in a great degree.

The soils and subsoils referred to are mostly pale gray or buff-colored, fine siliceous silts, with but little coarse sand, accompanied by *irregularly* shaped concretions of bog ore; very unretentive, and poor in phosphoric acid and lime. Their character varies measurably in accordance with the materials of the bordering uplands, whereas the first bottom soils are chiefly dependent, for their character, upon the materials into which the bed of the present stream is cut. Beneath the subsoil, we find the materials stratified precisely in the manner described by Prof. Swallow with reference to the "Bottom prairies" of Missouri, to which I have no doubt they are equivalent, as well as to the "river terraces" described years ago in this Journal (by Dr. Newberry, I believe,) from observations on the valleys of Ohio. There is but one serious point of difference as regards the former, viz., that the Bottom prairie contains the fossils of the Bluff formation, whereas the hummock deposits of Mississippi, as far as known, present but a very few and indistinct stems and leaves, occasionally, in the more clayey bands. But it must be considered, that neither is the Bluff formation itself represented on the streams in question. It therefore remains to be determined whether those fossils are an essential characteristic of the Bottom prairie, outside of the region of the Bluff formation, and on the smaller streams I have not thus far succeeded in discovering any fossils in the somewhat equivocal deposits which seem to represent the "second bottom" epoch near the mouths of the Big Black, Bayou Pierre, Homochitto and other streams, on the territory of the Bluff formation. And as to the existence of any representative of that epoch in the great Mississippi Bottom itself, I have not had any opportunity of observing.

It is evidently during the period of the Second Bottoms that the great denudations which have traced the valleys of our water-courses of the second, third, and even fourth order, were accomplished by agencies considerably more energetic than those operating at present. It was then that the sketch was made of the map whose more delicate tracery and shades the alluvial epoch has since, and is now working out. Unless we assume a somewhat *sudden* transition, a more or less *abrupt* remission of the denuding agencies, it is difficult to understand why there should be any terraces of the kind described—why they, with their easily denuded material, should not have attained a gradual slope of surface toward the channel, instead of being as level as the first bottom itself. To my mind, the era represented by the second bottoms appears as distinctly marked as that of the Bluff formation, and as much entitled to a distinctive *name* recognized everywhere. The difficulty of the study of the quaternary formations, sufficiently great of itself, is greatly enhanced by the want of such terms, and the failure on the part of many observers, hitherto, even to attempt to parallelize in different localities the formations more recent than the Loess. If I am not greatly mistaken, the Yellow Loam, also, is as distinctly represented in Illinois and Missouri as it is south of the Ohio. Then why should not the "Loam period" and that of the "River terraces" be as distinctly recognized among American geologists as those of the Drift and Loess? Even if these divisions were not recognizable outside of the Mississippi valley, they would serve a good purpose for the study of not a small portion of the earth's surface.[1]

Since writing the above, I have received from Prof. Winchell a copy of his interesting remarks on the subject of the apparent northward transportation of large boulder deposits in the Drift of Michigan. While appreciating the force of his reasoning as regards those deposits, all my observations in this state and such portions of Alabama as I have visited, contradict the assumption of any northward transportation amongst the materials of the Drift. The steady decrease of the "grain" of transported materials as we advance southward, provided the evident direction of the transporting currents be taken into account, is an insuperable obstacle to that supposition as far as the Orange Sand is concerned. Of the "red loam" mentioned by him I cannot speak from personal knowledge, though I presume it to be identical with the material found in corresponding positions in Mississippi. If so, I cannot agree with Prof. Winchell as to its being a mere surface disintegration of the Rotten Limestone "altered *in situ* or with slight transportation." It will be seen by a glance at my map of the formations of Mississippi, that in view of the change of direction in the strike of the Cretaceous strata, the geographical position of the "red loam," supposing it to be essentially connected with the Rotten Limestone, can be accounted for equally as well by the assumption of southeasterly, as of northerly currents. That is precisely the direction indicated, as above stated, by the trend of the eastern pebble band of the Orange Sand delta.

University of Mississippi, December, 1865.

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[1] The epoch here referred to as deserving a name is that designated the *Champlain*, in Dana's Mineralogy (p. 547), from deposits of the era upon the borders of Lake Champlain called the Champlain formation by Prof. C. H. Hitchcock.—Eds.

ART. XXXVIII.—*Caricography*; by Prof. C. DEWEY.

(Continued from vol. xli, p. 230, 1866.)

No. 293. *C. cephaloidea*, Dewey, Boott Illust., No. 285.

Spica composita oblonga raro sub-crassa infra foliati-bracteata, spiculis 5–10 ovatis compactis apice staminiferis interdum interruptis; fructibus *distigmaticis* ovatis oblongis in rostrum planum acute bifidum vel longi-dentatum contractis, supra convexis enervibus margine superne subalatis denticulatis lævibus, squama ovati-lanceolata vel cuspidata brevioribus vel eam subæquantibus; culmo foliaceo 2–3-pedali; foliis et spicis viridi-pallidis.

Ringwood, Ill.,—Dr. Vasey, by whom it has been liberally spread among botanists; Nebraska,—Dr. Hayden. As it grows near or among *C. sparganioides*, it may have been confounded with that species. A variety has fewer and smaller spikelets, less compacted, and grows to the height of three feet. Sometimes also there occurs nearly round-oval fruit, short rostrate on some of the spikelets, with the common form. It is distinguished from *C. sparganioides* by its long *acute* 2-*toothed* beak, and more winged and denticulate margin, and by its longer and cuspidate scale, as well as by its commonly more dense or compact spikelets.

Note.—This species in Boott is not *C. cephaloidea* Dew. in Wood's Botany, as the characters, so different, show; and it was first described in 1862 in his Illust. as above. How *C. cephaloidea* came to designate it, is unknown to me; but as Dr. Boott has fixed the name on this plant, and as no one has recognized the other, it may be well to substitute this description in Wood hereafter, giving to Dr. Boott the honor.

No. 294. *C. alopecoidea*, Tuck. Enum., p. 18, 1843.

Spica composita oblonga, spiculis 8–10 interdum pluribus ovatis subaggregatis infimis nunc subremotis superne staminiferis flavescentibus; stigmatibus 2; fructibus ovatis lanceolatis vel in rostrum mediocrem bifidum margine serrulatum acuminatis plano-convexis fere enerviis lævibus glumas ovatas mucronatas vel cuspidatas sub-æquantibus; culmo triquetro sub-2-pedali scabro basin foliato.

Found by Dr. Sartwell, Penn Yann, N. Y., and named *C. cephalophora* var. *maxima* Dew., in this Jour., vol. xliii, p. 92; in 1842, appropriately renamed by Prof. Tuckermann. It has also been discovered in Michigan by Dr. Cooley; also in Canada.

No. 295. *C. angustata*, Boott, Hooker Fl. Bor. Am. 1840.
— *stricta*, Lam. 1789.

Spicis cylindraceis tenuibus erectis 4–6; staminiferis 2–3; pistillatis 1–4 subsessilibus, superioribus apice staminiferis superne teretibus, inferioribus longioribus et infima brevi-pedunculata, inferne laxifloris distigmaticis; fructibus ovatis ellipticis subacutis brevi-rostratis vel apiculatis ore integro vix nervosis, squama arcti-oblonga subacuta varia fusca brevioribus vel eam aequantibus; culmo bipedali triquetri-acuto per-scabro foliis longis angustis rigidis glaucis margine per-scabris longiore.

Culm 1½–3 feet high, erect and stiff, very sharp and scabrous 3-sided, especially above, in large clusters or bogs, with long and recurved leaves above bracteate; spikes 4 or 5 to 6, cylindric, rather slender for their length; staminate spikes 2–3, sessile, the lowest bracteate; pistillate spikes 1–4, commonly 2–3, upper staminate above and tapering upward and sessile, the lower longer and short-pedicellate, more loose-flowered below; stigmas 2; fruit oval or ovate, subacute, short-rostrate orifice entire, equalling or shorter than the narrow oblong acute tawny scale.

This is the *C. acuta* of Muhl. (not of Linn.), and thence of American authors for years, till Dr. Boott showed the mistake; and as they had adopted the *C. stricta*, Gooden., Dr. Boott thought it advisable to change the name given by Lamarck to that species (though the older) into *C. angustata*, as above, and continue the *C. stricta*, Gooden. Mr. Carey still retains *C. stricta* Lam., and alludes to the other species as *C. stricta* Gooden. The opinion of later botanists is that *C. angustata* is clearly distinct from the *C. stricta*, Good.

As Dr. Boott introduced the older name, *C. Magellanica*, Lam., to the exclusion of *C. irrigua*, Smith, and so long current, it is to be regretted he did not continue the work and make the change in other cases. Then *C. tenella*, Ehrht. would have banished *C. tenella*, Schk., even though Schk. himself had not already expunged it, as a synonym of *C. loliacea*, Linn.: so of some others.

No. 296. *C. juncea*, Willd., Syst. Veg. 1826.
— *miser*, Buckley;[1] Sill. xlviii, 141, 1845, and xxix, 346, 1860.

Terminal spike staminate, short-cylindric, with scales oblong and obtuse; pistillate spikes 2, rarely 3, slender, subremote, loose and alternate flowered, pedunculate, long and setaceous-bracteate; stigmas 3; fruit slender, lanceolate, subtriquetrous, scabrous above, longer than the ovate obtuse white-edged scale; culm a foot or more, slender, longer than the radical narrow leaves; plant light green.

Boston or vicinity, very rare, doubtless introduced from Europe.

No. 297. *C. rotundata*, Wahl. 1803.
— *globularis*, Schk., No. 111, fig. 93.

Terminal spike staminate, linear, erect, with tawny linear and obtuse scales; pistillate spike one, rarely two, cylindric, sessile, distant exsertly leafy-bracteate, densely flowered; stigmas 3; fruit ovate, subglobose, rather obtuse apiculate or short-rostrate, smooth, about equal to the ovate obtuse scale; culm short, erect, longer than the narrow subulate roughish leaves.

Arctic regions, Dr. Richardson. These brief characters may help some of our botanists in discriminating this species. In my Lapland specimen, said to be from Wahlenberg, the fruit may be too young for the figure of Schk., as the fruit is scarcely globular.

No. 298. *C. extensa*, Gooden., Schk., p. 56, No. 62.

Terminal spike staminate cylindric, an inch long, with oblong obtuse or sub-acute reddish-brown scales, rarely a short small staminate one below and near; pistillate spikes 1–4, often two, round oval short sessile and approximate, or one of them longer and cylindric, sometimes 3 or 4 cylindric except the upper one near the terminal staminate at the sum-

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[1] For his description see this Journal, xlv, 1843.

mit, sometimes 2 near the staminate and a third remote cylindric, rarely quite long exsertly-pedunculate, all leafy-bracteate and the lower bract sheathing while the leafy bract equals or surpasses the culm; stigmas 3; fruit ovate or oval, tapering below and acutely above into a bidentate short beak, nerved and nearly twice longer than the ovate short-mucronate scale; culm erect, smooth, triquetrous, leafy toward the base; leaves narrow, long, scabrous above on the edges and about the length of the culm; plant pale green.

Common along salt marshes in England, France, Sweden, &c., and in our country in similar position at Coney Island and on Long Island, where it was found several years ago, and since very abundantly, by Dr. T. J. Allen. On some specimens from France are four pistillate spikes and two staminate spikes nearly an inch long, and similar to this on the German specimens: some from Coney Island have two staminate spikes. The figures in Schk. are too defective to be useful. My specimens come through the politeness of J. A. Paine, Jr., the discriminating author of the Catalogue of Plants from Oneida Co., &c.

C. lupulina, Muh., vol. xi, p. 165, this Journal, 1826.
var. *gigantoidea*, Dew.

Staminate spikes 1–3, often 2–3, sometimes 1 with stamens on one or two of the upper pistillate spikes, cylindric, erect and covered with long and large lanceolate scales, the upper quite long and the lower shorter and near; pistillate spikes 2–3, cylindric or oblong, large and thick, densely flowered, the lower short pedunculate; fruit ovate-lanceolate, more ventricose than the common plant, or slightly ovate-globose, and more like that of *C. gigantea.* The achenium or seed very different from that of *C. gigantea*, and not like that of the common *C. lupulina*, which is too nodose in fig. 162, and too little nodose in fig. 279 on p. 95, No. 232.

The following differences need consideration, which are very obvious, as *C. lupulina* and this so named variety grow together and are abundant. The former rarely has more than one staminate spike, the latter very rarely has so few as *one*, and often three.

Of the former the fruit is very long and nearly erect; and of the latter smaller and somewhat shorter, as well as horizontal or even reflexed at the base.

The spikes of the latter have less diameter, or about two-thirds the size of the former.

The seed of the latter is mature early in August; that of the former is ripe late in September on the same ground; and on the late maturing latter plant the seed is not developed beyond its small beginning, and will be abortive.

The achenia of the two are unlike; that of the former is triquetrous, with nodose projections on the middle of the three edges, and quite tapering 3-sided above and below; that of the latter is not thus knotted, and is shorter and less tapering or somewhat round-edged above.

The spikes of the former were green on the middle of September; at that time those of the latter were brown or straw color, or quite mature.

The former is not so tall as the latter more slender plant.

The latter grows in well defined tufts or clusters; the former in single or few detached plants and not in tufts; the difference is obvious and striking.

The divergence of the fruit resembles *C. retrorsa* more than *C. lupulina*, yet the achenia are very different.

These differences are too marked for the same species; but for the present, and until connecting forms fail to be discovered, it may be wise to call it var. *gigantoidea.*

Near Cayuga Lake, Ludlowville, Tompkins Co.,—H. B. Lord, Esq., who has pointed out most of the above differences. He stated also that Dr. Gray, as well as myself, thought the plant a form of *C. gigantea* at the first.

C. gigantea, first described by Rudge in the Transactions of the Linn. Soc., 1803, was credited to Carolina. It has been found growing in Louisiana, and northward as far as Kentucky and Delaware. From the last state it was sent me a few years ago and also this year, by Wm. M. Canby, Esq. It is a southern plant, and finely shown in Boott.

The first *C. lupulina* that I saw with two staminate spikes, was received many years ago from Dr. Short, of Louisville, Ky. I hoped it was *C. gigantea*, but it proved a real *C. lupulina.*

Note 1.—Discoveries have made more full descriptions of some species desirable. Only a few can be given.

C. filifolia, Nutt., vol. xi, 1826, and vol. xii, 1827, of this Journal.
Illust., No. 36, fig. 37, Boott.
Uncinia breviseta, Torr. Mon., p. 428.

Spike single, staminate above, cylindric or tapering, with broad close and obtuse scales, brown and white edged, pistillate at the base and also much larger by the three to six or eight fruit; stigmas three; fruit ovate-triquetrous, rather obovate in maturity, tapering below, 1–4 on the small form and 3–8 on the taller, short-apiculate, about equalling the short very broad and often very obtuse or even retuse scale, which is white hyaline when the fruit is mature and brown with white edges when young; culm 3–4 inches, or 6–8 inches, clustered, with involute filiform leaves often nearly as long as the culm.

Plains of Missouri,—Nuttall, 1818, "cespitose, scarcely a hand breadth high;" Arctic America and widely on the Rocky Mountains,—Richardson & Hall; Fort Pierre, Nebraska,—F. V. Hayden, 1855: the taller on the Rocky Mountains.

C. livida, Willd. Wood's and Gray's Bot.
— *limosa* var. *livida*, Wahl. in this Journal, vol. x, p. 41, 1826, credited to Becket, Mass.
var. *radicalis*, Paine.

This curious variety has a pistillate spike on a long radical peduncle from the same root, with a leafy culm bearing a terminal staminate spike, the peduncle nearly as long as the culm.

Cold marshes, Litchfield, Herkimer Co., N. Y., with the typical form,—Paine, in his excellent "Plants of Oneida County and vicinity," now (1865) being printed; also, in Manchester, N. J.,—Knieskern.

This is very like that described in this Journal, vol. xxxix, p. 71, 1865, from the same section of the state, which sometimes has a pistillate spike contiguous to the staminate on the leaf-bearing culm.

Of *C. irrigua*, Sm., vol. x, p. 42, now *C. Magellanica*, Lam., vol. xxxix, 1865, is found a form approximating toward that of the preceding anomalies, viz., nearly, but not quite, radical long peduncles bearing a single pistillate spike. Swamp near Rome,—Paine.

C. pubescens, Muh., so regular in its form, occasionally has a long, nearly radical, peduncle and spike, far from the usual place of the lowest pistillate. Mr. Paine.

C. Sartwelli, Dew., vol. xliii, p. 90, 1842, is found to be a variety of *C. intermedia*, Gooden. in Schk. (the *C. multiformis*, Thuillier), which was afterwards seen to be a form of the earlier named *C. disticha*, Huds., in Fl. Ang.; but all these, sometimes in one locality, are found growing in the states of New York, Illinois, Wisconsin, Canada West and other British possessions. The designations should have the following order:

C. disticha, Huds., substituted for the later synonym,
— *intermedia*, Gooden., vol. iv, p. 343, 1847;
var. *Sartwellii*, Dew., in place of this named species above.

And the only needed additions to the description of *C. intermedia* as *C. disticha*, are the often recurring *two-rowed form* of the *spikelets*, which diminishes with the stamens till both disappear frequently in a regular spike of only pistilliferous spikelets. Specimens precisely like the varying forms of *C. Sartwellii*, have come to me from the north of Europe.

C. muricata var. *cephaloidea*, Dew., this Journal, vol. xi, p. 308, 1826, is *C. sparganioides*, Muhl., var. *minor*, Boott, Illust., No. 284, and first published in 1862 by him.

C. miliaris, Mx., vol. x, p. 36, 1826 this Journal. The description according to that of Michaux was given to aid botanists in detecting the plant; but near thirty years have passed, and this is the only species of the Carices of Michaux which has not been ascertained satisfactorily. Dr. Boott obtained figures of it taken from Michaux's herbarium at Paris, and learned that it has two stigmas and a staminate spike with *narrow linear* scales. I also have a figure of the same, taken at Paris and sent to Dr. Torrey, who long since politely made me a present of it. All the figures are very much alike, and indicate the plant to have an erect slender culm, with stiff, very narrow and not very long leaves, at most are all shorter than the culm. On my figure the stigmas are not given, but the fruit agrees with Michaux's language, with a scale ovate-oblong, obtusish, and rather longer than the fruit. His friend also wrote to Dr. Boott that he found the "curious character" of *glands* or *glandular hairs* covering the upper part of the fruit to the vertex, which *disappeared on the mature fruit*, or was displaced or removed by friction. Such is the amount of present knowledge of *C. miliaris*, Mx. Dr. Boott thinks, it will be found to be, when discovered, "inseparable from *C. saxatilis*, L. (*C. pulla*, Good.). Illust., No. 187.

This may be hoped. On the specimens of *C. saxatilis*, L., the scales of the staminate spike are oblong and not narrow linear; the fruit is longer than its scale; and the leaves are broader than the figures represent, and also more flexible.

C. stenolepis, Torrey, this Journal, xxx, 59, 1836.

Some addition to the description given in the Journal, on specimens sent me by Dr. Torrey, is required. For Dr. Torrey soon found in a large number of specimens that many have not the terminal spike wholly staminate, but pistillate above, some of which spikes were not half staminate; in some the staminate spike is very small or merely rudimentary, and the pistillate spikes "smaller and shorter, so as to be ovate or subglobose." Similar differences occur in the specimens from Texas as well as Kentucky. Torr. Mon., p. 421–2.

C. adusta, Boott, var. *minor*, Boott, Fl. Bor. Am. 1840, is held by him to include *C. argyrantha*, Tuck., which some still doubt.

C. Vaseyi, Dew., this Journal, xxix, 347, 1860.

In his Illust., No. 71, Dr. Boott gave the difference between this plant and both *C. vesicaria* L. and *C. monila* Tuckerman; and hence it was named as above. Yet I have been led to enquire, if the not mature form, *C. Vaseyi*, from Dr. Sartwell, may not be an immature state of *C. monila.* Both Prof. Tuckerman and Dr. Boott have decided to the contrary. Another season may give satisfactory conclusions to all.

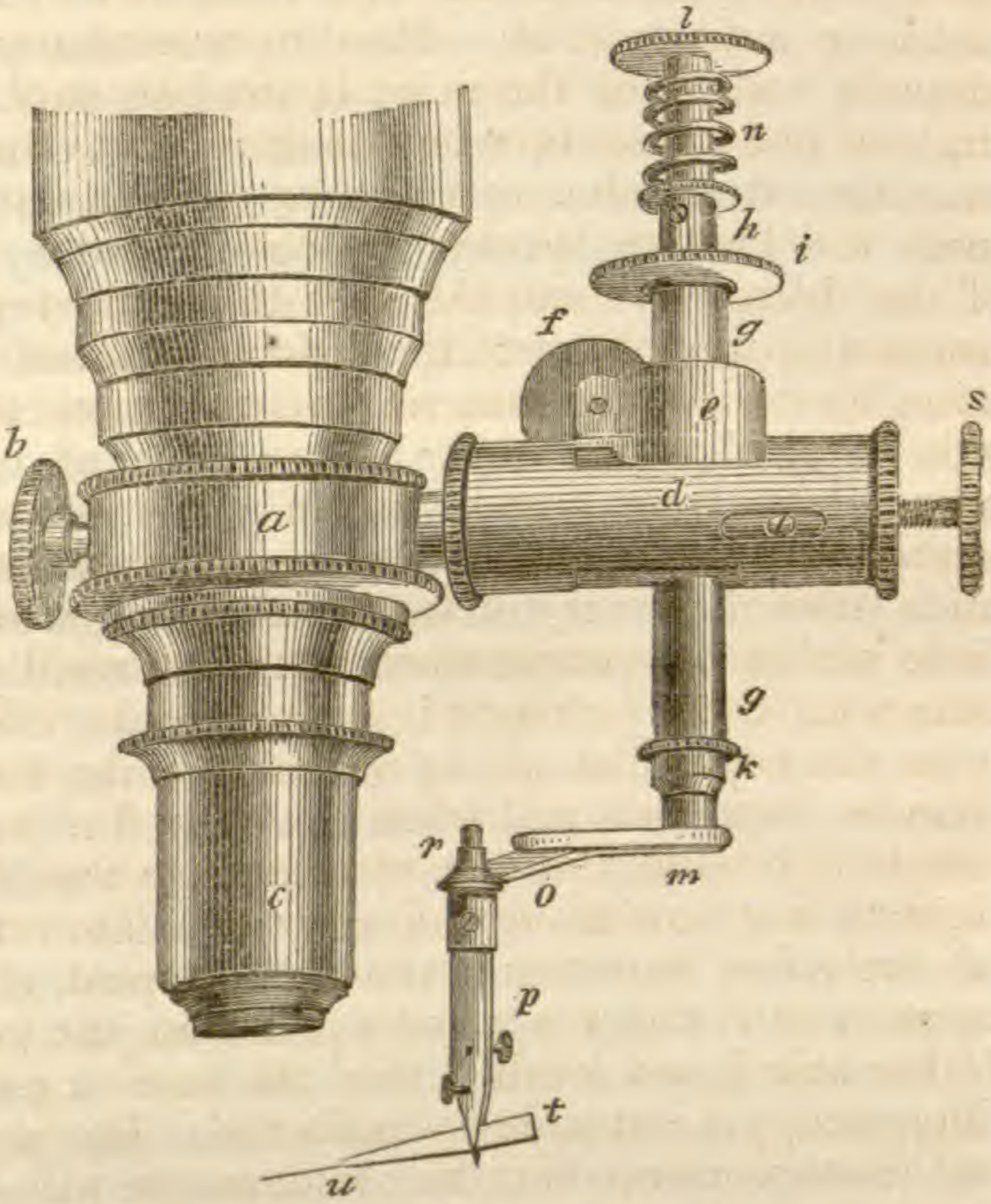
C. cylindrica, Schw., from more extended comparisons of discovered species, appears to belong to the small form of *C. utriculata*, Boott, and to be *C. utriculata*, var. *minor*, Boott, in his Illust., No. 37.

Note 2.—In the midst of ill health I have completed this forty-first article in the series on Carices, which was begun in this Journal, vol. vii, 1824, and which has been continued at intervals to the forty-second year, an extent and period wholly unanticipated. Encouraged by the honored and successful and lamented first editor, and favored by his learned successors, I am happy to express my obligations, and to record my gratitude and respect. Should health be given, I may perhaps prepare the often-solicited catalogue of all the species, a natural and fitting termination of this Caricography.

ART. XL.—*On a Mechanical Finger for use with the Microscope;* by H. L. SMITH, Kenyon College.

IN order to make out satisfactorily the structure of the Diatomaceous frustule, viewed as an opaque object, I found it necessary to be able to change its position while still in view; and for this purpose, to mount it upon the end of a fine bristle, or hair. The bristle, having the diatom frustule adhering, may be placed in one of Mr. Beck's revolving slide holders for opaque objects, and examined with comparative ease on several sides. To pick up the diatom upon the end of the hair, or bristle, I contrived the little piece of apparatus which, perhaps, may not inappropriately be named "a mechanical finger," and which is figured in the accompanying wood-cut. I find it answers most admirably to pick out diatoms and, of course, other minute objects, from a mass of accompanying dirt or debris, and transfer them to a clean slide. Thus from a sample of the "Bermuda deposit" the finer forms of Heliopelta may be rapidly picked up and placed together on one slide, the Eupodiscus *Rogersii* on another; Craspedodiscus *elegans* on another; and in like manner, the various species of Coscinodiscus and Aulacodiscus. These being all mounted after the method presently to be described, in the center of the usual glass slide, present great facilities for ready reference, and appear much more beautiful than when mixed with a lot of foreign material. The precision with which even very minute diatoms may be picked up and transferred constitutes the chief value of this little instrument. It is not, indeed, so very difficult for an experienced microscopist, who has become accustomed to the reversed motion of the hand when using the compound microscope, to pick out with tolerable ease the larger diatoms by means of a hair mounted in a suitable handle, but if the specimen is a very fine or rare one, he is exceedingly liable, through over nervousness, to injure or lose it; and, if very small, to fail entirely. The mechanical finger is entirely free from this nervous excitement, and the hair touches gently, and with the utmost precision, the indicated diatom or other object, and holds it until the receiving slide is made ready, then drops it just where it is desired. By far the greater number of those working with the microscope will, however, be found entirely unable to pick out and transfer specimens by the unaided hand, and to this class the present invention will, no doubt, be acceptable.

The cut represents the instrument attached to the lower or objective end of the microscope. An adapter, having the "Society screw" outside and inside, is screwed into the nose piece of the microscope, and upon this adapter the ring *a* moves freely between two collars and may be clamped, by means of the milled-head screw *b*, in such position as may be deemed best for use. Into the lower part of the adapter an objective (*c*) is screwed; the ⅔d-inch will answer very well, using the B eyepiece. A tubular arm (*d*) is screwed to the ring, opposite to the clamping screw *b*, and inside of this arm moves another tube carrying the piece *e*, which is a circular clamp tightened by means of the milled head *f*; the whole is moved to or from the microscope body by means of the screw *s*, which pushes against a stout spiral spring. Within the clamp *e*, the smaller tube *g* moves up and down, parallel to the body of the microscope, and may be clamped in the proper position by means of the screw *f*. Inside of the tube *g* is fitted neatly another tube *h*, having the large milled flange *i* firmly attached above, and the smaller one *k* screwed on to it below. This tube can be turned around freely in the tube *gg* by means of the milled flange *i*, but it has no motion up or down. Within the last mentioned tube the rod *n m* moves smoothly up and down a limited amount, determined by the slot and guide pin, as shown near *h*. A milled-head (*l*) receives the finger when it is desired to depress the rod, and, on releasing the pressure, the spiral spring *n* instantly elevates it. To the lower end of the rod the flat double-jointed arm *mo* is attached, having free lateral movement; the end of the arm carries the small spring forceps *p*, which turns freely in the socket *r*. The forceps grasp the triangular slip of card *t*, which has a bit of human hair *u*, gummed to it, and projecting about $\frac{1}{10}$th of an inch.



The slips of paper and the size and length of the hair may be varied to suit the different objects which are to be picked up. To use the instrument the following adjustments are necessary. We will suppose the $\frac{2}{3}$-inch objective is employed. The ring *a* is first firmly clamped, and the slip of card bearing the hair is put in the forceps *p*, inclined downward as represented in the cut, but not too much; the tube *g* is elevated in the clamp *e*, and, by means of the milled head *i*, the arm with forceps and hair turned one side. For my own use I prefer to clamp the ring *a* in such position as to place the tube *d* at the left hand of the microscope, using one of the fingers of the left hand to depress the head *l*, the right hand being free to use with the mechanical stage, and for focussing. Place on the stage a slide with a bit of thin paper pasted near its centre, and having a small cross marked on it, or a simple black dot. Next, bring this dot into focus, and, while thus remaining, turn back the tubes *g* and *h* by means of the head *i*, and so adjust by slipping the tube *g* up and down, and by moving the arm *m o*, or the forceps *p*, in the socket *r*, that the end of the hair shall stand just over and a *trifle above* the dot; now clamp *g* by means of the screw *f*; and bring the point of the hair so that it may be seen, slightly out of focus, when looking into the microscope, just over the intersection of the cross, or the dot, by means of the screw *s*. The whole may now be elevated by means of the rack of the microscope and the adjusting slide replaced by another containing the material from which it is desired to pick up certain objects. If the material is dried upon mica from a suspension in alcohol, the object may be picked up easily; if dried upon glass, from suspension in water, it sometimes adheres strongly, but with a little care is easily detached. If the illumination from below is too strong, the hair, which is, of course, a little within the proper focus, is not so readily seen at the same time with the object as it is with a feebler illumination. Upon depressing the tube of the microscope the forceps and hair are likewise depressed, and when the desired objects are in focus the hair will be dimly seen, projecting into the field of view. The object being now brought under the point of the hair, by means of the stage movement, the hair is pushed down gently by means of the finger applied at *l*, its tip just touching the object. If the hair is too much within the focus it may first be slightly depressed, yet not so as to touch the object, and then, by means of the stage movement, the object can be placed distinctly under the point. Sometimes the first touch will lift the object, but generally it will take two or three touches to dislodge it. When it rises with the hair upon releasing the pressure, the whole is to be gently elevated by means of the rack of the microscope, so that the slide can be removed without disturbing the hair. In doing this care must be taken to avoid a current of air, made by the breath, or quick movement of the hand, as this might dislodge the object. In order to place the objects quickly at just the right place on a clean slide, I cut a small hole in the center of a gummed label and stick it on to the slide, so that the hole is exactly in the center. This may be done rapidly, by previously marking the outline of the slide on a paper and placing a dot at the center. The perforated label is supposed to be on the under part of the glass slide. Upon breathing heavily upon the upper surface of the slide, a copious deposit of moisture is effected, and the slide is then to be immediately placed on the stage, and its central portion, indicated by the hole in the gummed label, brought to the center. If an achromatic condensor is used this is easily done, as the spot of light will show itself shining through the paper. The tube of the microscope is now depressed, of course carrying the hair and the object with it, until the moisture is in focus; a slight touch of the finger now causes the hair to descend, and instantly the moisture takes the object off and causes it to lie flat on the glass. Of course the slide, having the objects thus placed upon it, must be handled gently; but there is no danger of disturbing or losing the objects if it is first gently breathed upon, but not obliquely unless with great care. The next step is to mount the objects, of which we will suppose there are several, say of *Stauroneis acuta*, in the center of the slide, without displacing them and altogether making but a slight white spot when viewed without a magnifier, or by a lens of one or two inches focus. Cut a small circular disc or square of thin glass of about a quarter of an inch in diameter or breadth, and warming it gently, after cleansing it, place at one edge a minute drop of Canada balsam, not too old, nor yet too fluid. Warm the slide gently to drive off all moisture, but not hot enough to cause the balsam to flow when the little cover is put on, yet sufficiently warm to make it stick. The cover being lodged over the objects, but not touching them, as it is held off by the little drop of balsam, the next step is to warm the slide at one end very gently; the heat conducted along the slide soon causes the drop of balsam to spread and move forward under the slide. Care must be taken not to do this too rapidly. If heated slowly the balsam will move forward and the cover settle down without disturbing at all the positions of the objects, and seldom requiring any reheating. The balsam should be hard enough to fix the cover firmly, and all pressure upon it carefully avoided when the slide is entirely cooled.

To finish the slide, all that is necessary is to paste another label, with a small hole in its center, directly over the glass cover, and coinciding with the hole below; or if preferred the under label may be removed, leaving only the small round disc on top to cover the object. I prefer the perforated paper above and not below, as it indicates readily the exact spot occupied by the objects, and protects the covering glass from accidental dislodgement, and the slides thus finished appear quite neat if the gummed labels are properly selected.

The instrument as described above was made for me by Wales & Co., Fort Lee, New Jersey, and is a very fine specimen of their skill in the nicer forms of mechanical work. It is but justice to them to attribute much of the success of this contrivance, to the very careful manner in which they have made it.

The hair should move nicely up and down when magnified by the microscope, and touch the desired object with precision; for this purpose the rod *n* must move very smoothly, and all lateral motion of it prevented by the careful arrangement of the pin and slot, as shown near *h*. If, after the object is mounted on the clean side, it is desirable to examine it with a higher power, say a $\frac{4}{10}$th- or $\frac{1}{5}$th-inch objective, it is not necessary to remove the hair from the forceps; the whole may be turned one side without disturbing the arrangements, by means of the milled collar *i*, and the lower objective being removed, a higher may be substituted; upon again replacing the first objective, and turning back the head *i*, the hair will again appear in the right place for use.

It will frequently happen that the hair will gather up considerable dirt and must be cleansed; this is readily done by slightly scraping it, without removing from the forceps, by the edge of a sharp, clean knife. The little spring of the hair as the knife edge slips off the end, will readily throw off all the loosened dirt. If too much dirt is picked up with the diatom, or other object, it may first be deposited upon a cleaner place of the slide, and again picked up freed from most if not all the foreign material.

One great advantage of this little instrument is, that it enables us to turn over a diatom, or deposit it on end, and thus obtain views very difficult to be had from balsam mounted specimens; and again, the frustules viewed dry often present particulars with great distinctness that can only be glimpsed, or guessed at, when mounted in balsam, and for this purpose it is very necessary to have them mounted on a clean slide, and themselves free from dirt. If the diatoms stick too firmly to be raised by the hair, they can generally be loosened by strongly heating the slide, and on this account I prefer mica to receive the material from which the selections are to be made.

I have been more particular in describing this instrument, as some who have procured the reflector for opaque illumination,[1] did not succeed well in using it until after many trials and disappointments. I have, however, received testimony from many of the most experienced workers with the microscope in this country as to its complete success, and trust the "mechanical finger" will be duly appreciated, and prove fully capable of doing all I have claimed for it.

Since the preceding article was written a further experience in using the mechanical finger enables me to add a few useful suggestions. It will happen frequently that specimens having considerable thickness, e. g. Triceratium *favus*, or some very fine specimen of Actinoptychus may be picked out; these, if mounted under a small bit of thin glass, will probably be crushed, and entirely ruined; and especially if the label punctured with a small hole is pasted over the glass cover, to indicate the exact locality of the object. In a case of this kind, the injury may be

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[1] See this Journal, Sept. 1865.

prevented by inserting a small bit of tissue paper under the glass cover, to keep it from pressing the object, when the balsam runs under. If the alcoholic solution containing the diatoms should deposit any resinous or gummy matter, on drying, the diatoms will stick fast to the glass; excessive heating will be of no avail to dislodge them, and may be injurious. To meet this difficulty breathe gently, but sufficiently long to deposit considerable moisture, on the slide, without removing it from the stage, and immediately bring the hair in contact with the object; it will now be loosened, and if kept moving, by pushing it on the slide until the moisture has evaporated it can be picked up. I have found that the outside bristle of an ordinary clothes brush has generally a nice point worn upon it, if the brush has been long used; it is somewhat stiffer than the hair and may therefore project farther beyond the paper to which it is gummed. With care the diatoms may be so located that they will be in the exact center of the slide, and thus, when the microscope is adjusted for one, the others, although on different slips of glass, will be in the field with a high power, and this even when the ends of the slide are reversed. It is best to thoroughly explore the slide before picking up the objects, and to register those desired to be preserved. In this way the choicer specimens can be selected, and the whole slide completely examined.

ART. XLI.—*The Distribution and Migrations of North American Birds;* by SPENCER F. BAIRD, Asst. Sec. Smithsonian Institution. (Abstract of a memoir presented to the National Academy of Sciences, Jan., 1865.)

[Concluded from p. 192.]

A COMPARISON of the carefully prepared lists of Greenland birds by Reinhardt in the Ibis for 1861, and of Iceland birds by Newton, published in "Iceland, its Scenes and Sagas," by Sabine Baring-Gould, in 1863, will show that all the land birds mentioned as abundant in Iceland are, with few exceptions, more or less common in Greenland; and it is therefore very probable that the additions to the lists of European birds found in Greenland are to be looked for among the remainder of the Icelandic species. The following list, compiled from the above sources, of all land birds of Iceland and of the European species occurring in Greenland, will illustrate the relationship in this respect.

European land birds found in Iceland and Greenland.

	Iceland.	*Greenland.*	*North America.*
Haliætus albicilla (Linn),	Common.	Very common.	? Very rare.
Falco Canadensis, Gmel.,	Rather rare.	Common.	Quite common.
" Islandicus, "	Very common.	Rare.	Rare.
" peregrinus, L.	Problematical.	Not common.	Very rare.
" æsalon, L.	Very common.		
Nyctea nivea, H.	Rather rare.	Very common.	Very common.
Otus brachyotus,	Rare.	Very rare.	" "
" vulgaris,	One specimen.		
Chelidon urbica (Linn.),	Rare.		
Hirundo rustica, L.	"		
Troglodytes borealis, Fischer,	"		
Turdus merula, L.	Seen twice.		
" iliacus, L.	Common.	Two specimens [killed.	
" pilaris, L.	Doubtful.		
Ruticilla tithys (Scop.).	Seen once.		
Saxicola œnanthe, Linn.	Common.	Common.	Rare.
Motacilla alba, L.	"	Two specimens.	
Anthus pratensis,	"	One specimen.	
Plectrophanes Lapponica, L.	Very rare.	Common.	Very common.
" nivalis, L.	Very common.	Very common.	" "
Aegiothus linaria, L.	Rare.	Common.	Common.
" canescens, Gld.		"	
Sturnus vulgaris, L.	Rare.	One specimen.	
Corvus corax, L.	Common.	?	
" cornix, L.	Rare.		
Lagopus Islandorum, Fabr.	Common.	Common.	Common.

From an examination of the above list it will be seen that the only land bird abundant in Iceland and not noticed in Greenland is *Falco æsalon.* The European species to be looked for in Greenland as occurring in Iceland are only the *F. æsalon*, *Chelidon urbica*, *Hirundo rustica*, *Troglodytes borealis*, *Turdus merula*, *Ruticilla tithys*, *Corvus corax?*, and *Corvus cornix.* It will also be noticed that all the European land birds common in Greenland have also been found in continental North America.[1] The Ptarmigans of the three regions will quite probably be found identical.

The following is a table of the water birds of Greenland and Iceland belonging to the European fauna, from which it will be seen that two species, *Crex pratensis* and *Ortygometra porzana*, are found in Greenland and are not yet recorded from Iceland; eleven or twelve species in Iceland and not in Greenland; one in Newfoundland, *Scolopax rusticola*, and neither in Greenland or in Iceland; eleven in both Greenland and Iceland. There are in Greenland proportionally fewer water birds than land birds of the European fauna that occur in continental North America.

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[1] *Haliætus albicilla* was noticed by Sclater as found in Newfoundland and Nova Scotia; although now he considers the evidence rather uncertain. The Smithsonian Institution possesses specimens of true *Falco peregrinus* as distinguished from *anatum* from Moose Factory, Hudson's Bay.

	Iceland.	*Greenland.*	*North America.*
Vanellus cristatus (Meyer),	Occasional.	Two specimens.	
Charadrius hiaticula (L.),	Not rare.	Not rare.	
" pluvialis (L.),	Very common.		
Hæmatopus ostralegus (L.),	Common.	Three specimens.	
Ardea cinerea (L.),	Occasional.	Two specimens.	
Falcinellus igneus,	Very rare.		
Numenius phæopus (L.),	Very common.	Not rare.	
" arquatus (Linn.),	Rare.		
Philomachus pugnax (L.),	One specimen.		Several specimens.
Limosa ægocephala (L.),	Common.	One specimen.	
Gallinago media (Leach),	"	Common.	Bermuda.
Scolopax rusticola (L.),			Newfoundland.
Fulica atra (L.),	Rare.		
Crex pratensis (Bechst.),		Very rare.	Occasional.
Ortygometra porzana (L.),		"	
Rallus aquaticus (L.),	Rare.		
Bernicla leucopsis (Temm.),	Common.	Common.?	Doubtful.
Anser ferus (L.),	Rare.		
" segetum (Bechst.),	Rare.		
" brachyrhynchus (Baill.),	Rare.		
Cygnus ferus (Leach),	Common.	Not rare.	
Nettion crecca (L.),	Very common.	Common.	Not rare.
Mareca penelope (L.),	Quite common.	Not rare.	"
Querquedula querquedula (L.),	Problematical.		
Fuligula ferina (L.),	One specimen.		
Oidemia nigra (L.),	Rare.		
Larus canus (L.),	Very rare.		

The following list embraces the strictly North American birds which are recorded by Reinhardt as occurring in Greenland.

Falco candicans.
Hirundo horreorum.
Cistothorus palustris.
Regulus calendula.
Dendroica coronata.
" virens.
" striata.
Parula Americana.
Helminthophaga ruficapilla.
Geothlypis Philadelphia.
Anthus Ludovicianus (breeds).
Turdus minor.[2]
Tyrannula pusilla.[3]
Contopus borealis.
Vireo olivaceus.
Xanthocephalus icterocephalus.
Zonotrichia leucophrys.[4]
Loxia leucoptera.

Eremophila cornuta.?
Sphyropicus varius.
Colaptes auratus.
Charadrius Virginicus.
Numenius Hudsonicus.
" borealis.
Actodromas maculata.
Gambetta flavipes.
Macrorhamphus griseus.
Porzana Carolina.
Fulica Americana.
Nettion Carolinensis.
Bucephala albeola.
Pelionetta perspicillata.
Podiceps Holbölli.
Rhodostethia rosea.
Xema Sabini.

While therefore it appears that Iceland in all probability furnishes a considerable number of species of European birds to Greenland, the latter supplies very few American birds in return. This is owing to the fact that Iceland lies east of the southwestern extremity of Greenland, and in part south of its

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[2] It is difficult to say which of the three allied species of North American thrush is meant here.

[3] This species is also indeterminable.

[4] Quite as likely to be *Z. Gambelii.*

eastern coast, so that the visitors from the continent of North America in their northward or northeastern movement and corresponding return would not come near Iceland at all, while on the other hand a migration to the north and northwest from Iceland would necessarily soon strike Greenland at a distance of only a few hundred miles, especially aided by the prevalent aerial currents, of which mention will be made hereafter. The following are the only peculiarly North American or Greenland species noted in Mr. Newton's list: *Falco candicans* Gmel., *Numenius Hudsonicus* Lath., *Histrionicus torquatus* Bon.

It is difficult to say whether the Iceland Golden Eye (*Clangula Islandica*) is a gift from Iceland to Greenland and North America, or *vice versa.* While abundant in Iceland, it is by no means rare in North America, being some years quite common as far south as the St. Croix river.

The British island of Heligoland in the North Sea, off the coast of Denmark, is of special interest in an ornithological point of view, from its furnishing more species of European birds than any other locality of its extent (400 out of about 500 species admitted by Blasius), as well as several Asiatic and North American species not recorded as having occurred elsewhere in Europe. To the labors of Herr Gätke, a resident of the island, extended over more than twenty years, we are indebted for the curious and remarkable facts referred to (Naumannia, 1858, 419). The North American birds observed by him are—

Anthus Ludovicianus,	Nov. 6, 1851.
Dendroica virens,	Oct. 19, 1858.
Harporhynchus rufus,	Oct. —, 1857.
Galeoscoptes Carolinensis,	Oct. 28, 1840.
Charadrius Virginicus,	Dec. 20, 1847.
Tryngites rufescens,	May 9, 1847.
Pelionetta perspicillata,	Oct. 9, 1851.
Xema Sabinii,	Oct. 25, 1847.
Rhodostethia rosea,	Feb. 5, 1858.

The following North American birds are recorded in Prof. Blasius's "List of the Birds of Europe, 1862," edited by Newton, in the British Museum Catalogue of British birds, and in other authorities, as occurring in Europe:—

Falco candicans,	
Nauclerus furcatus,	(England.)
Nyctale Acadica,	"
Scops asio,	"
Colaptes auratus,	"
Picus villosus,	"
" pubescens,	"
Coccygus Americanus,	"
" erythrophthalmus,	(Lucca.)
Ceryle alcyon,	(Ireland.)
Progne purpurea,	(England.)
Hirundo bicolor,	"
Dendroica virens,	(Heligoland.)
Harporhynchus rufus,	"
Galescoptes Carolinensis,	"
? Lanius excubitoroides,	(England.)
Turdus Pallasii,	(Germany.)
" Swainsoni,	(Belgium; Italy.)
" migratorius,	(Germany.)
Anthus Ludovicianus,	(Heligoland.)
Vireo olivaceus,[5]	(Chillaston, near Derby, Eng., May, 1859.)
Regulus Calendula,	(England.)
Ampelis cedrorum,	"
Loxia Americana.	
" leucoptera,	"
? Aegiothus canescens,	(Belgium.)
Spiza ciris,	(England; cage bird?)
Agelæus phœniceus,[6]	(England.)

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[5] Ibis, 1864, 394.

[6] Ibis, 1861, 177.

Sturnella magna, (England; March and October.)
Ectopistes migratoria, (England.)
Charadrius Virginicus, (Heligoland.)
" vociferus, (England.)
Gambetta flavipes, "
Symphemia semipalmata, (Sweden.)
Actiturus Bartramius, (Germany; England.)
Tringoides macularius, (Eng.; Germ.)
Tryngites rufescens, (Eng.; Heligoland.)
Macrorhamphus griseus, (England.)
Actodromas maculata, "
" minutilla, "
" Bonapartii, (England; France.)
Numenius Hudsonicus, (Iceland.)
" borealis, (Scotland.)
Porphyrio martinica, (England.)
Porzana Carolina, (England: Newbury, Oct. 1864; Zoologist, 9540.)
Botaurus lentiginosus, (England.)
Nycticorax violaceus, "
Anser hyperboreus, (Germany.)
Bernicla Canadensis, (England.)
Querquedula discors, (Northern France.)
Mareca Americana, (England.)
Cygnus Americanus, "
Fulix affinis, "
" collaris, "
Bucephala albeola, "
Pelionetta perspicillata, (Heligoland.)
Lophodytes cucullatus, (England.)
Plotus anhinga, "
Tachypetes aquilus, (Weser.)
Sterna fuliginosa, (Engl.; Magdeburg.)
Anous stolida, (England; France.)
Rhodostethia rosea, (Heligoland; England.)
Xema Sabini, (Heligoland; England.)
Chroicocephalus atricilla, (England.)
" Philadelphia, (Ireland.)
Oceanites oceanica, (England.)
Puffinus fuliginosus, (France; England.)
" obscurus, (England.)
Podiceps Holbölli, (Holland.)

Of the 69 species of the above list, all but 19 occurred in Great Britain and Ireland.

List of birds supposed to be identical in Europe and North America, or not satisfactorily separated.

Archibuteo lagopus.
Aquila chrysætos.
Pandion haliætus.
Brachiotus vulgaris.
Nyctea nivea.
Surnia ulula.
Cotyle riparia.
Ampelis garrulus.
? Pinicola enucleator.
Aegiothus linaria.
Plectrophanes Lapponicus.
" nivalis.
? Corvus corax.
? Lagopus albus.
? " mutus.
Squatarola Helvetica.
Strepsilas interpres.
Phalaropus hyperboreus.
" fulicarius.
Tringa canutus.
" maritima.
" subarquata.
Calidris arenaria.
Bernicla brenta.
Anas boschas.
Dafila acuta.
Spatula clypeata.
Chaulelasmus streperus.
Fulix marila.
Histrionicus torquatus.
Bucephala clangula.
" Islandica.
Harelda glacialis.
Polysticta Stelleri.
Somateria mollissima. ?
" spectabilis ?
Mergus serrator.
Sula bassana.
Graculus carbo.
Stercorarius (all species).
Larus glaucus.
" leucopterus.
" marinus.
Rissa tridactyla.
Pagophila eburnea.
Rhodostethia rosea.
Sterna Anglica.
" Caspia.
" Hirundo.
" macrura.
" Paradisea.
Hydrochelidon fissipes.
Colymbus torquatus.
" septentrionalis.
Podiceps cristatus.

I have omitted the strictly Pelagic or ocean-wandering birds and those belonging to both coasts of the North Atlantic.

No North American birds have yet been found in Spitzbergen—indeed there are there but about 26 species in all, according to Malmgren. The only land birds recorded are *Falco gyrfalco*, *Nyctea nivea*, *Plectrophanes nivalis*, and *Lagopus* var. *hyperboreus.* Of the birds of Jan Mayen's Land, which lies in a direct line between Iceland and Spitzbergen, and nearer to Greenland than to either, I have seen no catalogue; but they probably have some relationship to Greenland species.

Bermuda,[7] in lat. 32° 15′ and long. 64° 51′, is about 700 miles off the coast of the Carolinas, Cape Hatteras being the nearest land. It is nearly on the same parallel with Charleston, and about 900 miles south of Nova Scotia, nearly midway between the latter and the Virgin Islands of the West Indies. The entire group to which it belongs is about fourteen miles in length by about three or four in width. There are no indigenous Vertebrates, with the exception of a lizard (*Plestiodon longirostris* Cope, Pr. Acad. Nat. Sci., 1861, 315), and the birds are entirely North American in character, much like those of the middle United States. The fauna is especially characterized by the existence throughout the year, and the breeding, of the following birds: *Vireo Noveboracensis*, *Galeoscoptes Carolinensis*, *Sialia sialis*, *Cardinalis Virginianus*, *Corvus Americanus* (said to have been introduced), *Chamæpelia passerina*, *? Gallinula galeata.*

In addition to these the following species are supposed to breed occasionally in the islands: *Sphyropicus varius*, *Ardea herodias.*

All the other species appear to be accidental visitors, noted for a day or two one year, and not seen again perhaps for several. By far the greater number make their appearance in autumn only, very few occurring in spring.

There are no West Indian birds, properly so called, in the Bermudas; and the occurrence of *Milvulus tyrannus*, a South American species, is very questionable.

A few species of European birds have been noted in the Bermudas, consisting of *Saxicola œnanthe*, *Alauda arvensis*, and *Gallinago media.*

It will be noticed that the first and the last of these have been found in Greenland, the *Saxicola* on the continent only.

As out of the line of migration of our land birds, it is not likely that there are any regular visitors to the Bermudas, *en route* for other regions, the great majority of the species detected there having, in all probability in most cases, been driven out of their course by storms. They certainly do not all stop *en route* to the West Indies, as many of the species are not found in the latter islands.

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[7] See "Ornithology of the Bermudas," "Jardine's Contributions to Ornithology," 1849 and 1850, and "The Naturalist in Bermuda," by J. M. Jones, London, 1859.

The water birds seem to appear more regularly, owing to the fact that many of the species apparently take their flight southward from Nova Scotia and Newfoundland straight for the West Indies, and pass directly over the Bermudas.

In the following list of the birds recorded as occurring in the Bermudas, it will be seen that the greater portion of the insectivorous birds and many of the Raptores occur also in the West Indies; rather more than half of the number visit the latter group.

List of birds recorded as occuring in the Bermudas.[8]

Cathartes aura (W). No. of specimens 1, December.
Falco anatum (W). 2, January, February.
" columbarius (W). Through year, especially in September.
" sparverius. 1, December.
Circus Hudsonicus (W). Occasional in autumn.
Haliætus leucocephalus. Seen.
Pandion Carolinensis (W). Abundant.
Otus Wilsonianus (W). 3.
Syrnium nebulosum. 1, April.
Nyctale Acadica. 1, January.
Nyctea nivea. 3, Autumn.
Coccyzus Americanus. "Thousands," Oct. 1849; a few in April.
Sphyropicus varius (W). Perhaps breeds; December to April.
Trochilus colubris (W). At one time common; April.
Chætura pelasgia. Several; Sept. 1849.
Chordeiles popetue (W). Sometimes very common; April to Sept. 1864.
Ceryle alcyon (W). Common; September to April; regular visitor.
Milvulus tyrannus.?? One; March, 1847.
Tyrannus Carolinensis (W). Abundant; April.
" Dominicensis (W). March and April.
Contopus virens (W). One; April.
Turdus mustelinus (W). Several.
" Swainsoni (W). Two; October.
" migratorius (W). Several; February and March.
Saxicola œnanthe. One each; October, March.
Sialia sialis (W). Common; resident.
Anthus Ludovicianus. One; November.
Mniotilta varia (W). Three; October.
Parula Americana (W). One; April.
Geothlypis trichas (W). One; October.
Seiurus Noveboracensis (W). Abundant in autumn; regular visitor.
Dendroica coronata (W). One; January; several in April.
" pinus. Common in September; several seasons.
" palmarum (W). Two; December.
" discolor (W). One; October.
Myiodioctes mitratus (W). One; March.
Pyranga rubra (W). Several; April.
" æstiva (W). " "
Hirundo horreorum (W). Rare in spring; common Aug. to Sept.; great flight in Sept. 1849.
" bicolor (W). Sept. 1849.
Cotyle riparia (W). August and September.
Progne purpurea. Great flight Sept. 22, 1849.
Ampelis cedrorum (W). Abundant October to December.
Collyrio borealis. One; March.

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[8] **Species with (W) are found also in the West Indies.**

Vireo Noveboracensis (W). Common; resident.
Mimus Carolinensis (W). " "
Eremophila cornuta. Three; October and February.
(Alauda arvensis.) One; June 12.
Chrysomitris tristis. Several; March.
Curvirostra Americana. January to May.
" leucoptera. March to May.
Plectrophanes nivalis. January to February.
Passerculus savana (W). One; April.
Pocœcetes gramineus. One; Oct. 25.
Coturniculus Henslowi. Small flock; December.
Melospiza palustris. One; December.
Guiraca Ludoviciana (W). Two; October and April.
Cardinalis Virginianus. Common; resident.
Dolichonyx oryzivorus (W). Nearly every autumn; October.
Icterus Baltimore (W). Two; October.
Corvus Americanus. A few every year; perhaps breeds.
Zenaidura Carolinensis (W). One; March, 1850.
Chamæpelia passerina (W). Common; resident.

Also most of the waders and a considerable number of the swimming birds.

Conclusion.—From a careful consideration of the facts mentioned in the preceding pages, we are, I think, entitled to derive the following generalizations in regard to the interchange of birds between America and Europe.

European birds, especially the land species, reach Greenland and return to the continent by way of Iceland, the Faroe Islands forming a stepping-stone from Great Britain and Scandinavia. In very rare instances species seem to proceed direct to Greenland, without stopping in Iceland, although this may be due to the fact that while visiting Iceland they have not yet been noted there by any naturalist.

The European birds found on the continent of North America reach it by autumnal movement from Greenland in company with strictly North American species.

Birds of North America rarely, if ever, reach England from Greenland by direct spontaneous migration by way of Iceland, as shown by the fact that only three of the American birds occurring in Greenland are found in Iceland, and that few of the American species observed in Europe are found in Greenland at all.

Most specimens of American birds recorded as found in Europe were taken in England (about 50 out of 69), some of them in Heligoland; very few on the continent (land birds in only five instances).

In nearly all cases these specimens belonged to species abundant during summer in New England and the eastern provinces of British America.

In a great majority of cases the occurrence of American birds in England, Heligoland, and the Bermudas, has been in the autumnal months.

The clue to these peculiarities attending the interchange of species of the two continents will be found in the study of the laws of the winds of the northern hemisphere, as developed by Prof. Henry and Prof. Coffin. These gentlemen have shown (see Prof. Henry's articles on Meteorology, "Report of Commissioner of Patents for 1856," page 489) that "the resultant motion of the surface atmosphere, between latitudes 32° and 58° in North America, is from the west, the belt being twenty degrees wide, and its greatest intensity in the latitude of 45°. This, however, must oscillate north and south at different seasons of the year with the varying declination of the sun. South of this belt, in Georgia, Louisiana, etc., the country is influenced, at certain seasons of the year, by the northeast tradewinds; and north of the same belt by the polar winds, which on account of the rotation of the earth, tend to take a direction toward the west. It must be recollected that the westerly direction of the belt here spoken of is principally the resultant of the southwesterly and northwesterly winds alternately predominating during the year."

From these considerations and facts, therefore, we are entitled to conclude that the transfer of American birds to Europe, is principally, if not entirely, by the agency of the winds, in seizing them during the period of their migration, (the autumnal especially) when they follow the coast, or cross its curves, often at a considerable distance from land, or a great height above it. Carried off, away out to sea, mainly from about the latitude of 45° (the line of greatest intensity of the winds) the first land they can make is that of England, whence the fact that most of the species have occurred in the British Islands as well as Heligoland, equally well fitted to attract stragglers and furnish them a resting place. It is probable that, apart from its few permanent residents, the Bermudas are supplied in the same manner.

Iceland being in the latitude of the reverse current, from east to west, such of its species as are caught up by the winds and carried off would soon reach Greenland, only a few hundred miles distant. This may be the principal agency of supply from Europe to Greenland, as most European land birds are only met with there at rare intervals, although as Greenland lies north of Iceland, there may be a regular migration to some extent.

As remarked, the prevailing direction of the winds, whether violent or moderate throughout the year, as well as during the period in which our birds are on either their spring or autumnal migration, is from America toward Europe. Even should their direction be reversed and that rare phenomenon, a summer "northeaster," occur, it would merely have the effect of bringing the birds back upon our own coast, or into the interior, the line of the storm being in fact about parallel with the eastern shore line of the United States, and its influence extending only a short distance from the coast, and not involving the vicinity of Europe at all. That such storms do affect the movements of our birds is shown in the case of the golden plover. It is well known that this species breeds in immense numbers in the northern regions of America, and that the southward migration in summer and autumn, is principally confined to the region along or near the Atlantic coast. Generally, large flights would seem to start directly from Newfoundland and Nova Scotia for the West Indies, where they are met with every autumn passing still southward into South America, and reaching almost to Patagonia. Usually it is but a comparatively small number that touch and rest along the Atlantic states; but it is well known to the sportsmen of New England that, should a violent northeast storm occur off the coast toward the end of August, unusual flights of plover and curlew may be looked for.[9] This was the case in 1863, when the islands of Nantucket, Martha's Vineyard, and other localities along the coast of Massachusetts, swarmed with incredible flights of these birds. On similar occasions immense numbers have been carried far into the interior of the Atlantic states, furnishing the occasion of a regular carnival for gunners, much as in the case of great flights of the wild pigeon.

Another instance of the influence of northeast storms is in the occurrence of the Stormy Petrel, (Mother Carey's Chickens) and other oceanic birds far in the interior, and even across the Alleghanies, during and after such storms. The collections of the Smithsonian Institution embrace specimens of *Thalassidroma Leachii* killed about Washington in August, 1842, with hundreds of others. I myself obtained at Harrisburgh, Penn., a fine adult Pomerine Jager, *Cataractes pomarinus*, killed on the Susquehanna, near that city, in September, 1839. Adults of the species mentioned are rarely seen within the limits of the United States at all, and in summer the latter would hardly be likely to occur south of Newfoundland.

The present is not the occasion to discuss the nature of that impulse which causes the bird or the fish to retrace its steps in spring so unerringly; the fact is a well established one and of much importance in reference to the multiplication or diminution of species. A region deprived of its spring birds or fishes by extermination will only be filled up again in the course of a long period of time. The result, however, can be greatly accelerated by artificial propagation in the places to be supplied.

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[9] Mr. G. N. Lawrence mentions (Annals N. Y. Lyceum, viii, 1864, 100,) that the Golden Plover is always found at Montauk Point on the 28th of August, should a northeast storm occur.

It may be considered as established that the migrations of birds are generally more or less in a north and south direction, influenced very materially by river courses, mountain chains, forests, conditions of moisture, mean temperature, altitude, etc. Middendorf (Die Isepiptesen Russlands) suggests that birds migrate in the direction of the magnetic pole; a suggestion not at all borne out by the facts in North America.

It may be further remarked that while birds proceed generally in the spring to the very spot of birth, and by a definite route, their return in autumn is not necessarily in the same line. Many birds are familiar visitors in abundance, in certain localities in either spring or autumn, and are not known there in the other season. This is a fact well known to the diligent collector, and I have been inclined to think that, in very many instances, birds proceed northward along the valley of the Mississippi, to return along the coast of the Atlantic.

In general the northward vernal movement is performed much more rapidly, and with fewer stops by the way, than the autumnal.

Birds generally make their appearance in given localities with wonderful regularity in the spring, the *Sylvicolidæ* especially; a difference of a few days in successive years attracting the notice of the careful observer; this difference is generally influenced by the season. The time of autumnal return is, perhaps, less definite.

ART. XLII.—*On the Meteoric Fireball of July 13th*, 1846; by DANIEL KIRKWOOD, LL.D., Prof. of Math., Indiana State University.

ON the 13th of July, 1846, at about 9h. 30m. P.M., a brilliant fireball passed over Maryland and Pennsylvania, and was seen also in Virginia, Delaware, New Jersey, New York and Connecticut. This meteor was noticed in many newspapers immediately after its appearance; but I believe no account of it was given in this Journal.

When this brilliant object appeared I was in the parlor of a friend, in York, Pennsylvania. The meteoric light shone brightly into the room, and immediately after, I heard exclamations of surprise from persons in the street. I hurried to the door, but before I could reach a point from which the meteor was visible it had disappeared. The same evening, and also the next day, several citizens of York, who had had good views of the meteor, pointed out, at my request, its apparent path. A few days subsequently I had persons in Chanceford, York Co., Pa. (twenty-five miles southeast of York, Lancaster City, Pa., and Shawsville, Harford Co., Maryland, to do the same. Among those who saw it in York was my learned friend, Daniel M. Ettinger, Esq., whose statements I regard as eminently trustworthy. Mr. E., it is proper to remark, is a practical surveyor, and hence accustomed to accuracy in the measurement of angles. At York, the least zenith distance of the meteor's track was estimated by Mr. Ettinger to be 10°—doubtless a close approximation to the truth.

The August number of the Literary Record and Journal, a monthly periodical then published at Gettysburg, Pa., contained the following editorial notice of the phenomenon:—

"It appears, from various accounts received from abroad, that the extraordinarily large and brilliant meteor, which apparently passed over our town on Monday the 13th ult., was seen over a wide district of territory. It was observed in places very distant from each other, not only in the direction of its motion, which we would expect as a matter of course, but also at right angles to that direction, which was not expected by those who saw it; each observer having been persuaded that it was near the earth, and that it passed nearly over his zenith. It was seen at points west of Gettysburg, and at numerous places east of it as far as the seaboard.

"At Gettysburg, it seemed to burst upon the view at a point a little west of south, and an elevation estimated at about 30°, to pass about 25° east of the zenith, and to be extinguished at a little east of north, and an elevation of about 30° or 35°. It is very much to be regretted that no observations were made by those who saw it, to determine these items with accuracy."

The next number (September, 1846) contained the following communication:—

"New Haven, Conn., Aug. 8, 1846.

* * * "In the 'Literary Record and Journal of the Linnæan Association of Penna. College,' Aug. 1846, I notice some account of the splendid meteor of the 13th ult. This body was also seen by several persons in New Haven, and tolerably well observed. The observations were published in the Daily Herald of this city, but as I have seen no copy of them in other papers, I fear they have not come to your knowledge, and therefore take the liberty of sending you the principal particulars.

"*Time*, July 13th, 1846, 9h. 30m. ± P. M., New Haven.

Place when first seen.—Az. 69° west of true south; altitude 10°—both uncertain, probably two or three degrees; and moreover the observer probably did not notice the meteor at the instant it became visible.

Place of disappearance.—Az. $87\frac{3}{4}$° west of true north; altitude $7\frac{1}{2}$° to 8°. Azimuth may be one degree more or less; altitude very nearly correct.

Motion, exceedingly slow.—Time of flight not less than 20 seconds. This seems scarcely credible, but the chief observer, who is an exact man, well aware of the danger of over-estimating small portions of time, thinks the time still longer.

Apparent size.—Equal to that of the planet Venus on the average, at the same altitude.

The meteor left no train, emitted no sparks, and did not vary in brightness during its course.

* * * "Several accounts of the same body have come from Pennsylvania, New York and Virginia, but so miserably defective as to be of scarcely any use. * * * The very slow relative motion of the meteor led me at once to suppose that it was travelling nearly in the path of the earth, overtook and passed by it, with a real velocity of perhaps twenty-five miles per second. That point of the ecliptic toward which the earth was then tending was at that hour beneath our horizon and in the N.E. quadrant. The elevation of the meteor at extinction could not have exceeded thirty miles, and was probably somewhat less. Its size must have been very great to have presented at this distance so large a light (for definite disc could not be seen), probably not less than 200 feet in diameter, perhaps more; and yet there is so much danger of illusion that this element should be derived from an estimate of the angular diameter taken as near as possible."

I had furnished the same number of the Record and Journal with an article on this meteor. As published, however, it contained several unfortunate typographical errors. A further comparison, moreover, of the descriptions given of the phenomena led me to a slight modification of my results. As might be expected, some of the accounts by observers were very unsatisfactory and even conflicting. I even found it impossible to harmonize those which separately would have been considered trustworthy. Without further details I will merely state that after various trials the following results were found most nearly in harmony with the best observations.

The course of the meteor's path was north, about 30° east, and its projection on the earth's surface passed about four miles west of Lancaster, Pa., and nearly through Mauch Chunk, in Carbon county. The almost unanimous testimony of those who saw the meteor at Lancaster was that it passed a little west or northwest of the zenith; while a few stated that it passed directly "overhead." When west of Philadelphia, according to a correspondent of the Public Ledger, its angle of elevation was 42°. This would make its altitude above the earth's surface, when near Lancaster, about 59 miles. The place of the meteor's disappearance, as seen from New Haven, was at the distance of about 135 miles, near the south corner of Wayne county, Penn. Its apparent altitude at disappearance being about 7¾°, would give its elevation above the earth's surface about 18 miles. It was a little northeast of Lebanon, Penn., when first seen at New Haven, and its distance from the latter was about 189 miles. The corresponding altitude was 33 miles; or if we suppose this angle of elevation to have been 13° (and the writer admits an uncertainty of two or three degrees) the altitude was 44 miles. When nearest York its altitude, according to Mr. Ettinger's estimate of the zenith distance, was about 68 miles; and when nearest Gettysburg, (the zenith distance being 25°), about 70 miles. The point in Virginia to which it was vertical when first seen from Gettysburg was probably about 50 miles southwest of Washington, D. C. The length of the projection of its visible path on the earth's surface was therefore at least 250 miles. The length of that portion observed from New Haven was about 78 miles. When it is remembered that the Gettysburg observation is uncertain to the amount of several degrees, and that those of York and Philadelphia, being but estimates, may be in error at least one degree, entire harmony in our results could not be expected. We may conclude, however, in general, that the meteor's path was far from parallel to the earth's surface; the altitude, when south of Gettysburg, being about 70 miles, and when last seen at New Haven, about 18 miles.

Velocity.—The estimates of the time of flight by different observers were so discordant that nothing definite could be inferred from them. That of the observer at New Haven was perhaps the most reliable. This would give a velocity with reference to the earth's surface of about four miles per second. The heliocentric velocity was probably between 20 and 25 miles per second.

Apparent magnitude.—The estimates of the apparent diameter by persons in York and Lancaster varied from ⅓ to ⅔ that of the full moon; while some at greater distances from the meteor's path thought it about ⅙. The apparent size at New Haven was much less. It is to be remembered, however, that the distance was much greater. Moreover, at York and Lancaster the meteor had a train about 1° in length, while nothing of the kind was observed at New Haven.

Was the disappearance of the meteor followed by a report?—I was assured by persons in Harford county, Maryland, Chanceford, York county, Pennsylvania, and in York, that shortly after the disappearance of the meteor a distinct report like that of a distant cannon was heard. As this was noticed by a considerable number of persons, and in places so remote from each other it is scarcely possible they could have been mistaken. As might be expected, their estimates of the interval which elapsed were different; but Mr. Ettinger of York, who was paying particular attention in expectation of a report, stated that it was a little over six minutes. This would indicate a distance of about 75 miles. It could not therefore have resulted from an explosion at or near the termination of the meteor's path. Like many others I did not notice this report. This may be explained, however, by the very considerable interval which had elapsed after the disappearance of the meteor, when, no report being expected, a distant explosion would not attract attention.

What became of the meteor.—The inclination of the path to the surface of the earth was such that the body could not have passed out of the atmosphere. Perhaps the entire meteoric mass may have been dissipated before reaching the earth.

The meteor at extinction was nearly equally distant from Gettysburg and New Haven. Hence its apparent altitude at the former must have been about 8°. It would seem, therefore, that the Gettysburg observation as to the point of disappearance was nothing more than a rough conjecture by one not accustomed to measuring arcs by the eye. I am also compelled to adopt the same conclusion in regard to a similar estimate by an observer at Lancaster. To a majority of those who saw it both in Lancaster and York it disappeared behind buildings, so that no estimate could be given. The errors in regard to its apparent altitude when it first appeared, are readily explained on the assumption that few saw it at the first moment of visibility.

ART. XLIII.—*Whitney's Geology of California.*

[Continued from p. 231 of this volume.]

IN the preceding part of our notice of Prof. Whitney's Report on the Geology of California, we considered that portion relating to the Coast Ranges. We will now notice the Sierra Nevada, and such other matters treated of in the Report as our space will allow, following as nearly as is convenient the order the author pursues.

THE SIERRA NEVADA.

This mountain chain, the grandest in the United States, possesses a peculiar interest from whichever point of view considered. Possessing, as it does, the highest peaks in the country, so far as is known, and perhaps the greatest magnitude of mass of any chain in North America, abounding in the grandest scenery, containing mines the products of which have changed commercial values throughout the civilized world, and which have stimulated an emigration that has built up eleven states and territories west of the meridian of 103° within seventeen years, seven of which states and territories lie entirely on the west of the Rocky Mountains; a chain about which so much has been written and yet so little accurately known previous to the publication of this Report, we turn therefore with special pleasure to the facts here published.

As stated respecting the chain, in the last number of this Journal, it has the direction N. 31° W., from Mt. San Jacinto to Mt. Shasta, a distance of about 600 miles.

The region *popularly* known under the name of Sierra Nevada, extends from the Tahichipi Pass to Lassen's Peak, about 430 or 440 miles. For this distance the chain is very continuous and unbroken, and preserves many common features. It is from 75 to 100 miles wide, generally between 80 and 90 miles, and has everywhere a long gradual slope on the western side to the Great Central Valley of California; while on the eastern it descends precipitously to the elevated valleys and deserts of the Great Basin. The culminating peaks are nearly in a straight line, and, although near the eastern edge, yet the water-shed is generally still farther east of this line.

The chain consists essentially of an immense core of granite, flanked on either side by metamorphic slates, and more or less covered by lava, this latter increasing in quantity as we go north. The culminating points in the *southern* portion are of granite, in the *central* of slates (belonging to the eastern flank), and the *northern* of volcanic rocks. In regard to the comparative ages of the Sierra Nevada and the Coast Ranges, the Report says, "we consider all those chains or ranges of mountains to belong to the Coast Ranges, which have been uplifted since the deposition of the Cretaceous formation; those, on the other hand, which were elevated before the epoch of Cretaceous are reckoned as belonging to the Sierra Nevada."

In passing along the foot hills of the chain, at its western base, we find at numerous points the marine Tertiary or Cretaceous, or both, resting in a horizontal position on the upturned edges of the slates and metamorphic rocks of the auriferous series. At the southern end of the great valley, near Fort Tejon, as we skirt the base of the mountains which close entirely around like a grand amphitheater, we pass suddenly from the undisturbed Tertiary to rocks of the same age and series highly inclined; and, in so doing, we pass from the Sierra Nevada to the Coast Ranges, although the chains form a perfect topographical junction. And, again, at the northern end of the valley, in Shasta county, the Cretaceous strata lying to the east of Sacramento river are horizontal, while on the western side they are highly disturbed.

These horizontal strata may be traced at intervals for over 400 miles, forming a narrow belt at the western base of the chain, not however continuous, but occurring in patches, some very small and others large, the larger lying nearer the two extremities, the central portions, as might be expected, having been more extensively swept away by denudation. Portions are highly fossiliferous. To the north the Cretaceous predominates, and the fossils are numerous and especially well preserved; in the south Tertiary predominates, and the fossils are fewer and in a poor condition.

These marine strata do not extend to an altitude of more than 1000 feet, except at the extreme southern part, where they occur at a height of over 1200 feet, if the altitudes given upon the maps of the Pacific R. R. explorations are to be relied upon. They are nowhere worked for gold, and are not to be confounded with those extensive fresh-water deposits which occur so frequently in the mining regions, which sometimes extend up to a great height, and often contain the precious metal in quantities sufficient for profitable extraction.

To the south of the latitude of Sacramento they are entirely Tertiary. The most considerable mass commences near White river and extends to the head of the valley. Between White and Kern rivers they form a belt denuded into rounded hills from 200 to 600 feet high; the rock is soft, easily decomposing, and the hills dry and treeless. They rest on a floor of granite which is exposed by denudation at frequent intervals. Wherever fossils have been found, they are in poor preservation and have been referred to the Miocene. South of Kern river the deposits are widely distributed, but are not so extensively denuded.

Passing north, occasional patches occur at intervals to the American river at Folsom. Here the first Cretaceous rocks occur, which become more common as we travel north.

Near Pence's Ranch, in Butte county, the relations of these strata to the auriferous and volcanic series are most beautifully seen. Resting on the edges of the auriferous slates, which here dip to the east at a very high angle, are the highly fossiliferous Cretaceous shales perfectly undisturbed; and on these again are strata supposed to be Tertiary; and these in turn are covered by tables of basaltic lava. North of this the strata are mostly overlaid by beds of lava, but in a number of streams, cañons have been worn to such a depth that they cut through into the fossiliferous beds beneath, so that the formation was found at intervals nearly to Pitt river.

Of more interest to the general reader is the great *auriferous belt* along the western slope of the chain.

Auriferous Belt.—The auriferous region of the state is not exclusively confined to the western slope; but this portion will be first noticed.

This belt may be said to begin in the neighborhood of Tejon Pass, and to extend through the state and across its northern borders into Oregon. The gold region reaches still farther in each direction, north and south, of which 700 miles or more in length lie within California.

But to return to the western flanks of this chain. Owing to geological peculiarities different portions of this slope are of very unequal importance as gold-producing regions. That portion lying south of the San Joaquin is generally barren; but gold occurs in a few places, and commonly not so near the base of the chain as farther north, and mostly on or in granite.

Commencing at the southern end of the chain, popularly considered, that is, near the Tejon Pass, there is but a very moderate development of metamorphic slates. At the Tejon Reservation they are represented by a narrow belt of mica slates, associated with some crystalline limestone. For 150 miles, travelling north, they are feebly represented, forming but a narrow belt; in some places isolated hills of highly altered rocks, standing in front of the granitic slope of the main chain, in others forming the base of the chain itself, but rarely if at all yielding gold enough to repay working. Where gold occurs, it is farther east within the chain and on or in the granite. These mining regions we will notice in this place before passing to the more productive slates north.

A belt of auriferous rocks extends within the chain from the Tahichipi desert northward to the Kern river, which is sufficiently productive to be worked at intervals. Some few placer mines occur in the Tahichipi Valley, and again in Walker's Basin ("the Park" of the Pacific R. R. maps); but whether the gold is derived from granite or the truly metamorphic rocks, is not known. Near the Kern river, especially about Keysville and Greenhorn, are more extensive workings, entirely on granite. Several fine quartz views occur, some of large size, and a few have been worked with profit. One near Keysville was visited which had been highly productive. It was entirely in granite, the vein well defined, and the yield satisfactory. Numerous placer mines occur, and considerable quantities of gold have been sent from this region. It generally assays lower than that from the slates farther north. Placers occur at intervals to White river; but north of this there are none of much extent until we reach the San Joaquin.

In passing north from this last point the metamorphic slates rapidly increase in breadth and importance, and before traveling thirty miles we reach the great auriferous region of the State, which forms a continuous field for more than 200 miles, and which has yielded perhaps nine-tenths of the gold that has been produced in the State. This lies mostly on the metamorphic slates which continue to expand in width as we pass north, but it laps over on the granite at numerous points.

The precise area of this field cannot be given in the present state of our knowledge; it probably embraces six thousand or more square miles. To the north it is covered by the heavy beds of volcanic rocks that have overflowed the auriferous series. The settlements of the whole western slope, in and adjacent to this region, are mostly confined to the gold-producing portions. The lands as a whole have little value for agricultural purposes, so that the richer the mines the denser the population.

We will briefly consider this gold-field, commencing at the south with Mariposa county.

The great feature of this county, economically considered, is the so-called "Mariposa Estate," on which are some of the most noted mines in California, and which, on many accounts, have attracted much attention both at home and abroad. This estate embraces about seventy square miles of territory, extending from the Merced river, southeast, for about sixteen miles, on the line of the great quartz veins of this region. Placer mining has been carried on here since 1849 and quartz mining was attempted as early as 1852. The magnitude of some of the quartz-lodes, and their rich yield of gold, at times, might well give rise to hopes of boundless wealth—expectations that, thus far, have not been realized.

The geology of the estate has been examined in some detail by Mr. King, and many interesting features noted, only a few of which can here be mentioned.

The topographical features of the estate are strictly subordinate to the geological structure, the courses of the streams and of the mountains being in the main parallel with the strata. Through the center is a broad belt of slates, and on each side of this are belts of sandstone, mostly in a highly metamorphic condition; these, in turn, have masses of slate outside of them, of which but small corners fall on the estate.

Subordinate to these belts of slate and sandstone are masses of serpentine and beds of limestone. The extreme southern end of the estate is occupied by granite, which cuts across these belts and extends, on either side, beyond its limits.

The slate belt is of the most interest to the public, for in it, are the larger part of the gold-bearing quartz veins here so numerous, and on it have been the most considerable placer mines. The strike of the strata is not uniform. Along the southern end the direction is N. 54° W. for over seven miles. Then occurs a break, extending across them, where the slates are much broken and confused. North of this, the strike is N. 28° W., a change of 26°. This portion extends from the Ophir to the Pine Tree mine. Near this is another break, where the strata again change the direction of their strike 26°, and then continue in the direction of N. 54° W.

The slates on each portion are remarkably parallel, and have every possible degree of metamorphism, and in places have sandstones interstratified with them. They dip at all angles, but always to the east.

The quartz veins are very numerous, and generally have the same direction as the strike of the slates, or very near it. Those occurring in the granite are commonly parallel with those in the slates, but some are at right angles to them. Parallel with these cross-veins in the granite are dikes of trap generally of small size.

Some of the quartz-veins are noted for their size, and are indeed the most remarkable known in the State. In the Pine Tree and Josephine mines, near the north end of the estate, the average breadth of the quartz is fully twelve feet, and in places it expands to forty feet, all of solid vein-stone. As with most of the other quartz-veins of the region the gold is very unequally distributed through the vein, and only portions pay for working. This is the great reason why their yield of the precious metal, and the profit of its extraction, have been so very variable and uncertain. The processes of extraction, however, have not always been the best, or the most economical.

The Princeton mine, six miles southeast of the mines last named, is the most extensive, and has yielded the most gold. The works extend to over 500 feet in depth, and over 1400 feet in length, and the yield is stated to have been about $2,000,000. But we cannot enter into further details.

It was near the Pine Tree mine that Mr. King discovered, first in Jan. 1864, those Jurassic fossils which indicated unmistakably the age of these slates. Some of them were found within a few feet of the vein.

A line of very heavy outcrops of quartz commences at the Pine Tree and Josephine mines and extends northwest nearly 70 miles to Jackson, in Amador county. Many persons have supposed this to be one vein. If it cannot be proved that these are continuous, and in fact one great lode, it is certain that these many enormous masses of quartz are on nearly a straight line for the distance named, and that the principal quartz-mines and heaviest placer diggings of Mariposa, Tuolumne, Calaveras and Amador counties are on or near this line.

In Mariposa county there are scarcely any of those superficial volcanic accumulations that so modify the mining features to the northwest. Hence, there are few or no "deep diggings" or great hydraulic washings; the placers are more shallow, and, as a consequence, sooner exhausted.

In passing northwest the next county entered is Tuolumne. In this the volcanic rocks become more abundant; and they continue to play a more important part the farther we proceed in this direction along the western slope, until, in Butte, Plumas, Shasta and Siskyiou counties, the immense quantities of these materials that have been ejected from the very numerous craters and vents have covered up most of the auriferous deposits.

Tuolumne, like Mariposa county, lies partly in a high mountain region on its eastern side, and sinks into the mining belt on its western. The latter part is about twenty-five miles wide, and contains nearly all the inhabitants and wealth of the county. Over the auriferous deposits there are some extensive volcanic deposits which determine the character of the mining. Here we find more hydraulic workings and deep diggings. In these have been found the remains of more large animals, the elephant, mastodon, etc., than anywhere else in California. The auriferous rocks proper need not be noticed more in detail than to state that they are of the same kinds found in Mariposa county; that there is the usual variety, both as regards age and metamorphism; that the truly metamorphic rocks are often cut by trap or granite; and that there is a much greater development of crystalline limestones, and these generally occur near the eastern edge of the metamorphic belt. No recognizable fossils have been found in these limestones; but their position indicates that they are the same that have been pronounced Carboniferous by Mr. Meek, who has examined the fossils found in other localities on the same line. The gold extends into the granite adjacent the metamorphic strata.[1]

In this county the system of mining known as "Table Mountain mining" is seen in the greatest perfection perhaps in the State; and, as it has been seldom described, we will notice it more at length than the other systems.

The volcanic materials, in this part of the State, have issued almost entirely from regions lying east of the true mining belt, and generally comparatively near the crest of the Sierra, and they have flowed down the western slope in immense quantities. Sometimes this has been in the form of liquid lava, which has descended by the old river courses, more or less filling the old valleys, and hardening into basaltic masses. At others, it has spread out into immense sheets, like strata, and thus hardened, effectually covering the auriferous gravels. In this way it overlies immense areas farther north. In others, it has been ejected in the form of ashes, which have been arranged into strata by water or other means, and afterward solidified to various degrees

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[1] Here it should be understood that I use the term *metamorphic* only for rocks not granite, or granitic, for convenience merely, and without advocating any theory in regard to the origin of the granite.—W. H. B.

of hardness. In still others, the finer ashy materials have become suspended in fresh water which formed large lakes along the flanks of the chain, and thus deposited in sedimentary strata, of various colors and hardness, and often rich in fresh-water infusoria.

The term *cement* is often applied to certain forms of these consolidated volcanic materials, commonly to the breccia, or coarser materials; but the term is used loosely, and is often applied to true auriferous gravels now hardened. To notice all the phases that these superficial volcanic deposits assume, or all the modifications they give rise to in mining, would exceed the limits of this article; we will therefore notice but one, "Table-Mountain Mining."

As before stated, the lava often flowed down the old river valleys, and then consolidated into very hard basaltic rock. Such a mass has withstood the denuding effects of later times much more completely than the slates on either side. Hence, the streams have cut new channels; and, at present, these basaltic streams are left as tables, capping ridges between the present water-courses, and imparting a most peculiar aspect to the scenery. The basaltic mass is often bounded on either side by steep slopes, sometimes walls of rock nearly vertical; and its top is a very gentle slope descending to the west, remarkably regular as a whole,—a dry, rocky, barren table of dark basalt, supporting a scanty growth of shrubs and stunted trees, in marked contrast with the hills of slate that have a more rounded outline, and are covered with more soil, and support a more vigorous growth of vegetation, and which slope away from the base of these walls into the deeper cañons or valleys on either side.

The denudation that has taken place since the period of eruption has been extraordinary. The Stanislaus river has cut through the main table-mountain of this county, in one place, and now runs about 2000 feet beneath it, in a narrow valley or mere gorge. And in other parts of the State evidence is cited of even much greater denudation. On the Middle Yuba, on the north side of Pilot Peak, the slates have been cut 3000 feet below the base of the lava which forms the summit of Pilot Peak and the adjacent heights, which lava is here about 650 feet thick. Instances might be greatly multiplied in proof of the stupendous amount of denudation.

Of course this lava now covers the auriferous gravels that were superficial before its flow,—the "flats," "bars," "gulches" and "bottoms," that form the rich placer-grounds of those early ages. Here it has been safely kept from harm and locked from sight. But it was not secure enough to escape the knowledge of modern "prospectors," who have found it out, and drive a profitable business in mining these old river-beds and flats.

Where the lava has flowed in a valley that is comparatively narrow, the Table-mountain is now narrow, and the old river bed, with its gravel and gold, is somewhere beneath it, but lower than the junction of the basalt with the slates on either side. Accordingly, a drift (or *tunnel* as it is universally called in these mines) is run beneath this basalt, through the slates which once formed the sides of the valley. This portion of the slates is called the "Rim-rock." The old river-bed is found, its gravels laden with the precious metal is carried out through the tunnel by means of cars, and the gold separated by the usual processes. Sometimes immense quantities of these gravels exist. The entire thickness of these old detrital beds, in one place, is at least 200 feet. But all is not "pay-dirt" or "pay-gravel."

But other strange things are found besides gold. The old valley has come down to our times more perfectly preserved than Herculaneum and Pompeii, which, long after, were covered in a similar manner. There are the old arrangements into fine and coarse materials, made by the current and old waterfalls and cascades, with the rich "pay-gravel" in the pools at their base, so long dry; there are beds of fine clay that were formed by eddies in quiet pools, preserving between their thin laminæ the leaves of the trees that clothed the old hills where now the valleys are 3000 or 4000 feet below the surface they then had; and there are bits of wood, and even entire trunks of trees, sometimes silicified; and the teeth and bones of animals that fed in those old forests;—in short, such things as would be found by a modern river, except that the remains of the animals and plants belong to extinct and not living species. These organic remains have not yet been investigated. Dr. Newberry, who has hastily examined some of the leaves, refers them to the later Pliocene age. So far as they have been studied, it seems that the fauna that flourished just before, and at the time this volcanic convulsion came on, was entirely distinct from that which flourished later, the Post-tertiary remains, which figure so very conspicuously in many placer-diggings. Those beneath the volcanic deposits appear to be late Pliocene, while those found in the other auriferous detritus are Post-pliocene. The remains of the elephant and mastodon have thus far not been found beneath the volcanic beds; at least there is no authenticated instance of it. It seems that the great volcanic disturbance that closed the Tertiary period in the State exterminated the Tertiary higher animals, and then came those later ones: the elephant, bison, tapir, horse (two species), mastodon, &c., the last of which apparently became extinct after the advent of man. In this county, stone mortars and mastodon bones have been found together in the diggings in several cases. We expect most interesting results from a careful study of the vertebrate remains, which we trust they will receive.

Farther north, where the lava has flowed over extensive flats and slopes in sheets rather than in streams, the gravel is often worked beneath the beds. For reasons obvious to the reader, the presence of a "rim-rock" of slates beneath the lava is considered desirable by the miner, indicating, as it does, that he is at work in an old valley; but there are many cases, especially in Sierra county, where "table-mountain mining" has been profitable although such "rim-rock" was not found,—where the lava sheets had spread over more extensive flats, one edge of which is now denuded, the other not yet being found even in extensive workings.

With regard to the next county north of Tuolumne, namely, Calaveras, we will only notice the copper mines lately so famous and so productive. The principal claims are located on two parallel belts five or six miles apart, one of which lies along the base of the Bear Mountain Range; the other follows a broken range of hills, called the Gopher Hills. The first is rather regular, and claims have been located in regular sequence for some twelve miles in length, the direction of the productive part of the lode being about N. 30° W., the claims curving to the northward as it goes west. The other line is more irregular and the mines have been far less productive.

The deposits of copper ore in this region, as in nearly all others in California, do not appear to be included in regular fissure veins, but rather form independent masses lying in the direction of the strike of the enclosing rocks, and dipping with them. But, though not exhibiting all the characters of true veins, some of these deposits are of enormous dimensions and of remarkable purity and richness. The first important discoveries were made in July, 1861, and the first house of the now thriving town of Copperopolis was built the following September.

At present the two principal mines at Copperopolis are the "Union" and "Keystone," both of which are opened on an extensive scale, and have sent large quantities of ore to market. In the Union mine is one of the largest deposits of ore ever struck in any part of the world. The shipments have been on an immense scale, and the ore is of great richness. At the 200-foot level the lode is 21 feet wide, at the 250-foot 31 feet, and composed of Nos. 1 and 2 ores. At the latest accounts the lowest levels had reached a depth of over 400 feet, and the mine continued still to be rich.

The ore is copper pyrites, more or less mixed with iron pyrites, the latter in some of the mines greatly reducing the percentage of copper. Copper mines occur in various other places in the State. Some in Plumas county promise well, and others in Del Norte county have sent some ore to market of great richness; but thus far the yield of all the other mines has been insignificant compared with that from those of Calaveras county. The shipments of ore from the State have been as follows:

1863, - - -	5,933 tons, valued at	$512,925
1864, - - -	14,325 " " "	1,094,660

We have not yet complete returns for 1865. The newspapers state that the Union mine shipped an average of 1000 tons per month, and the other mines of the vicinity 350 per month. These figures would give over 16,000 tons from this locality. Furnaces have been erected the past year at some of the mines to reduce or concentrate the purer ores, but we have no reliable data relating to their success.

In this article we cannot notice more at length the mining matters of the western slope, although they are treated of in considerable detail in the volume before us. We will merely glance at some of the more interesting geological features.

As we pass north, the physical aspect of the Sierra changes with the geological structure. The crest of the chain becomes lower, the passes lower, the granitic core of the chain narrower, the belt of metamorphic rocks on the western slope correspondingly wider, and the superimposed volcanic grows more abundant, it covering a greater area and being of greater thickness. North of the Truckee Pass the culminating peaks are all volcanic; south of that point they are of granite or metamorphic slates.

With the increase in the breadth of the region of metamorphic schists there is a corresponding increase in the breadth of the mining region, until it is 60 or more miles wide; but large areas are covered up by the volcanic. In these larger areas of slates, it frequently happens that considerable portions have escaped the usual metamorphism.

We are now led naturally to consider the question of the age of the rocks of the auriferous series in California. They have been regarded as older than the Carboniferous by all writers on the subject previous to the publication of the Reports under consideration. The announcement, therefore, of their later age has created unusual interest among geologists. We will, therefore, notice with some detail the paleontological evidence. The earliest labors of the Survey led to surmises that the rocks really belonged to later formations; but we will here notice only the proofs that subsequently confirmed these surmises, and the principal data upon which our present conclusions rest. For convenience we will consider these historically, and begin at the north, since in that direction the first fossils were found.

At Bass' Ranch, near Pitt river, (about lat. 40° 45′ N.), there is a large development of the limestone formation of the Sierras. It is highly altered and forms several hills of considerable altitude. Dr. Trask first noticed fossils in these limestones, and mentions the locality in his Report of 1855, where he refers them correctly to the Carboniferous; but the material was too incomplete for a satisfactory conclusion. Placer mines occur in the region but not in the immediate vicinity, and the relation of these limestones to the true auriferous rocks, and to the chain of the Sierras, could not there be made out, nor indeed whether the limestones were identical in age or not with those of the true mining belt farther south.

In 1862 the party visited this locality and collected a large amount of material, which was immediately submitted to Mr. Meek for a critical examination, and he referred the species to the Carboniferous. Dr. Trask generously placed his original fossils in the hands of the Survey to give greater completeness to the collections.

The descriptions of such of the species that could be satisfactorily determined were published in the first volume of the Paleontological Report, (plates 1 and 2). These species numbered fourteen, of which only four or five were referred to species before known. A number of others were too imperfectly preserved to be satisfactorily determined. Later in the same year, fossils were found at Pence's Ranch, 80 miles southeast of the last locality, in the limestones that are enclosed in the true auriferous slates. These, though imperfect, were considered identical with those of Bass Ranch. Other fossils, also imperfect, but apparently of the same age, have since been found near Genesee Valley, in a similar rock. All these limestones are of the same lithological character, and there seems little doubt that all the patches are of the Carboniferous age that lie in nearly a direct line from north of the Klamath river to the Tahichipi Valley, a distance of over 500 miles. This line is almost precisely parallel with the assumed axis of the chain. Whether or not the other masses having the same character that lie to the east of this line are also all Carboniferous, is not proved, but we are led to infer that they are so from their character, from the fossils found near Genesee Valley, and from their stratigraphical position.

In the same year, Triassic fossils were found in several places east of the Sierra Nevada, in the (then) territory of Nevada. They were found by Prof. Whitney, near Dayton, and by Messrs. Gorham, Blake and R. Homfray in several localities in the Humboldt mining region.

The next year, 1863, the party made a most interesting discovery of fossils on the north slope of Genesee Valley, in Plumas county. The Carboniferous, before spoken of, with the Triassic and Jurassic were all in place. The Triassic were found at Gifford's Ranch in calcareous slates, and some of the species are identical with those from the Humboldt mining region. These have been described by Mr. Gabb and are figured in the Paleontological Report on plates 3, 4, 5, and 6. About four miles west of this, north of the valley, were found more than a dozen Jurassic species in slates and sandstones. They were described by Mr. Meek and figured in the same volume on plates 7 and 8. These were not only the first Jurassic species, but also the first fossils of any kind found *in situ* in the true auriferous slates of the State. The same year Mr. Gorham Blake obtained a fossil near Spanish Flat, in El Dorado county, which appeared to be identical with a Humboldt species, and a similar fossil from the same place, an imperfect cast, had been in the possession of Dr. Trask for some time previous. These were found in the rich mining region of that vicinity, but neither was in place. The same autumn Mr. Gabb succeeded in finding, in this same region and *in place*, imperfect remains of Cephalopods which cannot be distinguished from the Belemnites found later on the Mariposa Estate.

During this same year several new localities of Triassic fossils were found east of the Sierra Nevada. One single specimen was found by Dr. Horn east of Owen's Lake, some 200 or 300 miles south of the Humboldt localities, and Mr. Rémond found others in Sonora, Mexico, at San Marcial.

The next winter, Jan. 1864, Mr. King found the fossils on the Mariposa Estate already spoken of, and this was followed the same year by further discoveries by him and by other persons. Those in the possession of the Survey are described and figured by Mr. Meek in an appendix to the volume before us.

The next year, 1865, Mr. Rémond, having returned from Mexico, resumed his position on the Survey and made a more critical examination of the strata in detail. His labors were rewarded by the discovery of many new localities of fossils extending from Mariposa to the Stanislaus river, some of the species being identical with those of Mariposa and others new. These discoveries were noticed in the last number of this Journal, but no detailed description has yet been published.

The occurrence of these fossils for a distance of more than 250 miles along the western flank of the Sierras, and in so many localities, leave no doubt in regard to the true age of the auriferous slates of California. We omit here many minor details, and those other geological features that lead to the same conclusion. We can, however, more strongly affirm the statements of Prof. Whitney made in the preface to the volume on Paleontology, and in this Journal nearly two years ago, that "we have not a particle of evidence to sustain the theory which has so often been brought forward that all, or even a portion, of the auriferous rocks are older than the Carboniferous,—not a trace of any Silurian or Devonian fossil ever having been discovered in California, or indeed anywhere to the west of the 116th meridian."

We showed in our previous article that, on the other hand, gold occurs in the Coast Ranges in very numerous localities, sometimes in workable quantities, in rocks as new as the Metamorphic Cretaceous.

The fact seems proved, also, that the silver mines on the eastern side of the Sierras are at least in part in rocks of Jurassic age; and the evidence is very strong that all the principal gold and silver mines of the Pacific states—now known to extend eastward more than 250 miles from the western base of the Sierra Nevada, and north and south from British Columbia to Mexico—are of this series. We may look to the facts demonstrated by the labors of this Survey for a key to solve the intricate problems of Mexican geology also, which up to this time have baffled so many geologists.

In the extreme northern counties the auriferous rocks do not differ in their lithological characters from those of the true Sierras, but no fossils have thus far been found in them north of lat. 41°, within the state. The series, however, widens to the westward, until north of the Klamath river it extends quite to the coast of the Pacific.

In the tier of counties lying north of the head of the great valley, there are numerous placer mines, extending to the very sea shore, and quartz veins have been worked to a limited extent. This region is very rough, the topography complicated, and, owing to the absence of surveys, but little is known more than its general features. Peaks rise to 8000 feet in each of these counties; the higher points west of the Sacramento river are granite, so far as is known, and those on the east are volcanic. There are frequent intrusions of granite or similar rocks in the region named, west of the Sacramento, apparently not only forming the core and culminating points of the higher ridges, but occurring frequently in other masses. The placer diggings are scattered over a large area, and in the aggregate they have afforded a large amount of gold.

The most of the northeastern part of the state is covered by lava. One patch, continuous or nearly so, covers an area of not less than 10,000 square miles within the state, and extends beyond the borders in the little known regions adjacent on the north and east. Cretaceous strata pass beneath this lava on the north and south sides of Mt. Shasta, and also at numerous points along the eastern side of the Sacramento valley for nearly a hundred miles south of Pitt river. In places these volcanic rocks have an immense thickness; in fact, the lofty Mt. Shasta and Lassen's peak are but enormous piles of these volcanic products.

These two prominent peaks are the grandest objects of northern California. Both were ascended and measured barometrically by members of the survey, the former in 1862, the latter in 1863.

Mt. Shasta is a very regular cone, rising to an altitude of 14,442 feet from a base of 2800 to 4000 feet on its different sides. Its profile is very symmetrical, its sides steep, and its summit sharp. Rising 8000 feet above any near surrounding object, its base clothed in forests of the magnificent Conifers for which the Pacific coast is famous, its upper 6000 feet white with perpetual snow, its regular outlines cut with wonderful distinctness against the intensely blue and clear sky of that delightful climate; it forms a feature in the landscape of wonderful beauty and grandeur. Its ascent is neither dangerous nor difficult considering the great height. Wind, will and muscle are the only requisites. The view from the summit is extensive and sublime, but is surpassed by that from its inferior neighbor, Lassen's peak. The remains of an old crater exist near its summit, and emenations of steam, hot water, sulphur, and gases are now its only symptoms of activity.

Lassen's peak lies about eighty miles southeast of this, on the line of the crest of the Sierras, and is 10,577 feet above the sea. Here there is a better defined crater, and about it a greater variety of volcanic products. The view is also much more extensive, embracing, between the extreme limits of vision, the enormous area of 50,000 square miles, or a distance of 380 miles from north to south, and 260 miles from east to west. The peak is less regular in outline, and it rises from a much higher base than Mt. Shasta. On its broad flanks are a large number of smaller cones, many with craters in their tops, some of which are of remarkable regularity. On the southeast side of this peak, at an elevation of 5000 or 6000 feet, are a number of very copious *hot springs*, where most interesting chemical phenomena are taking place. The basaltic lava is being decomposed on an enormous scale, the siliceous portions partially dissolved, and some phases of metamorphism can be well studied. In fact, hot or warm springs are very numerous in the state, along its entire length, too numerous for even an enumeration in this place.

The immense mass of the higher Sierras, lying between the latitudes of 35° and 39°, was left unnoticed in our consideration of the western slope of the chain. Here is found the greatest magnitude of mass, the loftiest peaks, the deepest cañons, the highest waterfalls, and the sublimest scenery of the state. The chain was crossed by the party at eleven places between these parallels, and a large number of peaks ascended,—a most laborious work, as can be believed when we consider the rough character of the country, its remoteness in most parts from civilization, its great altitude, the absence of previous information respecting large portions of it, the cold, and the many other difficulties to be surmounted. Some few facts will bring these more vividly to the mind.

South of the Truckee Pass, for about 300 miles, there is not a pass below 6000 feet. For 250 miles south of the Placerville Pass there is not a pass below 7000 feet. For nearly 200 miles from the Sonora Pass southward there is not one below 10,000 feet, while for 150 miles there is not one below 11,000 feet, and for a hundred miles not one below 12,000 feet. At least none are known. The culminating point is near lat. 36° 30′, where the highest peak (named Mt. Whitney in honor of the director-in-chief of the survey, by the party who explored this region) is about 15,000 feet.

Near this, within a radius of 25 or 30 miles, nearly a score of peaks rise to 14,000 feet or higher. These peaks are all of granite, which rock here occupies nearly the entire width of the chain (nearly or quite 80 miles wide). Cañons from 3000 to 6000 feet deep abound; and everywhere above 4000 feet, but especially from 6000 up to 11,000 feet, are traces of former glaciers on a most stupendous scale, the glaciers themselves having disappeared. Large areas of rocks are polished, and immense moraines are common. Heavy forests clothe the slopes between the altitudes of 4000 and 9000 feet. Below the former altitude we have the scattered trees and shrubby vegetation of the hot and dry foot-hills, and above the latter up to 10,000, or in places up to 11,000 feet, the stunted growth of alpine species. These last are largely composed of small trees and shrubs; above these limits are the desolated slopes of snow and granite. Here and there a grassy flat is found in some valley; but the green pastures that form such an element in the alpine scenery of Europe are entirely absent. Hundreds of little lakes and ponds nestle in the valleys or occupy the beds of old glaciers, as clear and as blue as the sky they reflect. Some were seen frozen over in midsummer, and many of them are doubtless frozen the most of the year.

The desolation of these higher solitudes, the deep silence that rests upon them, the intensely deep blue of the clear sky, nearly cloudless by day and entirely so, except at rare intervals, at night, the deep blackness from which the stars and moon shine with a peculiarly white silvery luster, the air fragrant with the odor of firs and balsam, warm and genial by day but intensely cold at night, the wildness of the region so seldom visited by man, the peculiar forms of vegetable and animal life,—all conspire to produce an effect on the mind of the explorer that cannot be imagined by others, even by one familiar with the grandest scenery of the Alps.

The high peaks a hundred miles farther north, near Lake Mono, are of entirely different aspect. Mt. Dana rises to an altitude of 13,227 feet, and has a more rounded outline. This as well as its neighbor, Castle Peak, which is about 13,000 feet, consists of metamorphic slates. These slates belong really to the eastern slope, but here form the crest; and a little farther south they become enclosed in the granite and finally end within the chain.

Mt. Dana will doubtless soon become the resort of tourists, being very accessible from the Mono Trail, which runs along by its southern base, and lying directly back of Yosemite valley. It is rare indeed that so much sublime scenery can be found within so short a distance as within the forty miles from Yosemite valley to this peak. The ascent is easy, and the view extensive, embracing the whole western slope on that side, and extending to the coast ranges, which in places are 200 miles distant; and in the opposite direction reaching far over the deserts, and the many mountain chains that rise from them.

The eastern slope is everywhere very precipitous along this part of the chain. From both Mt. Whitney and Mt. Dana, the *average* slope from the summit to the eastern base amounts to 1000 feet per mile, portions of the declivity being of course very much steeper. And such slopes as these are common in the higher Sierras, even on slopes as much as 6,000 to 10,000 feet together.

Yosemite valley lies in the broad granite belt of the center of the chain. It has been so often described that we omit any particular notice here. Similar valleys or cañons occur on the other rivers south, in the same belt of granite, having the same general features, which are most probably of the same origin. Some are even deeper than Yosemite, but no other one possesses so much to interest the tourist, or is nearly as accessible. Those on the Kings and Kern rivers are especially deep and grand, but they lack some of the most striking features of the Yosemite, especially the immensely high waterfalls.

For further particulars respecting this intensely interesting region we must refer to the Report, which treats of it at considerable length.

Everywhere to the east of the Sierra Nevada, within the state, the country as a whole is a desert. Limited valleys are fertile, where water may be obtained for irrigation, and in a few such places the soil is very productive; but the region is a most inhospitable one, and portions of it are absolutely unknown to civilized man.

North of lat. 35°, to the Oregon line, the water that drains the eastern slope of the Sierras runs into closed basins, where it sinks into the sands, or forms salt lakes having no outlet to the sea. These form part of the Great Basin lying between the Rocky Mountains and the Sierra Nevada. To the south of this the Colorado river drains a region of similar physical characters. The southeastern part of the state, to the extent of perhaps 30,000 square miles or more, lies in these deserts.

Our geographical and geological information relating to this region is exceedingly limited. It is, however, sufficient to render it certain that some of the data which have been furnished the public from official sources, on both regions, are of a very unreliable character. This much is known: that there are many chains of barren mountains, having in the main a north and south direction, with desert valleys between, some of which are sinks of streams; that at least one of these valleys, Death valley, is below the level of the sea; that portions of the Colorado Desert have been stated to be also lower; that the other valleys lie at various elevations up to 6500 feet, the altitude of Mono Lake; that the mountain chains are made up of volcanic, granitic and metamorphic rocks; that the latter are probably of the same age as those of the auriferous veins of California, Triassic and Carboniferous fossils having been found; that Tertiary rocks occur; and that the region has become very much drier since very recent geological times. It is certain that large areas now dry or occupied by salt lakes of limited size were at a late period covered by lakes or inland seas that have gradually wasted away as the climate has grown more and more dry. These had their development perhaps at the time when those stupendous glaciers existed in the higher mountains, whose traces are now so very abundant, especially in the high Sierra Nevada. A great number of most interesting questions arise in connection with this region, some of which must long remain unanswered; for others we have perhaps the data for their solution. W. H. B.

The volume which has been here reviewed, and which, as the abstract presented has shown, is so rich in facts, is only a preliminary report on the Geology of the State. Professor Whitney has nearly ready another, giving the systematic geology with all its details and general conclusions; and he proposes to follow this with one or two on the Economical Geology, Mining and Metallurgy, in which department a large amount of material has been collected, and also by one on Physical Geography. In addition, the plan of the Survey, as we learn from the Preface, contemplates a second volume on Paleontology by Mr. Gabb, Dr. Leidy, Dr. Newberry and others; one on the Botany of the State, by Prof. W. H. Brewer; three or four on Zoology by Dr. Cooper, Mr. T. Gill, etc.; and one of Maps, Sections, etc.

This first volume on the Geology is beautiful as a work of art, both in its printing and in its numerous landscape and other illustrations, and well worthy of the rich State from which it emanates.

Up to the commencement of the current year the aggregate sum appropriated by the Legislature of the State for carrying on the work has been $95,000. In addition to this, $9,000 has been appropriated for publishing the results.

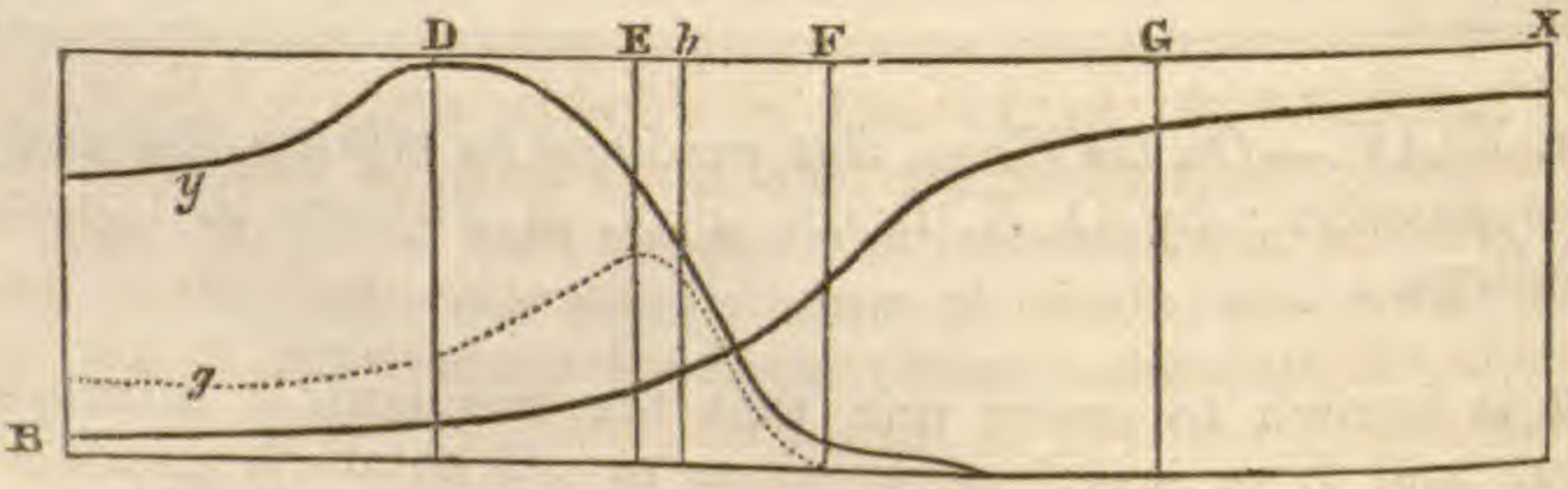
That this sum has been most economically used, the volumes bear ample testimony. This is less than $16,000 per year for field-work, salaries, and all expenses whatsoever, except those of publishing. With this sum a reconnoissance has been made of a territory larger than the combined areas of the three largest States east of the Mississippi river, portions of it over most inhospitable regions; considerable areas have been examined in some detail; the main feature of the geology of a region embracing at least 200,000 square miles has been demonstrated, and the key furnished for future work over the immense region west of the Rocky Mountains; and, aside from the practical questions of the greatest moment, most important contributions have been made to many departments of science.

We not only earnestly hope but trust that the Survey with its publications may be continued to a satisfactory completion. It surely will be if the Legislators of the State view the work with the interest that is felt by the world outside. J. D. D.

ART. XLIV.—*On the Green tint produced by mixing blue and yellow powders;* by O. N. ROOD, Prof. of Physics in Columbia College.

IT is known to every one, that the mechanical mixture of yellow and blue powders, ("water or oil colors,") produces a more or less lively green. This fact, with others similar in nature, was formerly used by some physicists in support of the view that there are only three primary colors—red, yellow and blue,—and that the other tints of the spectrum are formed by a mixture of these three in certain proportions. Helmholtz has, however, shown that the mixture of the blue and yellow of the *spectrum* produces not green, but *white light.* Similarly it is now known that if a circular disc be painted with alternate blue and yellow sectors, and then be caused to rotate rapidly, the resultant tint will be gray, or reddish gray, but not green. Helmholtz has accounted for the production of a green color when blue and yellow pigments are mixed, in a manner like the following: Light reflected from a painted surface is of a two-fold kind: 1st, That which comes directly from the surfaces of the little atoms of colored powder; this will, in ordinary daylight, be white, and small in amount. 2nd, That light which penetrates through two or more atoms of the pigment, and is then reflected; this is always colored, and colored merely because in its passage through the atoms, certain rays have been absorbed. For example, the white light which penetrates through an atom of ultramarine, in this operation becomes deprived mainly of the red, orange, and yellow rays; the green, blue and violet rays being left comparatively unweakened. The particles of chrome-yellow, on the other hand, in the same process absorb the blue and violet rays, reflecting back the red, orange and green rays. Hence it will be seen that by the joint action of the ultramarine and chrome-yellow, all the rays of the spectrum are absorbed except the green; therefore green light alone is reflected back to the eye.

This theory I have lately tested with the aid of the spectroscope. Three strips of white paper, each $\frac{1}{10}$th of an inch in breadth, were painted respectively with chrome-yellow, artificial-ultramarine, and a mixture of these two pigments in such proportion as to produce a green. The strips were placed together before the slit of a spectroscope, illuminated by light from a white cloud, and their spectra compared with a normal spectrum from a strip of white paper. It was found that if the intensity of the tints of the normal spectrum be represented by the rectangle BX, the spectra from the yellow, green, and blue papers, will be approximately represented by the areas contained in the curves *y*, *g* and B. Mere inspection shows that the spectrum from the green paper is made up of those rays which are common to both of the other spectra, its maximum being between the fixed lines E and *b*. Inspection also of the curves given by the chrome-yellow and ultramarine, show that both are rather



deficient in the green element, and therefore comparatively unfit to produce a bright green by mixture.

A disc was now painted with alternate blue and yellow sectors, the same materials being used; when it was caused to revolve rapidly the resultant tint presented to the naked eye was slightly reddish grey. Next the same disc was made to rotate before the slit of the spectroscope: prismatic analysis showed that its spectrum was totally different from the spectrum furnished by the green paper: it approximated to the normal spectrum, being in fact the sum of the spectra *y* and B in the diagram; there was, however, a rather dark space between the fixed lines *b* and F. This may account for the fact that the revolving disc viewed by the naked eye appeared slightly reddish, instead of pure grey.

It will be seen, then, that the results of spectral analysis account for this singular phenomenon in all its details.

It would be equally easy to account for the fact, that much more brilliant greens are produced by mechanically mixing those yellow and blue pigments, which are, one or both, originally slightly greenish in tint.

New York, March 10, 1866.

ART. XLV.—*A method of Estimating and Correcting the Error caused by the unequal length of the Calendar Months, in reducing Observations of Temperature;* by E. L. DE FOREST, of Watertown, Conn.

THE mean daily temperatures throughout the year at any given place may be represented by ordinates to the curve whose equation is

$$y=A_0+A_1\sin(x+E_1)+A_2\sin(2x+E_2)+A_3\sin(3x+E_3)+\&c.$$

the length of the year being 360° measured on the axis of x. The values of the first twelve constants may be found approximately from the observed monthly means. But when these means are made use of as if the calendar months were all equal in length, an error will be introduced into the equation.

The amount of this error has been considerably underrated by Prof. J. D. Everett, of King's College, Nova Scotia, in an article which appeared in this Journal for January, 1863. Supposing apparently that because February is the month which differs most from the other months in length, it must therefore be the immediate cause of the greater portion of the error, Prof. Everett interchanged several days between it and the adjacent months January and March, and found that for Edinburg a difference of seven days in the length of February causes only a difference of ·03 in the mean annual temperature A_0, and 18′ or about one-third of a day in the "date" E_1; while the difference between giving February 29, and 31 days, does not affect either the mean temperature or the "amplitude" A_1, to two places of decimals, and only affects "date" by about $\frac{1}{16}$ of a day. This result indicated an error small enough to be disregarded. But the fact is that the unequal length of the months affects not only February but all the other months, and occasions an error several times greater than this, as will appear hereafter.

The length of the year being taken at $365\frac{1}{4}$ days, one twelfth part of it will be $30\frac{7}{16}$ days, which for convenience's sake I will call a *mean month.* I propose to show how to find the mean temperatures of the mean months, and to derive from them the equation of the curve, which will thus be corrected for the inequality of the months; then by comparing such equations with uncorrected ones found by using calendar months only, the real amount of the errors in question will become known.

Reckoning from the beginning of January, and allowing $28\frac{1}{4}$ days to the calendar month of February, we shall find that

The	2nd	mean	month	begins	$\frac{9}{16}$	days	before	February	begins.
"	3rd	"	"	"	$1\frac{5}{8}$	days	after	March	begins.
"	4th	"	"	"	$1\frac{1}{16}$	"	"	April	"
"	5th	"	"	"	$1\frac{1}{2}$	"	"	May	"
"	6th	"	"	"	$\frac{15}{16}$	"	"	June	"
"	7th	"	"	"	$1\frac{3}{8}$	"	"	July	"
"	8th	"	"	"	$\frac{13}{16}$	"	"	August	"
"	9th	"	"	"	$\frac{1}{4}$	"	"	September	"
"	10th	"	"	"	$\frac{11}{16}$	"	"	October	"
"	11th	"	"	"	$\frac{1}{8}$	"	"	November	"
"	12th	"	"	"	$\frac{9}{16}$	"	"	December	"

If we have the daily mean temperatures at a given place tabulated for every day in the year, as in the table for Greenwich given by Prof. Loomis in his remarks appended to Prof. Everett's article, it will be easy to find the means for the mean months. For instance, in the month of April the sum of all the daily means at Greenwich is 1387·1. From this must be subtracted 43·6 which is the daily mean for April 1st, and 2·76 which is one-sixteenth of the mean for April 2nd; then there must be added 50·0 the mean for May 1st, and 25·25 which is one-half the mean for May 2nd. This gives 1415·99 as the sum of all the daily means for the fourth mean month, and dividing by $30\frac{7}{16}$ we get 46·52 for its mean temperature.

The mean temperatures for the calendar months at Greenwich are, from 43 years' observations,

36·59	46·24	61·77	49·94
38·55	52·88	61·05	43·25
41·33	58·95	56·48	39·33

and the mean of them all, or the annual mean, is 48·863. In the manner just explained I have found that the means for mean months are

36·58	46·52	61·80	49·84
38·62	53·12	60·99	43·20
41·47	59·13	56·39	39·28

and the annual mean is 48·912. The mean months make the annual mean greater by ·049 than the calendar months do. We evidently cannot infer that the mean of the monthly means will be equal to the annual mean unless the months are all of equal length.

To find the equation of the curve for Greenwich I have followed the method given by Prof. Everett, determining first the equation which expresses the series of monthly means, and then multiplying the "amplitudes" A_1, A_2, A_3, &c., by the ratios $\frac{\text{arc } 15^\circ}{\sin 15^\circ}$, $\frac{\text{arc } 30^\circ}{\sin 30^\circ}$, $\frac{\text{arc } 45^\circ}{\sin 45^\circ}$, &c., respectively, and substituting $x-15^\circ$ instead of x, so as to place the origin of coördinates at the beginning of January. Finally, I have transformed the equation from

$$y=A_0+A_1\sin(x+E_1)+A_2\sin(2x+E_2)+A_3\sin(3x+E_3)+\text{ \&c.},$$

into the form

$$y=A_0\pm A_1\sin(x-e_1)\pm A_2\sin 2(x-e_2)\pm A_3\sin 3(x-e_3)\pm\text{ \&c.}$$

This is readily done, because when E_n is greater than 180° we shall have

$$\sin(nx+E_n)=\sin n[x-\tfrac{1}{n}(360^\circ-E_n)],$$

and when E_n is less than 180° we shall have

$$\sin(nx+E_n)=-\sin n[x-\tfrac{1}{n}(180^\circ-E_n)].$$

The advantage of this transformation is that the equation will show the "date of phase" at a glance, the arc e_1 being the measure of the time from the beginning of the year to the date when the term $A_1\sin(x-e_1)$ first becomes zero. In general, the arc e_n expresses the time between the beginning of the year and the first zero-point of the term $A_n\sin n(x-e_n)$. Furthermore, the positive or negative sign prefixed to any term will show whether the value of that term is increasing or diminishing at the point where it first becomes zero; in other words, to borrow a phrase from Astronomy, the sign will show whether the first *node* is an *ascending* or a *descending* one.

The means for the calendar months give the following as the final equation of daily temperatures at Greenwich.

$$\begin{aligned}y={}&48{\cdot}86\\&+12{\cdot}59\sin(x-112^\circ\,38')-{\cdot}85\sin 2(x-76^\circ\,1')+{\cdot}17\sin 3(x-23^\circ\,40')\\&+{\cdot}28\sin 4(x-40^\circ\,42')-{\cdot}26\sin 5(x-0^\circ\,39')-{\cdot}23\sin 6x.\end{aligned}$$

But the means for mean months make the equation stand thus:

$$y=48{\cdot}91$$
$$+12{\cdot}60\sin(x-111^\circ\,51')-{\cdot}80\sin 2(x-75^\circ\,30')+{\cdot}16\sin 3(x-23^\circ\,28')$$
$$+{\cdot}28\sin 4(x-40^\circ\,33')+{\cdot}25\sin 5(x-35^\circ\,37')-{\cdot}24\sin 6x.$$

It will be seen that these two equations differ somewhat in almost every term, but the most important difference is in the arc e_1 which is diminished by 47′ when derived from mean months, making the "date of phase" occur apparently more than three-quarters of a day earlier. The real difference of date is not quite so large, and is in the contrary direction; because the time elapsed from the beginning of the year to the date when the term $A_1\sin(x-e_1)$ becomes zero is estimated differently in the two equations. In the first one each of the months is supposed to correspond to 30° of arc; the months of January, February, and March will occupy 90°, and the remaining arc $112^\circ\,38'-90^\circ=22^\circ\,38'$ will represent a period of time to be found by the proportion

$$30^\circ : 22^\circ\,38' = 30 \text{ days} : 22{\cdot}63 \text{ days},$$

which gives the date required, reckoning from the beginning of April.

In the second equation the arc e_1 will represent a period of time to be found by the proportion

$$360^\circ : 111^\circ\,51' = 365\tfrac{1}{4} \text{ days} : 113{\cdot}48 \text{ days}.$$

But the months January, February and March occupy $31+28\tfrac{1}{4}+31=90\tfrac{1}{4}$ days; so that the time from the beginning of April to the required epoch is $113{\cdot}48-90{\cdot}25=23{\cdot}23$ days. Thus the use of mean months shows that the "date of phase" is really three-fifths of a day later than it is found to be when only calendar months are employed.

The date we have been considering is the one which occurs in spring; but if we take the autumnal one instead, then according to the method of calendar months the arc between the beginning of October and the required date will be 22° 38′ just as in April, and the time corresponding to it will be found by the proportion

$$30^\circ : 22^\circ\,38' = 31 \text{ days} : 23{\cdot}39 \text{ days}.$$

On the other hand, by the method of mean months the time from the autumnal date till the end of the year will be found by subtracting 113·48 days from $\tfrac{1}{2}$ of $365\tfrac{1}{4}$ days, which gives 69·14 days. But the last three months of the year contain $31+30+31=92$ days; so that the time from the beginning of October to the date required is $92-69{\cdot}14=22{\cdot}86$ days. The autumnal "date of phase" then really occurs a little more than half a day earlier than the method of calendar months would make it appear.

To determine whether such results are owing to any peculiarity in the climate of Greenwich, I have computed the equations for three other places whose climates are widely different, taking from the Army Meteorological Register the monthly means derived from 33 years' observations at Fort Columbus, New York Harbor, from 1822 to 1854, and those derived from 36 years' observations at Fort Snelling (St. Paul), Minnesota, and from 28 years' observations at Fort Moultrie, Charleston Harbor, South Carolina, from 1823 to 1854. But not having access to any concise table of daily temperatures for every day in the year at those places, I have been led to adopt the following method for finding the means for mean months directly from the means for calendar months, avoiding the use of daily means altogether.

We may assume that the portion of the curve which belongs to any three consecutive calendar months will coincide very closely with a curve of the 2nd degree whose equation is

$$y = \mathrm{A} + \mathrm{B}x + \mathrm{C}x^2.$$

If we take the middle ordinate of the middle month as the axis of Y, and let n_1 n_2 n_3 represent the number of days in each month respectively, their mean temperatures will be

$$m_1 = \frac{1}{n_1}\int_{-\frac{1}{2}n_2-n_1}^{-\frac{1}{2}n_2} y\,dx = \mathrm{A} - \frac{1}{2}\mathrm{B}(n_1+n_2) + \frac{1}{12}\mathrm{C}(4n_1^2+6n_1n_2+3n_2^2),$$

$$m_2 = \frac{1}{n_2}\int_{-\frac{1}{2}n_2}^{+\frac{1}{2}n_2} y\,dx = \mathrm{A} + \frac{1}{12}\mathrm{C}n_2^2,$$

$$m_3 = \frac{1}{n_3}\int_{\frac{1}{2}n_2}^{\frac{1}{2}n_2+n_3} y\,dx = \mathrm{A} + \frac{1}{2}\mathrm{B}(n_2+n_3) + \frac{1}{12}\mathrm{C}(4n_3^2+6n_2n_3+3n_2^2).$$

These three equations enable us to determine the three constants A, B, C, as follows:

$$\mathrm{A} = m_2 - \frac{n_2^2}{4}\left(\frac{(n_2+n_3)m_1+(n_1+n_2)m_3-(n_1+2n_2+n_3)m_2}{(n_1+n_2)(n_2+n_3)(n_1+n_2+n_3)}\right),$$

$$\mathrm{B} = \frac{(n_2+n_3)(n_2+2n_3)(m_2-m_1)+(n_1+n_2)(n_2+2n_1)(m_3-m_2)}{(n_1+n_2)(n_2+n_3)(n_1+n_2+n_3)},$$

$$\mathrm{C} = 3\left(\frac{(n_2+n_3)m_1+(n_1+n_2)m_3-(n_1+2n_2+n_3)m_2}{(n_1+n_2)(n_2+n_3)(n_1+n_2+n_3)}\right).$$

Now let x_1 represent the time, in days, from the middle point of the middle month to that of the corresponding mean month, and let c represent the number of days in the mean month; then its mean temperature will be

$$M_2=\frac{1}{c}\int_{x_1-\frac{1}{2}c}^{x_1+\frac{1}{2}c}ydx=A+Bx_1+C\left(x_1^2+\frac{c^2}{12}\right).$$

Substituting in this expression for M_2 the values of A, B, C, already found, and reducing, and putting h for the time in days from the beginning of the middle calendar month to the beginning of the mean month, h being negative when the latter begins earlier than the former, and employing H, K, L, as auxiliary letters, we obtain the following series of equations by which to find the value of M_2:

$$x_1=h+\frac{1}{2}(c-n_2),$$

$$H=(n_2+c)(n_2-c)-12x_1^2,$$

$$K=\frac{H+4x_1(n_2+2n_3)}{4(n_1+n_2)(n_1+n_2+n_3)},$$

$$L=\frac{H-4x_1(n_2+2n_1)}{4(n_2+n_3)(n_1+n_2+n_3)},$$

$$M_2=m_2+(K+L)m_2-Km_1-Lm_3.$$

Now taking those values for n_1, n_2, n_3, and h, which are appropriate for each of the twelve months in succession, allowing 28¼ days to February, and giving c its value of $30\frac{7}{16}$ days, we shall find that

$$\begin{aligned}
M_1 &= m_1 + {\cdot}0036\, m_1 + {\cdot}0029\, m_{12} - {\cdot}0065\, m_2\\
M_2 &= m_2 - {\cdot}0123\, m_2 - {\cdot}0028\, m_1 + {\cdot}0151\, m_3\\
M_3 &= m_3 + {\cdot}0027\, m_3 - {\cdot}0237\, m_2 + {\cdot}0210\, m_4\\
M_4 &= m_4 - {\cdot}0041\, m_4 - {\cdot}0190\, m_3 + {\cdot}0231\, m_5\\
M_5 &= m_5 + {\cdot}0015\, m_5 - {\cdot}0207\, m_4 + {\cdot}0192\, m_6\\
M_6 &= m_6 - {\cdot}0038\, m_6 - {\cdot}0171\, m_5 + {\cdot}0209\, m_7\\
M_7 &= m_7 + {\cdot}0025\, m_7 - {\cdot}0190\, m_6 + {\cdot}0165\, m_8\\
M_8 &= m_8 + {\cdot}0024\, m_8 - {\cdot}0098\, m_7 + {\cdot}0074\, m_9\\
M_9 &= m_9 - {\cdot}0026\, m_9 - {\cdot}0064\, m_8 + {\cdot}0090\, m_{10}\\
M_{10} &= m_{10} + {\cdot}0029\, m_{10} - {\cdot}0081\, m_9 + {\cdot}0052\, m_{11}\\
M_{11} &= m_{11} - {\cdot}0025\, m_{11} - {\cdot}0044\, m_{10} + {\cdot}0069\, m_{12}\\
M_{12} &= m_{12} + {\cdot}0032\, m_{12} - {\cdot}0062\, m_{11} + {\cdot}0030\, m_1
\end{aligned}$$

These twelve equations make it easy to compute the mean temperature, M_n, of any one of the twelve mean months when the mean temperatures, m_{n-1}, m_n, m_{n+1}, of the three nearest calendar months are known. And it may be remarked that this method of reduction is applicable not only to temperatures, but to observations of rain-fall, or any other phenomena where monthly means are employed. As a test of its accuracy I have used it for computing the equation of the curve for Greenwich, and compared the result with that obtained by the help of the table of daily means. It gives the means for mean months thus:

36·59	46·49	61·81	49·85
38·60	53·13	61·01	43·19
41·50	59·11	56·39	39·30

Taking as a standard the means previously obtained from the table of daily means, it will be seen that these approximate means for mean months differ from the true ones by only a maximum error of ·03 and an average error of ·016. They give for the equation of the curve

$$\begin{aligned} y&=48{\cdot}91 \\ &+12{\cdot}60\sin(x-111^\circ\,52')-{\cdot}81\sin 2(x-75^\circ\,35')+{\cdot}16\sin 3(x-24^\circ\,3') \\ &+{\cdot}28\sin 4(x-\ 40^\circ\,47')-{\cdot}26\sin 5(x-\ 0^\circ\,50')-{\cdot}23\sin 6x, \end{aligned}$$

and this result will be found to agree substantially with that previously deduced from the true means for mean months, except that e_1 is larger by 0° 1′; there are also some variations in the succeeding terms of the equation, but they are of little consequence because the coefficients are small.

I have computed the mean temperatures for mean months at New York, St. Paul, and Charleston by the same method of reduction. The observed means for calendar months at New York are

30·18	48·65	74·83	54·56
30·44	59·30	73·16	43·32
38·28	68·30	65·78	33·52

and the approximate means for mean months are found to be

30·19	49·09	74·93	54·41
30·56	59·69	73·09	43·20
38·68	68·59	65·63	33·45

The resulting equation of daily temperatures is for calendar months

$$\begin{aligned} y&=51{\cdot}69 \\ &+22{\cdot}75\sin(x-113^\circ\,28')+{\cdot}53\sin 2(x-\ 3^\circ\,37')-{\cdot}43\sin 3(x-5^\circ) \\ &-{\cdot}44\sin 4(x-\ 39^\circ\,26')-{\cdot}17\sin 5(x-34^\circ\,31')+{\cdot}40\sin 6x, \end{aligned}$$

and for mean months

$$\begin{aligned} y&=51{\cdot}79 \\ &+22{\cdot}75\sin(x-112^\circ\,42')+{\cdot}48\sin 2(x-\ 5^\circ\,52')-{\cdot}45\sin 3(x-4^\circ\,17') \\ &-{\cdot}44\sin 4(x-\ 38^\circ\,35')-{\cdot}18\sin 5(x-33^\circ\,37')+{\cdot}41\sin 6x, \end{aligned}$$

showing an increase of ·10 in the annual mean A_0 and showing a decrease of 0° 46′ in the arc e_1; this difference of arc being almost exactly the same for New York as it is for Greenwich.

Again, the means for calendar months at St. Paul are

13·76	46·34	73·40	47·15
17·57	58·97	70·05	31·67
31·41	68·46	58·86	16·89

and for mean months they are

13·74	46·92	73·44	46·97
17·79	59·41	69·93	31·50
32·05	68·73	58·68	16·79

The equation of the curve is found from calendar months to be

$$\begin{aligned}y&=44{\cdot}54\\&+29{\cdot}86\sin(x-105^\circ\,27')+1{\cdot}82\sin 2(x-55^\circ\,28')+{\cdot}91\sin 3(x-45^\circ\,23')\\&+{\cdot}88\sin 4(x-\ \ 0^\circ\,24')-{\cdot}74\sin 5(x-28^\circ\,58')+{\cdot}21\sin 6x,\end{aligned}$$

and from mean months it is

$$\begin{aligned}y&=44{\cdot}66\\&+29{\cdot}86\sin(x-104^\circ\,41')+1{\cdot}93\sin 2(x-55^\circ\,26')+{\cdot}96\sin 3(x-45^\circ\,33')\\&-{\cdot}84\sin 4(x-\ 44^\circ\,54')-{\cdot}77\sin 5(x-28^\circ\,40')+{\cdot}22\sin 6x.\end{aligned}$$

Thus the corrected curve increases the annual mean A_0 by ·12 and diminishes the arc e_1 by 0° 46′.

The Charleston observations give the following means for calendar months:

50·36	65·44	81·72	67·88
52·41	73·42	80·94	59·56
58·68	79·01	76·89	52·51

and reduced to mean months they are

50·35	65·75	81·76	67·76
52·51	73·69	80·90	59·47
58·97	79·16	76·78	52·46

The equation of the curve is for calendar months

$$\begin{aligned}y&=66{\cdot}57\\&+16{\cdot}07\sin(x-109^\circ\,21')+{\cdot}86\sin 2(x-34^\circ\,24')-{\cdot}15\sin 3(x-55^\circ)\\&+\ {\cdot}29\sin 4(x-\ 44^\circ\,10')+{\cdot}09\sin 5(x-\ \ 7^\circ\ \ 1')+{\cdot}32\sin 6x,\end{aligned}$$

and for mean months it is

$$\begin{aligned}y&=66{\cdot}63\\&+16{\cdot}07\sin(x-108^\circ\,35')+{\cdot}88\sin 2(x-35^\circ\,41')-{\cdot}13\sin 3(x-54^\circ\,6')\\&+\ {\cdot}31\sin 4(x-\ 44^\circ\,17')+{\cdot}09\sin 5(x-\ \ 5^\circ\,22')+{\cdot}33\sin 6x.\end{aligned}$$

Here the annual mean A_0 is increased by ·06, and the arc e_1 diminished by 0° 46′.

The diminution of e_1 is therefore almost exactly the same at Greenwich, New York, St. Paul, and Charleston. The coefficient A_1 is nowhere sensibly altered by changing from calendar to mean months. It will be found that the increase in the annual mean, A_0, bears a nearly constant ratio to A_1. This ratio is ·00404 for Greenwich, ·00436 for New York, ·00396 for St. Paul, and ·00384 for Charleston. The mean of the four ratios is ·00405. It may therefore be inferred that if we have for the climate of any place the equation

$$y=A_0+A_1\sin(x-e_1)$$

obtained on the supposition that the calendar months are of equal length, it will be corrected for the inequality of the months if we take

$$y = A_0 + {\cdot}0041\ A_1 + A_1 \sin(x - e_1 - 0^\circ\ 46').$$

This rule may be expected to hold good for extra-tropical climates generally.

The corrections due to the remaining constants, A_2, e_2, A_3, e_3, &c., seem to be dependent on local peculiarities of temperature, and not subject to any simple and general laws.

The utility of any system of representing climates by equations of curves must of course depend much upon the accuracy of the representation. Enough has been done to show that equations derived from monthly means will fail to determine the annual mean and the "date of phase" with any considerable degree of accuracy unless allowance is made for the inequality of the months. It is probably safe to assert that the method of mean months will give results of a higher degree of exactitude than any other method which does not employ more than twelve temperatures to determine the values of the constants.

Dec. 1865.

ART. XLVI.—*On the comparative composition of some Recent Shells, a Silurian Fossil Shell and a Carboniferous Shell Limestone;* by Prof. HOW, D.C.L., University of King's College, Windsor, Nova Scotia.

THE analyses of shells here given were originally made as part of an investigation which it was proposed to institute into the composition of various recent as compared with that of well preserved fossil molluscous shells. The enquiry was set on foot by Dr. Lyon Playfair, at that time Professor of Chemistry in the Museum of Economic Geology in London, where I was engaged in the British Admiralty Enquiry on Coals suited to the steam navy. It was not, I think, prosecuted very far, and I have never heard of the publication of any results of the experiments made. I now communicate the analyses which, with the exception of one or two determinations, I made myself, thinking they have sufficient interest for publication, and that they may perhaps induce some one else to carry on such an investigation as that of which they formed part. With these analyses I give the composition of a shell limestone.

The recent shells were obtained in the London markets and were scrupulously cleaned from their inhabitants. When the animal matter could not be entirely removed in the fresh state it was allowed to putrefy till it could be separated. The Silurian fossil shell was obtained from the collection in the British

Museum. The limestone is Nova Scotian. The first analysis is that of the shell of the Periwinkle (*Litorina litorea*). The results obtained were these:

	I.	II.	Mean.
Lime, - - - -	54·551	54·378	54·464
Carbonic acid, - - -	42·821	......	42·821
Sulphuric acid, - -	0·282	0·283	0·282
Organic matter,[a] - -	2·010	2·040	2·025
Sand and silica, - -	0·164	....	0·164
Phosphoric acid, - - -	0·001	....	0·001
			99·757

[a] Containing 0·07 nitrogen.

The analysis of the shell of the oyster (*Ostrea edulis*) gave,

	I.	II.
Lime, - - - - - -	53·368	....
Carbonic acid, - - - - -	40·600	....
Sulphuric acid, - - - - -	0·809	0·800
Organic matter,[b] - - - -	3·478	3·170
Sand and silica, - - - -	1·495	....
Phosphoric acid, - - - - -	0·106	....
Sesquioxyd of iron, - - - -	0·039	....
	99·895	

[b] Containing 0·155 nitrogen.

On comparing these numbers with the preceding, we observe a great increase in the amounts of sulphuric acid, phosphoric acid, and, especially in organic matter, in which, moreover, the nitrogen is much more abundant.

The analysis of the shell of the Mussel (*Mytilus edulis*) gave:

Lime, - - - - - - -	52·862
Carbonic acid, - - - - -	41·020
Sulphuric acid, - - - - - -	·350
Organic matter, - - - - -	5·020
Sand and silica, - - - - - -	·203
Phosphoric acid, - - - - -	·048
Sesquioxyd of iron, - - - - -	·036
	99·640

On comparing with the foregoing we observe again increased organic matter, while sulphuric and phosphoric acids are much as in Litorina.

The Silurian fossil was *Leptæna depressa*. It gave,

Lime, - - - - - - - -	54·02
Carbonic acid, - - - - - -	41·79
Sulphuric acid, - - - - - - -	0·55
Organic matter, - - - - - -	1·61
Silica, - - - - - - - -	1·58
Phosphoric acid, - - - - - -	0·14
Sesquioxyd of iron, - - - - - -	0·26
	99·95

The resemblance here shown between this brachiopod shell and that of the univalve Litorina is very great. We should rather have expected similarity in this respect between the brachiopod *Leptæna* and the *Conchifers, Ostrea* and *Mytilus,* all three having the two-valved structure. The presence of a much larger amount of organic matter in the two latter than in the univalve Litorina seems to show that the relative abundance of animal substance in the shell is essentially connected with the two-valved structure; if so, we must probably conclude that the Leptæna had been mineralized at the expense of a considerable amount of this material; in other respects it closely resembles the recent molluscous shells. The fossil occurs in limestones, slates, schists, and sandstones, but I have no record as to the matrix of the specimen analyzed.

The carboniferous limestone compared with the foregoing is a specimen of the Lower Carboniferous marine formation of Windsor, N. S.; it is made up to a great extent of shells among which brachiopods are abundant. It gave on analysis:

Carbonate of lime, - - - - -	97·64
Carbonate of magnesia, - - - - -	1·10
Sesquioxyd of iron, - - - - -	0·07
Clay, sand, and silica, - - - - -	0·68
Phosphoric acid, - - - - -	trace
	99·49

Here we may note the absence of organic matter and the addition of a little magnesia, introduced, no doubt, by the actions of sea-water. Had the investigation, of which the foregoing will indicate to some extent the design, been carried on, many interesting results would no doubt have been obtained.

ART. XLVII.—*Experiments on the Production of Organisms in Closed Vessels;* by GEORGE CHILD, M.D.[1]

THE researches, an account of which is contained in the following paper, are in continuation of those which, through the kindness of Prof. Phillips, I had the honor of communicating to the Royal Society in May last, and of which an abstract appeared in the 'Proceedings' for June 16, 1864. The former series of experiments did not pretend to be, in any respect, complete. Those which I am now about to describe will, I hope, be considered to be more so in regard to one main subject of the inquiry; but they also suggest further researches upon some collateral branches of it, which I hope to find time and opportunity to prosecute. In the former series I experimented with animal substances mixed with water and enclosed in glass bulbs

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[1] From the Proceedings of the Royal Society for April 27, 1865, p. 178.

in atmospheres either of common air passed through red hot tubes or of various gases, and the result at which I arrived was that where oxygen was present organisms of a low type were produced, but not so where that gas was not present. Thus, whatever the gas employed, where the substance was not boiled, the organisms appeared; but in the instances in which the substance was boiled, they appeared where oxygen or common air was used, but not where nitrogen, hydrogen or carbonic acid was employed. One experiment only appeared to have produced a result which could not be reconciled with the rest, viz. in which some meat and water had been boiled and sealed up in an atmosphere of nitrogen. In this, some organisms were found; but so completely was this result unlike that found in the whole of the rest of the series, that I felt convinced that some error must have been made in the experiment itself.

The experiments now to be described have a narrower range than the others. With the exception of a few, which were mere repetitions of the experiments of nitrogen just referred to, and which were undertaken solely with the view of seeing whether the experiment just mentioned were correct or not, they are confined to the single object of observing whether or not organisms are found in close vessels containing vegetable matter and water sealed up in an atmosphere of common air previously passed through an efficient heating apparatus.

In these experiments I have adopted some slight modifications of the apparatus used in the former ones. That now employed consists of a porcelain tube, the central part of which is filled with roughly pounded porcelain; one end is connected with a gas-holder, and to the other the bulb is joined which contains the substance to be experimented upon. The bulb has two narrow necks or tubes, each of which is drawn out before the experiment begins, so as to be easily sealed by the lamp; one neck is connected with the porcelain tube, as already stated, by means of an india-rubber cork, and the other is bent down and inserted into a vessel containing sulphuric acid. The central part of the porcelain tube is heated by means of a furnace, and when it has attained a vivid red heat the bulb is joined on, the end of the porcelain tube which projects from the furnace being made thoroughly hot immediately before the cork is inserted, the cork itself being taken out of boiling water, and the neck of the bulb being also heated with a spirit-lamp immediately before it is inserted into the cork. A stream of air is now passed through the apparatus by means of the gas-holder, and bubbles through the sulphuric acid at the other end. The substance in the bulb is then boiled for ten or fifteen minutes, the lamp withdrawn, and the bulb allowed to cool while the stream of air is still passing through the porcelain tube, maintained during the whole time at a vivid red heat. When the bulb is quite cool, the necks are sealed by means of a lamp. The advantage gained by means of this apparatus is that there is only one joint the perfection of which in any degree affects the success of the experiment, and that joint it is easy to make sure. The porcelain tube also being, for a considerable part of its length, filled with small fragments of porcelain, all heated up to redness, easily ensures that every particle of air admitted to the bulb shall be thoroughly heated. A precisely similar arrangement was used for the nitrogen experiments, substituting a glass combustion-tube filled with copper turnings for the porcelain tube, and a piece of india-rubber tubing for the india-rubber cork. The copper-oxyd was reduced by means of a stream of hydrogen when necessary between one experiment and the next.

A single experiment was tried on May 18, 1864, using apparatus similar to that employed in the experiments of the previous year.

Some pea-meal infused in water was boiled in a stream of heated air, allowed to cool, and then sealed and put by. I was then prevented from resuming my experiments for several weeks.

Then several experiments were made with nitrogen, for the purpose of confirming or correcting the nitrogen experiment of the previous year. Into the particulars of these I need not now enter, further than to say that seven experiments were tried with various infusions. Five of them were afterwards examined, and in no case were any organisms found, thus confirming me in the opinion already expressed upon that experiment. The series with which I am now concerned began on July 18.

VII. July 18.—Hay infused in water three hours, then filtered and boiled 12 minutes in a stream of heated air, and sealed up as above described.

VIII. July 18.—A similar experiment: boiled 10½ minutes.

IX. July 22.—Toppings, *i. e.* coarse flour infused in cold water 3 hours, filtered and boiled 10 minutes in a similar stream of air.

X. July 22.—A similar experiment: boiled also 10 minutes.

XI. July 25.—A similar experiment: boiled 12 minutes.

XII. July 25.—A similar experiment: boiled 10 minutes.

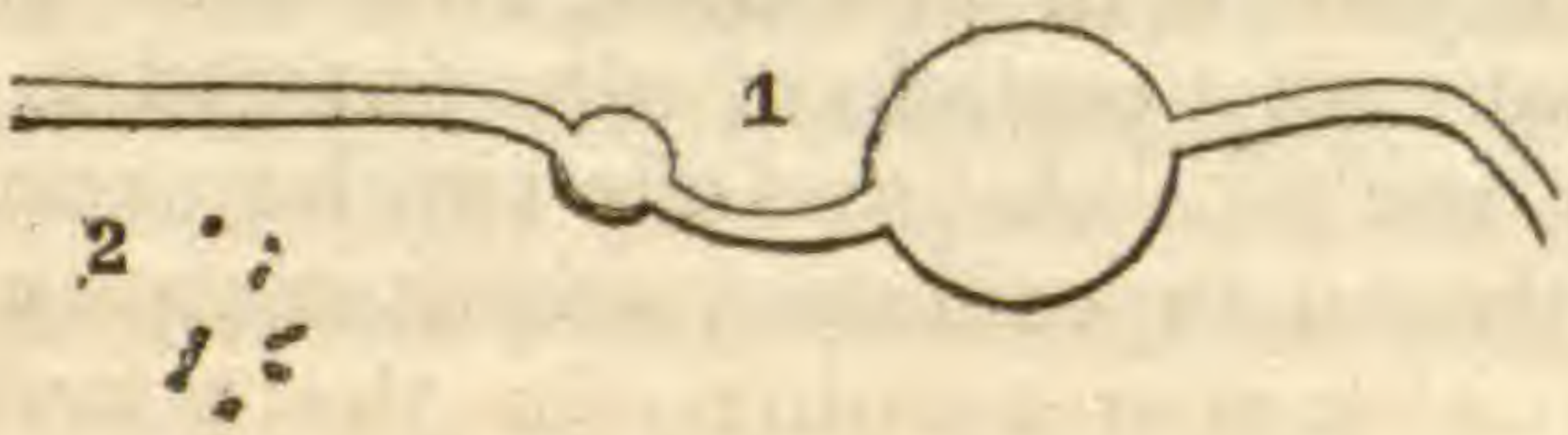
XIII. July 28.—Some sage-leaves bruised and infused in lukewarm water previously boiled. Allowed to stand 15 hours, filtered, and the clear fluid boiled 10 minutes in a stream of heated air, as in the other cases, and sealed up.

XIV. July 28.—A similar experiment: boiled 7 minutes.

XV. July 29.—A similar infusion of celery, allowed to stand 12½ hours, and treated as the last: boiled 12 minutes.

The bulb used in this last experiment was of a different form, which I have found much more convenient, and have always employed in my subsequent experiments, which are presently to be described. (It is represented in figure 1.)

The examination of the above series of experiments took place partly on Sept. 19, when Dr. Beale kindly visited me at Oxford, in order to give me his valuable assistance, and partly at Dr. Beale's home in London, on Nov. 16, 1864.



Exp. of May 18.—Viz. pea-meal and water. In this were found small organisms moving, as given by Dr. Beale in the accompanying drawing, figure 2. Their size was extremely minute, as they are here drawn as they appeared under a power of 1700.

Exp. VII.—Hay + water + heated air. Some large dumbbell-shaped crystals and a few bacteriums, very minute, but not so small as in the former case (fig. 3).

Exp. VIII.—The pair experiment to VII. Similar crystals, and organisms also similar, but larger.

Exp. IX.—Coarse flour + water + heated air. The result of this experiment was unsatisfactory, and serves well to show the difficulty of a decision upon these questions.

Even with the high powers above named, we were unable to be certain of our result in this and several following cases. There were no organisms distinctly recognizable as such, but many minute round spore-like bodies moving about the field.

Exp. X.—The fellow experiment to the last, and similarly unsatisfactory.

Exp. XIII.—Sage + water + heated air. A few crystals were seen, but no organisms.

Exp. XV.—Celery + water + heated air. Some prismatic crystals; no organisms.

It was resolved to leave the rest of these experiments till a longer time should have elapsed since the vessels were closed. The examination was accordingly resumed Nov. 16.

Exp. XII.—Coarse flour + water + heated air, contained some indeterminate granular matter, and some few bodies which might be dead bacteriums, but nothing that could safely be considered as such.

Exp. XI.—The fellow experiment to XII, and equally without result.

Exp. XIV.—Sage + water + heated air, gave also no definite result.

Now, omitting altogether the nitrogen experiments, seven in number, we have here a series of ten experiments instituted with a view of showing whether organisms can be produced in vegetable infusions within closed vessels supplied with heated air. In my desire to try a variety of substances I took almost anything which my garden afforded, and in this way probably my selection of sage and celery may have been a bad one, as the aromatic ingredients of these plants may be supposed to influence the result of the experiment, especially as in a close vessel any volatile oil would be retained. If, therefore, the three experiments with these substances be eliminated, there remain seven experiments, one with pea-meal, two with hay, and four with coarse flour. Of these, five were examined on Sept. 19, and in three (viz. the pea-meal and the two hay experiments) the vessels were found to contain moving organisms. In two (those performed with coarse flour) none were found, and in the remaining two, examined on Nov. 16, also none were found.

In the meantime, when, from several of the above experiments having produced negative results, I looked upon the series as inconclusive, I instituted a fresh series of twelve experiments in the end of September, as follows.

The apparatus employed was the same as that used in the last series, except that I had some large double bulbs made for the present series. In other respects the process was the same as before.

Exp. I. Sept. 30.—Hay infused $3\frac{1}{2}$ hours in water, filtered, and boiled 10 minutes in a stream of heated air—sealed up when cool.
Exp. II. Sept. 30.—Similar in all respects.
Exp. III. Oct. 1.—Similar.
Exp. IV. Oct. 1.—Similar.
Exp. V. Oct. 5.—Flour infused in warm water $3\frac{1}{2}$ hours and filtered: boiled 11 minutes, as before, and sealed.
Exp. VI. Oct. 5.—Similar: boiled 10 minutes.
Exp. VII. Oct. 5.—A similar infusion infused $6\frac{1}{2}$ hours, not filtered; boiled 10 minutes.
Exp. VIII. Oct. 5.—Similar.
Exp. IX. Oct. 7.—Flour infused $3\frac{1}{2}$ hours, not filtered: boiled 10 minutes in a stream of oxygen, and sealed as before.
Exp. X. Oct. 7.—Similar: boiled $10\frac{1}{2}$ minutes.
Exp. XI. Oct. 7.—Flour infused $4\frac{1}{2}$ hours and filtered: boiled 10 minutes in oxygen.
Exp. XII.—Similar.

On Oct. 8 this series of experiments was divided into two sets: [B], Nos. II, IV, VI, VIII, X, XII, were placed on a high shelf in my dining-room; the rest [A] in a hot closet, by the side of the cooking-stove, in the kitchen.

The object of the latter arrangement was to ensure the vessels being kept warm enough during the winter months; but the heat was, I have no doubt, too great. I saw the thermometer on more than one occasion over 140° Fahr., and have reason to believe that I did not see it at its highest. Moreover, the bulbs here were almost wholly deprived of light. Thus, before opening the vessels, I had made up my mind that the results of the other half of the series were most to be depended upon. The temperature of the room in which they were probably never fell below 40° Fahr., and was generally between 50° and 60°.

The examination of the B division of this series took place at Dr. Beale's house, Feb. 7, 1865. The results were as follows:

Exp. IV.—Hay + water + heated air. A few bacteriums were found in active motion.

Exp. II.—Hay + water + heated air. Very large numbers of similar organisms were found.

Exp. VI.—Flour + water + heated air. Few were found as compared with the last, but still several in active motion.

Exp. XII.—Flour + water + oxygen. No organisms found.

Exp. VIII.—Flour + water + heated air (unfiltered). A good many bacteriums, similar to the others.

Exp. X.—Flour + water + oxygen (unfiltered). Some bacteriums, but not moving.

The other set of experiments was examined by me at Oxford on various evenings between Feb. 16 and March 8; but during some part of that time I possessed no object-glass of sufficient magnifying power to avoid all uncertainty in the results.

In both of them, viz. Nos. V and XI, I could find nothing like bacteriums. In the three others, viz. III, VII and IX, there were what appeared to me dead ones (but a dead bacterium is an object of which few persons who have seen many would think it very safe to be very positive), and in one only viz. No. I, an infusion of hay, were they numerous and moving. This I mention particularly, because the objects were very well seen, and moving actively in the first slide which I examined, and could be the better seen on account of the clearness of the fluid and the absence of granular matter; but upon examining several portions after the vessel had been open for a few minutes, though they continued to be seen in equally large numbers, all movement had ceased. They were examined with a $\frac{1}{25}$ object-glass of Messrs. Powell and Lealand. Now, if we omit from these two series of experiments those which I have already shown reason to distrust, we have, in all, seven in the first, and six in the second series, which seem fairly to test the question; and these having been examined by Dr. Beale, as well as myself, bacteriums were found and seen by both of us in three out of the first seven, and five out of the remaining six—in all, in eight.

Now, it may be asked, why the same or similar organisms were not found in the other cases, if the experiments were fairly tried? The answer is this, viz. that we do not know all the conditions under which they exist. It is pretty clear that they appear more easily in some substances than in others. Thus, in the first series above described, it will be noticed that the four instances in which none were found were all those in which coarse flour was the substance used. In the remaining three, where pea-meal or hay were employed, there the bacteriums were seen. So also in the other series, the one case in which nothing was found, was a case in which flour was used, and in the remaining five the most numerous and distinct bacteriums were seen in the hay infusion. This may arise possibly from the fact that the infusion of flour is not so clear as the others, and always contains more granular matter; thus bacteriums are less easily distinguished in it: and, where doubtful, it is my practice to decide in the negative; that is to say, unless the bacteriums are clearly seen, I enumerate the experiment amongst those in which they are not found. Further, it is possible that in some infusions they may live and die sooner than in others, and in most of these experiments with flour there was a mass of indeterminate granular matter which might have contained the bodies of whole populations of bacteriums. Finally, it is quite possible that they might, if existing in small numbers, escape observation. Their minuteness is extreme, and observation of them far from easy. At any rate, positive evidence in a matter of this kind is of more value than negative; and the fact that in eight cases out of thirteen they have been seen, not by myself only, but also, by so accurate and practised a microscopist as Dr. Beale, is of more weight than our having been unable to discover them in the remaining five cases.

The question which now remains to be discussed is, how is it that the results above given so entirely disagree with those arrived at by Pasteur, and now, to a certain extent, vouched for by the Commission of the Academy of Sciences. I have observed all the precautions which Pasteur himself speaks of as "exaggerated," yet I have shown bacteriums to be produced exactly under the circumstances in which he asserts that they do not exist. I believe this discrepancy is very easily accounted for. Pasteur, in his memoir, speaks of examining his substances with a power of 350 diameters. Now my experience throughout has been that it is impossible to recognize these minute objects, with any degree of certainty, even with double that magnifying power. When once their existence on a slide is shown with a power of 1500 to 1700 diameters, it is quite possible afterwards to recognize the same object with a power of 750, but I have repeatedly failed to satisfy myself in the first instance with the latter power; and on the one occasion on which I enjoyed the use of an object-glass giving a power of 3000 diameters, I found the recognition of these very minute objects rendered very much more easy. On one occasion I tried the effect of a power of 450 (not possessing one of 350), and found that all satisfactory investigation of such objects with such a power was impossible. Any person has only to examine the drawings which accompany this communication (in one particularly, that marked 2) in order to satisfy himself that to come to any conclusion as to the presence or absence of such objects as are there represented, with a magnifying power of little more than one-fifth linear measurement of that from which they are drawn, would be quite impossible. The Commission of the Academy of Sciences, which has not yet concluded its labors, has not, so far as its present report goes, concerned itself with the microscopy of the question; it has, in fact, confined itself to the dispute (which has almost become a personal one) between MM. Pasteur and Pouchet. It is worth noticing, that the fact so often referred to by writers on this subject, of the fluid in the closed vessels becoming cloudy or not as a test of the presence or absence of bacteriums, is not satisfactory; I have constantly predicted, from the cloudiness or clearness of an infusion, the presence or absence of bacteriums, and very frequently been mistaken—quite as often too in the former case as in the latter.

As to the conclusions which can be drawn from these experiments, I need say very few words. I can now have no doubt of the fact that "bacteriums" can be produced in hermetically-sealed vessels containing an infusion of organic matter, whether animal or vegetable, though supplied only with air passed through a red-hot tube with all necessary precautions for ensuring the thorough heating of every portion of it, and though the infusion itself be thoroughly boiled. But how far this fact affects the question of what is called "spontaneous generation" is quite another matter.

It seems clear that either (1) the germs of bacterium are capable of resisting the boiling temperature in a fluid, or (2) they are spontaneously generated, or (3) they are not "organisms" at all. I was myself somewhat inclined to the latter belief concerning them at one time; but some researches on which I am now engaged have gone far to convince me that they are really minute vegetable forms.

The choice therefore seems to remain between the other two conclusions. Upon these I will not venture a positive opinion, but remark only, that if it be true that "germs" can resist the boiling temperature in fluid, then both parties in the controversy are working upon a false principle, and neither Pouchet nor Pasteur is likely at present to solve the question of spontaneous generation. In truth, if Pasteur's facts are incorrect, the whole question is relegated to the domain of what the French Academy Commission calls "pure discussion;" and the one point which I claim to have established by their researches is precisely that Mr. Pasteur's facts are inexact—not because his experiments were not most admirably performed, but simply because the magnifying power of his microscope was insufficient for the work to which he applied it. I desire to append two remarks to this paper. The first is, that the common *à priori* objection, which Mr. Pasteur so well expressed in his memoir, to heterogeny in all forms, viz. that it is a doctrine which has been gradually driven from all the higher forms of life in exact proportion as our observation of them has become more exact, until at last it has been compelled to take refuge in those lowest forms which we are almost or altogether unable to observe, is really of little or no force. Its cogency depends on analogy, and the analogy has no existence. It is quite equally to be expected *à priori* that if any forms of life are generated spontaneously, they will be the very lowest and simplest forms, and since these happen to be also the most minute, the objection loses its whole force. And it is also a thing to be expected that we should find only the lowest forms, the earliest, *i. e.* in the scale of existence, produced under the disadvantageous circumstances in which they must be placed in such experiments as those above detailed.

The other remark is this: that, so far as my present researches have led me, I cannot but look upon improvement in the construction of microscopes, and increase of their power, as the only way in which our means of investigation of such questions as the production of Bacterium is likely to be largely increased. The $\frac{1}{50}$ object-glass recently constructed by Messrs. Powell and Lealand, of which a notice has appeared in the Proceedings of the Royal Society, has already shown something like an appearance of structure in these minute objects, and leaves, I think, no doubt about their organic character.

ART. XLVIII.—*A word on the Origin of Life;* by JAMES D. DANA.

THE notion seems to be somewhat prevalent that if such experiments as those described in the preceding paper by Mr. Child really afford examples of spontaneous generation—that is, of the production of living organisms without the intervention of germs—they exemplify the process of the *first origin of life.* The claim made by Prof. H. J. Clark in the title of his recent work—"Mind in Nature, or the Origin of Life, and the mode of development of Animals"—to which we objected in the last number of this Journal, and which the body of the work endeavors to sustain, rests on no other basis. And his opinion of the firmness of the foundation is shown by his taking one long step onward from this basis, as follows:[1]

> The fact that the experiments[2] with the *sealed flasks* proved—if anything can be proved beyond the reach of change or improvement—that beings with motion, undoubted living beings, were produced when life could not possibly have existed previously, is *a sufficient* basis for the further assumption that still higher forms could arise from these. That is to say, if, under the conditions in the sealed flasks, living beings, either animals or plants,[3] of the lowest degree, arise, there is nothing illogical in assuming that, from these lowly organized, *animate* bodies, somewhat higher and more complicated beings may originate.

Now in the experiments referred to, and all of similar character, the experimenter starts with organic matter, either vegetable or animal. Allowing, then, that there are no germs present to breed such low organisms, the results are only examples of life from life; and to the question, what is the origin of life, they reply—*life.* For without some *pre-existing* plant or animal to afford the hay, or flour, or muscle, etc., there could have come none of the plants or animals bred by the alleged spontaneous generation. The world of such "creationists" would therefore have ever remained lifeless. Consequently, not the first stone is laid by these and like experimenters toward bridging over the interval between the inorganic and organic world; not the first step is taken into the yet dark regions back of the existence of life on the globe.

The organic matter operated upon is in one sense dead; that is, the organism as a whole has not its living functions. But still it originated through life; and, moreover, the particles in the fibre of hay or muscle are held together, or remain as they are, in virtue of the forces which, in the processes of life, formed it; just as the particles of a drop of water are retained as they are by the forces—far inferior in kind and amount—which made the combination water. When the decomposition of the material begins, and the forces are thus disturbed, then the moving things, claimed to be a spontaneous generation, make their appearance. From the compound *of high order* in the vegetable or animal kingdom—of high order no doubt chemically as well as vitally—comes the *lowest* in the vegetable kingdom, a cellular plant consisting of one or a few cellules, or perhaps an equally low animal organism.

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[1] On page 26. We have already expressed our high opinion of the microscopical investigations by Prof. Clark, which constitute a large part of his work, and make it an exceedingly valuable contribution to zoological science.

[2] The experiments mainly of Dr. Wyman, of which an account is given in the work at some length, are here referred to.

[3] Prof. Clarke speaks of the *Bacteria* as probably related to vegetable mould; and, after a microscopic study of certain *Vibrios* obtained by Dr. Wyman in his trials, pronounces them also *vegetable.*

In view of these facts, that from life has come the new life, and from the high only the *extremely low*, the assumption, cited above, which makes the second grand conclusion of Prof. Clark, "that still higher forms could therefore arise from these," is certainly without even the shadow of a foundation. Such spontaneous generation does not begin to climb the hill of life; it looks *downward* and not upward.

The best statement which we have seen of the relation of the generated organism—supposing it a real generation without germs—to the original organic matter, is that made by the chemist Fremy to the French Academy, and which we have reproduced (translated from the French) into this Journal, in vol. xxxviii, at page 439 (Nov., 1864).

But the absence of germs, although seemingly possible, is far from being proved, as Mr. Child admits. The high temperature used in the course of the experiments on spontaneous generation is sufficient, it is true, to destroy the life of ordinary plants or animals, but it does not decompose the vegetable or animal material employed in the trials. And, considering the low order of the organisms that are developed, it cannot be assumed that heat which this material stands will destroy their germs.

The following observations, communicated to the writer by Prof. W. H. Brewer, the Botanist of the Survey of California, as well as Assistant in the Geological department, show that plants of low grade may thrive in waters very near if not at the boiling point, and even when strongly acid or saline.

Observations by Prof. W. H. Brewer *on the presence of living species in hot and saline waters in California.*

Dear Sir:—In answer to your request I can give the following facts regarding the occurrence of plants in certain thermal springs, and animals in certain saline waters, of California.

The (so-called) Geysers on Pluton creek, a branch of the Russian river, lie at an altitude of 1700 feet above the sea. They consist of numerous steam vents, and hot springs, of various temperatures, the hottest observed being 97° C. (about 207° F.).

The temperature of the steam in the larger vents was not observed. It issues from some of them with a noise as if released from considerable pressure. The waters contain a variety of salts in solution, apparently mostly the sulphates of iron and alumina; and efflorescences of sulphur, and sulphurous gases are abundant. From most of the springs the water is decidedly acid, discoloring the boots, gloves, and clothes of the visitor.

In these warm mineral waters low forms of vegetation occur. The temperatures were carefully observed in many cases. The highest temperature noted in which the plants were growing was 93° C. (about 200° F.) But they were most abundant in waters of the temperature 52° to 60° C. (125° to 140° F.) In the hotter springs the plants appeared to be of the simplest kind, apparently simple cells, of a bright green color; but they were examined only with a good pocket lens. In the water below, about 60–65° C., filamentous Confervæ formed considerable masses, of a very bright green color.

Around many of the steam jets, on the soil, similar or identical plants formed a thin green coating, like *Nostoc* on wet surfaces. Here they were exposed alternately to jets of hot steam and cooler air. The highest temperature they were subjected to could not be observed; but the soil was hot, and as the steam was often "dry" and transparent, it was equal to, if not above, the temperature at which water boils at that altitude.

The specimens I collected were accidentally destroyed on our return trip; but later Messrs. Mann and Brigham collected specimens from water having a temperature of about 130° F. A part of these were placed in the hands of Dr. Jeffries Wyman of Cambridge, and Mr. A. M. Edwards of New York. The latter person states that he finds animal as well as vegetable organisms in the specimens.

At the "Little Geysers," a few miles distant from those last mentioned, and at an altitude of 2000 feet or more, the same phenomena were observed; but the altitude being greater, the waters were not quite so hot.

These observations were made in November, 1861, and the facts communicated verbally to the California Academy of Natural Sciences the following winter.

Plants occur also in various other thermal waters in the State. They were noticed in great abundance in water having a temperature of 122–125° F. in a warm spring in Owens Valley, about 35 miles above Camp Independence.

The celebrated Steamboat Springs, near Washoe Valley, in Nevada, are very extensive, and the waters hold much silica in solution, which is deposited as they cool. Where the water spreads out over the surface there is in places an abundant growth of confervoid vegetation in the gelatinous mass formed. This was most abundant where the temperature was about 100° F. or less, judging of the warmth of the water by the hand. The most interesting feature in this case is the abundant vegetable growth in the gelatinous silica.

In regard to the occurrence of *animals* in strongly *saline* waters, some facts are of equal interest. Mono Lake is intensely saline. The water has a very high specific gravity, and contains common salt, carbonate of soda, and borax, with other ingredients in less quantities. It dissolves grease easier than ordinary soap, and discolors certain woolens. It leaves a very unpleasant smarting sensation on the skin, and feels soapy to the touch. Yet it contains the larvæ of a certain species of fly in immense numbers. These are cast up on the shore at times in such quantities that a great stench is produced. These larvæ dried form an important item of food with the Mono Indians, who call it "*Koo-chah-bee.*" The flies are seen in equally large numbers about the shores of the lake.

Similar flies are mentioned as occurring at the Great Salt Lake, by various persons. Lieut. Stansbury speaks of their immense numbers in his Report, but we have no facts as to their specific identity.

New Haven, March 26, 1866.

We append the following important note on *the tenacity of life of the seeds and spores of some plants*, prepared for this place by Prof. Brewer.

Note by Wm. H. Brewer.—Edwards and Colin (Annales des Sci. Nat., [2], Bot. I, 257) made experiments on the power of resisting elevated or depressed temperature possessed by the seeds of various leguminous and cereal plants. They found that all lost their vitality if heated in water at 167° F., which is the temperature at which starch grains burst. The most of the seeds had their vitality destroyed when heated in water below this, but would stand a temperature of 122°; while in steam they would stand 144° F.; and in *dry* air some germinated after being heated a very short time to 167° F. Above this all lost their vitality. Some would stand a dry cold of 70° F. below zero.

Berkley states (Introduct. to Cryptogam. Bot., p. 68) that he has "recorded an instance of the germination of thousands of grape seeds after three immersions in boiling water; and Dr. Lindley mentions the fact of raspberry seeds growing after being boiled for jam, in which case, if the sugar were really boiling, the temperature would be above the boiling point of water." The author considers, however, that the observations were not sufficiently exact in either case.

Balfour states (Class Book of Botany, p. 628) "the seeds of *Phytolacca decandra* and of the Raspberry have been known to germinate after exposure for a short time to the heat of boiling syrup," but does not give his authority.

Hemmingway states (Ann. of Nat. Hist., [1], viii, 317) that the seeds of *Sambucus nigra* germinated after being twice boiled in making wine, being present during the vinous fermentation, and remaining twenty months in the dregs of the cask.

In regard to the spores of Fungi, Berkley remarks (Outlines of British Fungology, 32) "that the spores of certain Fungi would bear a moist heat equal to that of boiling water without losing their power of germination. They have also considerable powers of resisting frost, but the exact limits in either case under varying circumstances have not at present been ascertained."

More to the point are the experiments of the eminent cryptogamic botanist, Payen, on the red mould in the interior of bread, which created such a stir in Paris nearly twenty years ago. This mould, the *Oïdium* *aurantiacum*, was developed in the interior of the bread within an incredibly short space of time after it had been baked, especially in the Barrack-bread, ("pain de munition,") at Paris. He found (Ann. de Chim. et de Phys., [3], xxiv, 253) that pieces of bread, and also of dough, upon which the spores of this fungus had been sown, and then exposed in tubes in moist air for half an hour to the respective temperatures of 212°, 221°, and 248° F., afterwards produced the red fungus; while similar pieces of bread and dough, treated in a similar manner but not sown with the spores, did not yield this specific fungus. When the spores were heated in tubes to 284° F. they lost their red color and then ceased to germinate.

It seems that in this case, as in that of the cereals, the vitality of the seeds or spores is retained under certain circumstances up to nearly or quite the temperature required to decompose the chemical substances in the seed, or to disorganize the structu[illegible]n the still lower Cryptogams we have no data either as to the chemical character of their spores, the temperatures required to change their organic compounds, or to disorganize their structure, and none whatever as to the temperatures they may withstand and still germinate. It seems, therefore, unsafe to assume, without proof to the contrary, that their vitality (germinating power) is destroyed at a temperature much below that required for their actual destruction or disorganization.

One of the most remarkable examples of tenacity of life in the higher plants is presented by the *Lewisia rediviva* of Western North America, a large-flowering fleshy plant, of the Portulaceæ, growing in British Columbia, Oregon and California. Dried specimens that have been two years or more in an herbarium will still grow, and are often troublesome from sprouting while between the papers. One specimen, collected by Dr. Lyall, of the British Navy, was "immersed in boiling water" to stop this growing propensity before drying it; and yet, more than a year and a half afterward, it showed symptoms of vitality, and in May of 1863 it produced its beautiful flowers in the Royal Gardens of Kew. This plant in flower is figured in Curtis's Botanical Magazine for August of that year. It is very desirable that some special experiments should be made to ascertain just how much boiling it may undergo without loss of vitality.

April 6th, 1866.

ART. XLIX.—*On the Corundophilite of Shepard;* by F. PISANI.

THE mineral from the emery mines of Chester, Mass., which Prof. Shepard has pronounced to be his Corundophilite, occurs on the emery in lamellæ grouped parallel to the base of the prism, somewhat irregularly, and is associated at times with emerylite. The lamellæ are of a dark green color, translucent when quite thin, and flexible without elasticity. Cleavage is very easy parallel to the base. In a polarizing microscope the plates show two optical axes inclined as in clinochlore, with the double refraction positive.

The mineral fuses easily before the blowpipe to a brown scoria, and chlorhydric acid attacks it in part. The spectroscope affords evidence of traces of lime and lithia. Prof. Shepard has given for the composition, $\dddot{\mathrm{Si}}$ 34·75, $\dddot{\bar{\mathrm{Al}}}$ 8·55, $\dot{\mathrm{Fe}}$ 31·25, $\dot{\mathrm{H}}$ 5·87 = 80·02; and the loss of 20 p. c. he regarded as mostly alkalies.

The analysis which I have made of the Chester corundophilite, as well as the optical properties examined in detail by Mr. Des Cloizeaux, place the species with the ferriferous clinochlores (ripidolite). My analysis afforded me—

		Oxygen.		Ratio.
Silica,	24·0	12·79		6
Alumina,	25·9	13·06		6
Protoxyd of iron,	14·8	3·28	12·36	6
Magnesia,	22·7	9·08		
Water,	11·9	10·60		5
Lime, lithia, manganese,	trace			
	99·3			

Paris, February, 1866.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the wave-lengths of Fraunhofer's lines.*—Ditscheiner has communicated to the Imperial Academy of Sciences at Vienna the results of an extended investigation of the wave-lengths of the dark lines in the solar spectrum. The author employed a ruled glass plate from Fraunhofer's own hand, and a Meyerstein's spectrometer. For the details we must refer to the original memoir. The numerical results obtained are the following, the numbers in the first column referring to Kirchhoff's well known map of the spectrum. The author extended his determinations as far as H, but we omit this portion of his table of results because it requires a special map. The wave-lengths are expressed in millionths of a millimeter.

Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.
B 593	687·06	1029·4	585·62	1343·5	545·45
C 694	655·95	1096·1	576·09	1351·3	544·48
711·5	651·37	1103	575·15	1367	542·82
719·5	649·34	1135	570·88	1389·6	540·32
783·5	633·55	1155·7	568·08	1410·5	538·19
831	622·92	1174·4	565·71	1421·6	536·93
850	618·94	1200·4	562·35	1451	533·92
860	616·82	1207·5	561·36	1463	532·70
864	616·05	1218	560·15	1492·5	529·64
874·5	614·06	1231·6	558·52	1506·5	528·21
877	613·57	1242·5	557·16	1515·5	527·43
885	612·09	1280	552·66	E 1523·5	526·86
895	610·15	1303·7	550·52	1542	525·41
959	597·48	1307	550·09	1569·8	523·16
D*b* 1002·8	589·44	1324·8	547·53	1577·5	522·52
D*a* 1006·8	588·80	1337	546·18	1589·1	521·40

Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.
1601·6	520·75	2002	491·78	2457·5	456·31
1622·4	519·10	2018	490·87	2467·4	455·21
1634	518·16	2041·4	489·00	2489·4	453·23
b 1648·8	517·13	2058	487·64	2537·1	450·06
1655·6	516·58	2067	487·01	2547·2	449·64
1693·8	514·08	F 2080·1	485·97	2566·3	447·97
1737·6	510·86	2103·3	484·10	2606	445·51
1750·4	509·74	2119·8	482·28	2627	444·16
1777·4	507·85	2148·9	480·03	2638·6	443·36
1799	506·35	2157·4	479·02	2670	441·40
1834	504·00	2160·6	478·70	2686·6	440·39
1854·5	502·70	2187·1	476·41	2721·6	438·27
1867	501·71	2201·9	475·38	2734·9	437·32
1873·5	501·12	2221·7	473·82	2775·6	435·19
1885·8	500·52	2233·7	472·84	2797	433·86
1908·5	499·17	2250	470·74	2822·8	433·34
1920	498·23	2264·3	470·19	G 2854·7	430·88
1961	495·61	2309	466·56	2869·7	429·90
1975·6	494·50	2416	460·12	H	396·68
1983	493·80	2436·5	458·16	H′	393·32
1989·5	493·22				

—*Sitzungsberichte der k. k. Akad. der Wissenschaften*, l, Band 296.

W. G.

2. *On the mechanical equivalent of light.*—Professor THOMSEN of Copenhagen has given an ingenious method of determining the mechanical equivalent of light based upon the principle that light may be converted into heat by absorption when incident upon a black surface without luster. The heat produced was measured by means of a Melloni's apparatus, the indications of which were reduced to absolute measure. To effect this reduction a glass globe filled with warm water was placed at different distances from the thermo-electric battery. The globe contained 1351 grams of water (including the water value of the glass). At a temperature of 50° C. the cooling of the globe was 0°·185 per minute, so that 1351×0°·185=250 units of heat were lost in all. Of this quantity, however, according to Dulong's formulas, only 102 units of heat per minute were lost by radiation alone, the external temperature being 17° C. This source of heat placed at a distance of 0·8 meters from the thermopile produced a constant deviation of 17°·8; hence any source of heat or light, which at a distance of 0·8 meter from the thermopile produces a deviation of 17°·8 C., radiates 102 units of heat per minute; and since the deviations of the needle within certain limits are proportional to the radiation, it follows that under these circumstances a deviation of 1° corresponds to a radiation of 5·76 units of heat per minute. By placing the globe at different distances from the thermopile and noting the deviations of the needle, similar factors were obtained for some other distances at which afterward the different sources of light were placed. A candle was then placed at a distance of 0·8 meter from the thermo-pile and a constant deviation of 36°·5 obtained. Hence the total radiation of a candle burning 8·2 grams of spermaceti per hour was 5·36×36°·5=210 units of heat per minute. Since the corresponding quantity of spermaceti evolves about 1400 units of heat per minute, it follows that only $\frac{1}{7}$th of the whole quantity of heat evolved is given off as radiant heat and light, the other $\frac{6}{7}$ths being carried off by heated air.

Other and more intense flames were then tried; the results were as follows:

Nature of the flame.	Intensity of light.	Radiation for unit of light per minute.
Spermaceti candle,	1	210
Gas flame,	1·2	201
"	7·7	199
Moderator-lamp,	8·6	199

Hence the radiation of the flame is proportional to the intensity of the light and amounts, for the unit of light (8·2 grams of spermaceti per hour), to about 200 units of heat per minute. This is the action of the entire radiation, and to determine the portion due to the light alone the rays of heat must be eliminated. The author found by experiment that the invisible rays do not pass through a layer of water 0·2m. in thickness, or at least to so small an extent as to exert no appreciable influence on the result. Further experiments then showed that the absorption of light due to a layer of water 20 centimeters in thickness amounted to 0·13. A glass vessel with parallel sides of mirror-glass enclosing a layer of water 0·2m. in thickness was placed between the flame and the thermopile, the flame being at the same distance as in the first experiments. The deviation of the needle was therefore due exclusively to the heat produced by the rays of light. The results were as follows:

Flame.	Intensity of light.	Radiation of heat and light per minute for the unit of light.	Radiation of light per minute for the unit of light.
Spermaceti candle,	1	210	4·4
Moderator-lamp,	6·25	——	3·9
"	8·6	199	4·1
Gas flame,	7·7	199	4·2
"	1·2	201	3·7

The mean is 4·1 units of heat per minute. Hence in words the result is this: A flame, the light of which is equal in intensity to that of a candle which consumes 8·2 grams of spermaceti per hour, evolves per minute in the form of light a quantity of heat which would raise the temperature of 4·1 grams of water one degree Centigrade. The mechanical equivalent of light reduced to mechanical measure may then be expressed as follows. The unit of work per second, or one kilogram raised to the height of one meter per second, is equal to that contained in the rays of light which proceed per second from a source of light the intensity of which is 34·9 times as great as that evolved in a candle which consumes 8·2 grams of spermaceti per hour.

This is consequently the maximum of the mechanical equivalent of light and may be reduced by later researches. The author proposes to continue his investigations, using light of greater intensity, like that of the sun or of the electric spark.—*Pogg. Ann.*, cxxv, 348. W. G.

3. *Niobium and tantalum.*—The continued investigations of Marignac, supported by those of Blomstrand, to which we have already alluded, and by new determinations of vapor-densities by Deville and Troost, have at length dispelled all doubts as to the true constitution of niobic and tantalic acids. From these investigations it clearly appears that these acids are represented respectively by the formulas, NbO_5 and

TaO_5, in equivalents, or $Nb_2\Theta_5$ and $Ta_2\Theta_5$ in atoms. The columbites or tantalites of Bodenmais, Greenland and Haddam all contain both acids; thus the mineral from Bavaria contains 35·4 per cent of tantalic and 45·66 per cent of niobic acid, while the Haddam columbite contains at least 10 per cent of tantalic acid. There is no hyponiobic acid, but the white chlorid discovered by Rose, and which he considered as a sesquichlorid of niobium, Nb_2Cl_3, is in reality an oxychlorid, NbO_2Cl_3; the true chlorid of niobium is $NbCl_5$. There exists an oxyfluorid of niobium, NbO_2F_3, which combines with fluorid of potassium to form a well crystallized salt having the formula $NbO_2F_3, 2KF+2aq$. By the action of strong fluohydric acid upon this salt a fluoniobate of potassium having the formula $NbF_5, 2KF$ is formed, and this salt is isomorphous with the corresponding fluotantalate $TaF_5, 2KF$. The oxyfluorid of niobium, $Nb\Theta F_3$, is isomorphous in almost all its combinations with the fluorids of titanium and tin, TiF_4 and SnF_4, and with the oxyfluorid of tungsten, $W\Theta_2F_2$, a fact which Marignac explains by supposing that an atom of oxygen, Θ, is isomorphous with an atom of fluorine. The ilmenic acid of Hermann has no existence, and the dianic acid of v. Kobell is merely niobic acid, but Hermann was right in maintaining, against the authority of Rose, that the Bavarian columbite contained tantalic acid, and that Rose's niobic acid was a mixture of tantalic acid and Rose's hyponiobic acid. Marignac separates niobic from tantalic acid by converting the first into $NbO_2F_3, 2KF+2aq$, and the second into $TaF_5, 2KF$; the solubility of the former being about ten times as great as that of the latter the two are easily separated by repeated crystallization. In analyzing the oxyfluoniobate of potassium for the purpose of determining the equivalent of niobium, Marignac found a small quantity of another and analogous salt about five times less soluble than the niobium salt; this may prove to contain a new metallic acid, but the author reserves his opinion upon this subject for the present. The atomic weight of niobium was found to be 94, a number which however must be considered as only provisional. The density of pure niobic acid was found to be 4·37–4·46; prepared in another manner it was 4·51–4·53. The acid forms well crystallized salts with potash, contrary to the statements of Rose and Hermann. Marignac describes compounds having respectively the formulas

$$3Nb_2\Theta_5, 4K_2\Theta, 4H_2\Theta+12aq,$$
$$7Nb_2\Theta_5, 8K_2\Theta, 9H_2\Theta+23aq,$$
$$2Nb_2\Theta_5, 3K_2\Theta, 6H_2\Theta+7aq,$$
$$3Nb_2\Theta_5, 3K_2\Theta, Na_2\Theta, 9H_2\Theta,$$
$$3Nb_2\Theta_5, K_2\Theta, 5H_2\Theta.$$

The oxyfluoniobate of potassium, $Nb\Theta F_3, 2KF+H_2\Theta$, is a perfectly stable salt which does not change by repeated solutions and crystallizations; it loses its water at 100° C., but may be dried completely at 180° or 200° C., and then redissolves in water without decomposition. The salt dissolves in 12·5–13 times its weight of water at 17°–21° C., and is much more soluble in boiling water. Another oxyfluoniobate has the formula $Nb\Theta F_3, 3KF$; its crystals appear to be cubes, but an optical examination showed that they do not belong to either the regular or dimetric system. A fluozirconate of potassium, having the formula

$ZnF_4, 3KF$, crystallizes in regular octahedrons, while of the salts $SiF_4, 3NH_4F$ and $TiF_4, 3NH_4F$, the first crystallizes in square prisms and the second either in square prisms or cubes. The other oxyfluoniobates described have the formulas $Nb\Theta F_3, 3KF, HF$, isomorphous with $SnF_4, 3KF, HF$; $3Nb\Theta F_3, 5KF+H_2\Theta$ and $3Nb\Theta F_3, 4KF+2aq$. The fluoniobate of potassium, $NbF_5, 2KF$, is easily obtained by dissolving the normal oxyfluoniobate in strong fluohydric acid; though small the crystals are brilliant and easily measured; redissolved in water they give an abundant crystallization of oxyfluoniobate and leave a strongly acid mother liquor. In addition to several oxyfluoniobates of ammonia the author describes salts of zinc and copper having respectively the formulas $Nb\Theta F_3, ZnF_2+6aq$, isomorphous with fluosilicate, fluostannate and fluotitanate of zinc, and $Nb\Theta F_3, CuF_2+4aq$, isomorphous with fluotitanate and oxyfluotungstate of copper.

Deville and Troost have determined the vapor-densities of both chlorid and oxychlorid of niobium, and Marignac has proved by careful analysis and examination that the chlorid employed by the French chemists contained no appreciable quantity of chlorid of tantalum. The density of the vapor of the oxychlorid of niobium, $Nb\Theta Cl_3$, taken at 448° C. in the vapor of sulphur was found to be 7·87, and taken in the vapor of cadmium at 860° was found to be 7·89; the formula given requires 7·48, while Rose's formula, Nb_2Cl_3, would require 7·05. In like manner the vapor-density of chlorid of niobium was found to be 9·6; the formula $NbCl_5$ ($Nb=94$) requires 9·4, while Rose's formula requires 8·6.

The minerals tantalite and niobite have, according to Marignac, respectively the formulas $Ta_2\Theta_5, Fe\Theta$ and $Nb_2\Theta_5, Fe\Theta$ (in equivalents TaO_5, FeO and NbO_5, FeO). The tantalite from Kimito represents the first and the niobite from Greenland the second type, and the different varieties of columbite lie between these extremes. The atomic weight of tantalum, if we consider tantalic acid as TaO_5, would be about 172. In conclusion Marignac acknowledges the priority of Blomstrand in the discovery of the true constitution of niobite and tantalite, and as regards other results obtained by that chemist which, except as to the atomic constitution of the two acids, agree entirely with his own.—*Bibliothèque Univ. de Geneve*, xxiii, p. 167 and 249; Deville and Troost in *Comptes Rendus* for June 12th, 1865; also Marignac in *Ann. der Chemie und Pharm.*, cxxxvi, p. 295. W. G.

Note.—Marignac's researches clearly show that niobium and tantalum are pentatomic or quinquivalent, and they are thus associated with the nitrogen group, which therefore contains nitrogen, phosphorus, arsenic, antimony, bismuth, niobium and tantalum. Niobic and tantalic acids appear in their normal compounds to be monobasic like nitric, metaphosphoric, antimonic and bismuthic acids, but the bibasic and tribasic character appears in the double fluorids and oxyfluorids $NbF_5, 2KF$, $NbF_3O_2, 2KF$, $NbF_3O_2, 3KF$, and $TaF_5, 2KF$. The oxychlorid of niobium has its analogue in the well known oxychlorid of phosphorus, PCl_3O_2.—W. G.

4. *On Yttria and Erbia.*—Bahr and Bunsen have published the results of an elaborate investigation of the earths found in gadolinite, and

have, as appears, succeeded completely in overcoming the difficulty of separating and discriminating between yttria and erbia, the metal terbium having no existence. It will be remembered that Popp has recently endeavored to show that but a single earth, yttria, exists in gadolinite, while De la Fontaine has maintained the existence of the three discovered by Mosander. Bahr and Bunsen separate the oxyds of cerium, lanthanum and didymium from yttria and erbia by means of sulphate of potash, repeating the operation until the solution no longer exhibits the absorption bands of didymium with the spectroscope. Yttria and erbia were separated by converting the oxyds into nitrates, heating the mixed nitrates until the first gas-bubbles of nitrous acid were given off, boiling the mass in just sufficient water to give a clear solution, and separating the crystals of basic nitrate of erbia formed on cooling. In this manner by repeated operations the two earths were finally separated, the equivalent of yttrium being found to be 30·85, while that of erbium is 56·3. Erbia, as obtained by igniting the oxalate or nitrate with access of air has a faint rose-red color, and does not fuse at a white heat, but glows with an intense green light. The salts of erbia are more or less bright rose-red; they have an acid reaction and a sweetish astringent taste. Sulphate of erbia has the formula $3(ErO, SO_3)+8aq$. like the sulphates of yttrium, didymium and cadmium, and forms permanent rose-red crystals. The basic nitrate has the formula $2ErO, NO_5+3aq$: the oxalate is ErO, C_2O_3+aq. The authors give figures of the absorption spectra of erbium and didymium and show that the two contain no lines in common and that there are no absorption bands from which the existence of terbium can be inferred. The errors of previous observers in this particular are due to the fact that the broad indistinct bands in both spectra vary with the intensity of the light and the degree of concentration of the solutions. Erbia and the oxyd of didymium are distinguished from all hitherto observed substances by a most remarkable optical peculiarity. The *solid* substance when strongly ignited gives a spectrum with bright bands which in the case of erbia are so intense that they may be used as a means of recognizing the earth. Ignited erbia gives out a green light and appears to be surrounded by a greenish halo, which, however, depends simply upon irradiation. The spectrum of erbia is more intense and complete when in place of the dense oxyd the porous mass obtained by igniting the nitrate quickly upon a fine platinum wire is employed. The same effect may be obtained by moistening the oxyd with a solution of phosphoric acid before ignition and repeating the operation as long as an increase in the intensity of the spectrum is observed. Too large a quantity of phosphoric acid converts the earth completely into phosphate which gives only a faint spectrum. By either of these methods a spectrum of extraordinary beauty is obtained scarcely inferior to that of baryta in intensity and distinctness. The bright lines of the spectrum of ignited erbia exactly correspond to the dark lines produced by absorption in solutions of erbium, and the same is the case with bright and dark lines of didymium. The properties of the two oxyds lead to the remarkable conclusion that the position of the spectral lines of any substance may remain the same whether the temperature be below 0° C. or exceed the freezing point of water by thousands of degrees.

When the light of a luminous gas-flame passes through a crystal of sulphate of didymium only 1 millimeter in thickness and then falls upon the slit of the spectroscope we obtain an absorption spectrum of extraordinary sharpness and beauty in which not less than 17 bands may be distinguished. The spectrum of a solution of didymium contains one line which is not found in the spectrum of the solid sulphate and this last contains one line not found in the spectrum of the solution. That this is not an error of observation is shown by producing the absorption spectrum of this crystal and then bringing a solution of didymium between the crystal and the source of light, when both bands appear. Hence it is clear that in the passage from the liquid to the solid state spectral lines may disappear and new ones may be produced. Bahr and Bunsen consider it certain that the spectra of erbia and didymia are due to the compounds of the metals and not to the metals themselves, which are not reduced by ignition. They remark that the absorption spectra are the same respectively for all the salts of the two metals. Yttria, as prepared in a state of purity forms a soft nearly white powder which, when ignited glows with a pure white light and gives no trace of an absorption or emission spectrum. The solutions are colorless and have an acid reaction and sweet astringent taste. The sulphate of yttria forms transparent colorless crystals which have the formula $3(YO,SO_3)+8aq$. The basic nitrate $2YO,NO_5+3aq$. forms colorless needles; the oxalate is perfectly white and has the formula $YO.C_2O_3+aq$. For the quantitative estimation of yttria and erbia the authors recommend the conversion of the weighed mixture of oxyds into sulphates. From the weight of acid the relative properties of the oxyds may be determined by the method of indirect analysis. In conclusion, an elaborate analysis of gadolinite is given leading very precisely to the formula $2\dot{Y}_3\dddot{Si}+\dddot{B}\dddot{Si}$ or more simply $\dddot{Si}\dot{R}_3$ if glucina be considered a protoxyd.—*Ann. der Chemie und Pharm.*, cxxxvii, 1, Jan. 1866. W. G.

II. MINERALOGY AND GEOLOGY.

1. *Notes on Chalk and Cretaceous Deposits in Eastern Colorado;* by D. C. Collier, Editor of the "Daily (Colorado) Miner's Register."—In crossing the plains from Denver, Colorado, to Atchison, Kansas, last November, I was so fortunate as to make some geological and paleontological discoveries which may be of interest to the scientific public, an account of which, by request of Prof. James D. Dana, I herewith transmit for the Journal.

I first emigrated to Colorado in the year 1858. In passing up the Arkansas river I found, upon many of the nearly barren ridges and hills, about three hundred miles west of the Missouri river, fragments of indurated chalk intimately mixed with silex and containing nodules of flint. At that time I was travelling through an unknown region, with but five companions, and had no opportunity to examine the white bluffs to be seen in the distance. On approaching the base of the mountains we turned northward from the Arkansas, and crossed over the dividing ridge which separates the waters of that river from those of the Platte. In doing so I found a large portion of the rocks to consist of a white or whitish conglomerate. They were composed of a fine-grained or rather grainless substance, chalk-like in appearance, combining water-worn pebbles of white quartz and flesh-colored feldspar, mostly the former. Wherever the strata of this rock remained horizontal, or nearly so, I found it usually covered with a thin stratum of hard clinking red ferruginous conglomerate. Wherever bluffs of the white conglomerate existed, they were thus overlaid, and were worn into an infinite variety of monumental and architectural forms, which gave them, in the distance, an appearance of being old ruins. From these, Monument Creek has since received its name.

Underlying the Cretaceous conglomerate I found immense strata of a green argillaceous shale or marl, which in appearance closely resembles the greensand of New Jersey, as I have seen it this winter. This green marl I afterwards found to be very abundant. In the black shales and slates, which are highly friable, and which appear to underlie the green marl, I found immense deposits of bituminous lignite or coal, in layers from a few inches to nine feet in thickness. Still lower down, geologically, I found extensive deposits of fossil shells, mostly Baculites and Ammonites. On one occasion, in the year 1861, at a point on the Platte river sixteen miles above Denver, I uncovered, in a space not more than six feet in diameter, the shells of eighteen Baculites which had been crushed flat but retained all their beauty of outline and brilliancy of color. After being exposed for a few minutes they crumbled to fragments. The longest of these was about four feet in length; the smallest but a few inches.

In the fall of the year last mentioned, in company with other gentlemen, I examined cursorily the stratified rocks, from the point where they overlap the metamorphic granites of the mountain range where the Platte river issues out on the plains, and for a mile eastward. I found the rocks there tilted at an angle of fifty degrees, dipping from the mountains. They were composed first of micaceous shales, and then of strata of siliceous conglomerates, sandstone, limestone, a kind of red and white marble, gypsum, argillaceous shale containing alum, etc.

The inclination of the rocks we found to be about fifty degrees for a distance of fully two miles, wherever the outcrop was not so decomposed that we could not trace it, and where it was not concealed from view by soil. Encrinites and Asterias were often found in the upper deposits, as also fragments of petrified palm and other endogenous plants.

My residence being in Central City, surrounded on every side by granitic rocks, and business engrossing my entire attention, I was not able to devote any further attention to this subject till last November, when I crossed the plains on one of the coaches of the Butterfield line which then traversed what is known as the Smoky Hill route, down the Smoky Hill river, midway between the Arkansas and Platte rivers. For two hundred and fifty miles eastward from Denver we travelled day and night, and of course had little or no opportunity to examine rocks. After travelling that distance, fortunately for me, we came to a point where the Indians had driven off the stock, killing drivers, messengers and stock-tenders. This compelled slow travelling and frequent stoppages for our stock to rest. With my revolver cocked in my hand ready for an Indian fray, I was able often to go half a mile from coach or camp among the bluffs. On one occasion, in company with a companion I was able to climb to the top of a bluff of pure chalk, so soft that I could cut and carve it with the knife I carried in my belt, and so fine that it covered my clothes as thoroughly as when in my college days a classmate wiped the blackboard with my back. On the summit I found the remains of immense shells, some of which were nearly four feet in diameter. Among others were remains of Belemnites in immense quantities, but these latter I oftener found closely connected with the green shales which I am inclined to believe underlie the chalk.

When in the midst of these Indian fiends, at a distance of half a mile from the coach, I found the fossil jaw of a Mosasaurus, which, though broken in fragments, appeared to have been about four feet in length. The teeth remained whole, and the front extremity of one of the jaws was also complete. This portion, about fourteen inches in length, and also a portion of the vertebræ I carried along on one arm, with my revolver cocked in the hand of the other, till I overtook the coach, leaving behind the other bones, which I greatly coveted. This appeared to have been deposited in connection with green shales, which were readily disintegrated into what closely resembled a marl, and which often contained nodules or accretions of sulphid of iron.

After travelling in this way for some distance we were supplied with a military escort, the commandant of which put an end to my wandering away from the road, and thus ended my geological research.

The chalk bluff extends for a distance of over one hundred and fifty miles east and west, and may be found first at a distance of about three hundred and fifty miles west from Leavenworth, Kansas.

As the coach was driven rapidly along I could see many fossils by the wayside, and in the bluffs, which seemed to be chalk, much higher than those I have mentioned, but we travelled with so much haste and were surrounded with so many enemies, that I was unable to decide the relative position of these interesting rocks. While in the midst of these localities, and when crossing the outcroppings of the coal deposits, we were attacked by Indians, who were repelled only after killing five of their number and after they had wounded one of ours. Our only stoppage by the way, after being joined by the military, was to bury the bones of white men who had been murdered by Indians and stripped of their flesh by wolves.

The fossils which I obtained on this trip are now in the Cabinet of Oberlin College, Ohio, to which I gave them.

Brooklyn, N. Y., April 4th, 1866.

2. *Volcanic eruption at Santorin, Grecian Archipelago, and the formation of a new island in the Bay.*—Translation of a letter from J. Decigala, dated Santorin, January 23, 1866, by Mr. Canfield, American consul at Athens, as published, with illustrations from photographic views, in Harper's Weekly, April 7.

A remarkable phenomenon has for several days occupied the attention of the inhabitants of Santorin. On the 18th instant a low rumbling sound was heard from time to time in New Kaimeni, and especially at the place called Vulcano, where are the mineral waters. At the same time stones detached from different parts of the island were constantly falling about. The morning of the 19th cracks could be seen on the walls of buildings, as also in the ground and the newly erected quay. Toward noon the rumblings began to be more frequent, till they sounded like successive discharges of artillery. In the little harbor of Vulcano the sea was violently agitated, and an innumerable multitude of bubbles rose incessantly from the depths. At the same time we could see on its surface and on its borders white vapors giving an odor of sulphur. The afternoon of the same day the boiling of the sea increased, and the ground on the beach commenced gradually to sink down. On the morning of the 20th, about five o'clock, flames, forming a conical fire ten to fifteen square meters at the base and from four to five in height, were seen on the sea. After an hour they entirely disappeared. We then went upon the spot with the sub-prefect and some others to make a nearer examination of the phenomenon. We then saw that the whole southwestern part of New Kaimeni was shattered to pieces. A chasm, commencing at the western shore near the port of St. George, and directing itself toward the east, divided in two equal portions the conically formed hill and almost the entire island. Other numberless rents, some running from east to west, others from north to south, separated into a number of parts the ground of the whole southwestern portion of the island. This land, which is formed not of layers of earth but of an accumulation of volcanic stones and sand, or rather of the powder of basaltic rocks, was always very dry and in no way susceptible of vegetation. We saw here four little lakes of pure water, whose size was slowly increasing; for having measured the largest of all, which had hardly an area of twelve square meters, we saw its waters rise five centimeters within four hours. We advanced toward the focus of the volcanic action and perceived a sulphurous odor like that of rotten eggs. White and suffocating vapors arose from the agitated sea, and from time to time we saw spots appear of greenish color, proving that the vapors which arose were of hydro-sulphurous and hydro-phosphoric [?] nature. The ground was constantly shaken, though it subsided very slowly, directing itself toward the interior of the port in question. This depression of the ground was much more perceptible toward the western portion than the eastern: this last showed a depression of hardly three meters, while the western portion had sunk more than six meters. This subsidence, as I have said, took place insensibly and gradually; for having measured the surface of the waters at the moment of our arrival and that of our departure, we saw that in the space of four hours the soil of the western portion had sunk sixty centimeters (about two feet.)

The sea was agitated and red, like water containing a great quantity of argillaceous mud. Its temperature was that of the rest of the sea, but it tasted bitter, and when taken up in a transparent vessel appeared turbid. The effervescence was very great, and doubtless came from the abundant springs containing sulphate of iron, which spirted up with force from its depths, accompanied with much noise from the gases escaping with violence. About 5 P. M. of the same day we felt at Santorin a slight shock. * * * *

P. S.—N. C., *Jan.* 23, 11·30 A. M.—The reef has been changed to an island, to which I am unable to approach very closely on account of the temperature and the boiling of the water. I approached, however, on the land side within a distance of ten paces, and could observe all with perfect attention. The sight is a magnificent one, and the more agreeable since, without the least danger, we can see the island gradually increasing. The smoke, although thick, and rising in abundance from all parts of the rising island, has neither a disagreeably strong odor nor a very high temperature, and in no way impedes the respiration. There are no flames to be seen, and even the boards of huts destroyed by the subsidence, or belonging to the little vessels long since sunk in this port, and to-day raised with the bottom of the sea, appear attached to the rocks on the surface of the island, preserving themselves in the midst of the smoke without being at all burned. There are no quakings of the ground to be noticed. * * *

Now, as I am writing, I estimate the height of the islet at from 15 to 20 meters, and its size 20 to 25 meters in length by 8 to 10 in breadth. The subsidence of the neighboring soil appears to-day to have been arrested. The water of the entire Gulf of Santorin is, as yesterday, colored and thick. On the shores of New Kaimeni it is lukewarm, while on the spot where the eruption takes place, and on the west of Vulcano, along its exterior shores, it is in a state of constant ebullition. It is singular that these volcanic phenomena have as yet exercised no influence on the island of Santorin, except a slight shock, which made itself felt at five o'clock the morning of the 20th instant. The meteorologic condition has never exercised any influence upon these phenomena; for whether calm, or when violent winds were blowing from different points of the compass, or even amidst the rain, they have continued to operate alike.

3 P. M.—The island has increased to nearly double its former size. * *

3. *Notes on some points in the geology of Kansas;* by Prof. G. C. SWALLOW, (from a letter to J. D. DANA, dated Columbia, Mo., March 15, 1866).—Some months since I was permitted to examine the fragment of the lower jaw of a horse containing two molars, which was obtained from the sand-beds between the Bluff and Drift, at Maysville, Kansas. This and other bones were found by the Hon. E. C. Manning while sinking a well, 45 feet below the surface, in the sand-beds below the bluff. These beds of sand are very extensively distributed over Missouri, Kansas, Nebraska and Iowa, and are called *altered drift* in my Geological Reports of Missouri and Kansas. I have not seen the locality, but think there can be no mistake about the geological position of the fossils. I judge from my knowledge of the country and Mr. Manning's very clear description of the strata passed through. I compared the teeth with others and could see no material difference between them and those of the living horse, save that they are rather larger than the usual size. The fossils are interesting in connection with the remains of the horse from the Post-pliocene, announced by Mr. Holmes, of Charleston, S. C., in 1848.

I am now at work on my collections of fossils made in Kansas during the past two years.

The line of division between the Permian and Carboniferous will remain where I put it in 1858. The evidence is incontestible. The Carboniferous fossils above that line are not so numerous, in comparison with the Permian, as Maj. Hawn's collections seemed to indicate, and the lithological and stratigraphical evidences are too strong to be overlooked. The limestones change from an impure carbonate of lime to a carbonate of lime-and-magnesia; there is a want of conformity, and nearly all the well-marked Carboniferous types of animals cease; and only a few, such as are of doubtful specific relations, or have a very wide stratigraphical range, or such as come in high up in the Carboniferous series, range up through the lower Permian. I shall soon send you my preliminary Report.

4. *Evidence of a probable modern change of level on the coast of Florida;* by E. LEWIS, Jr. (From a letter to J. D. DANA, dated Brooklyn, N. Y., March 24, 1866.)—While recently at St. Augustine, Florida,—at which place I have been on account of health,—I saw stumps of cedar trees which were covered with salt water at low tide; and on the beach fronting the town I observed that an ancient peat meadow lies *underneath* the Coquina formation in one place—the Coquina, or beach shell-rock, being solid enough for building purposes, and from 8 to 11 feet in thickness. How much or how far the peat extends beneath I cannot say; it lies as low as the level of *very low* water.

5. *Supplemental Notes on the Structure and Affinities of Eozoön Canadense;* by W. B. CARPENTER, M.D., F.R.S.—In this paper Dr. Carpenter stated that a recent siliceous cast of *Amphistegina* from the Australian coast exhibited a perfect representation of the "asbestiform layer" which the author described in his former communication on the structure of *Eozoön*, and which led him to infer the Nummuline affinities of that ancient Foraminifer—a determination which has since been confirmed by Dr. Dawson. This "asbestiform layer" was then shown to exhibit in *Eozoön* a series of remarkable variations, which can be closely paralleled by those which exist in the course of the tubuli in the shells of existing Nummuline Foraminifera, and to be associated with a structure exactly similar to the lacunar spaces intervening between the outside of the proper walls of the chambers and the intermediate skeleton, by which they become overgrown, formerly inferred by the author to exist in *Calcarina.* Dr. Carpenter then combated the opinion advanced by Professor King and Dr. Rowney, in the preceding paper, and stated that even if the remarkable dendritic passages hollowed out in the calcareous layers, and the arrangements of the minerals in the Eozoic limestone, could be accounted for by inorganic agencies, there still remains the Nummuline structure of the chamber walls, to which, the author asserts, no parallel can be shown in any undoubted mineral product. In conclusion, the author stated that he had recently detected *Eozoön* in a specimen of Ophicalcite from Cesha Lipa, in Bohemia, in a specimen of gneiss from near Moldau, and in a specimen of serpentinous limestone sent to Sir Charles Lyell by Dr. Gümbel of Bavaria.—*Reader*, Feb. 10.

6. *Fossils of the Sierra Nevada.*—In the review of Whitney's Geology of California, on page 363 of this volume, it is stated that in January of 1864, Mr. King found Jurassic fossils on the Mariposa estate; and that this discovery was followed the same year by other discoveries by him and other persons. We add here that Prof. W. P. Blake, published a brief notice of fossils from the same region in the Proceedings of the California Academy of Sciences for October, 1864, vol. iii.

7. *Geological Sketches;* by L. Agassiz. 312 pp., 12mo, with a portrait and woodcuts. Boston, 1866. Ticknor & Fields.—This work has already been extensively read from the pages of the Atlantic Monthly, and admired for the simplicity and beauty of its style, the vividness of its descriptions of nature, and the grandeur of its views of the world's progress. Professor Agassiz reviews the prominent events of the successive eras in a manner that cannot fail to charm and instruct the most unscientific reader, and none can rise from the work without appreciating the reality of this progress, and being fully convinced, if not already debased by materialism, that there has been a system or plan in this progress, conceived in infinite wisdom, and sustained and carried forward at every step by a personal God.

While thus excellent in its aim and spirit, we are compelled to add that the work is not always a safe guide as to special facts or principles, owing to its oversights, or statements not accordant with observation.

Thus we find in the first chapter, on page 5, that water is the only substance which expands when freezing. On page 9, in the course of explanations on the metamorphism of rocks, or their alteration to the crystalline state, we read that sand is changed by heat to a coarse kind of glass,—when really it can make only baked or consolidated sand, or a sand-rock; also, that metamorphism is due to volcanic overflows or injections of melted matters,—when metamorphic rocks (gneiss, mica slate, etc.), occur where there are no volcanic overflows or injections, and such injections have at times, as in Canada, cut through even limestones without any alteration of the rock adjacent to the fissure. On page 15, we learn that the age of igneous rocks can be told by their crystals as easily as that of aqueous rocks by their fossils; on page 22, that the Azoic lands of North America are nowhere over 1500 feet in height,—when the Adirondacks of Northern New York exceed 5000 feet; on page 23, that the Laurentian mountains, the Azoic of Canada, are a granite range,—when the Canadian geologists assert that they contain no granite, but consist of gneiss, and allied metamorphic rocks, with some interstratified limestones; on page 25, that the metamorphic Azoic rocks have derived the larger part of the material of which they are made from marine volcanoes; and that there are "innumerable chimneys perforating the Azoic beds, narrow outlets of Plutonic rocks protruding through the earliest strata,"—while such "chimneys," or "funnels" for the ejection of granite as they are afterwards styled, have no place in the geological Reports of Canada, or of any other country.

Turning to the next chapter, we are told, on page 37, that the Silurian rocks are all of sea-beach orgin—when, in fact, geologists have distinguished that part were formed as immense sand flats, and part, including most of the limestones, as accumulations of organic origin over great shallow seas, and part may have been of deep-water origin. On the same page, and with more of detail on page 54, we are informed that fishes represented the subkingdom of Vertebrates among the very first living species of the globe, along with the earliest Crinoids, Mollusks, Trilobites, and Worms,—when no geologist has ever described any remains whatever of fossil fishes from the Primordial or earlier division of the Silurian—a division including, in some regions, thousands of feet of rocks representing an era one-third as long as the whole Silurian.

Again, in Chapter III, on page 69, we learn of an upheaval, "at the close of the Devonian age," which "raised the elevated ground on which Cincinnati now stands," and that "the force of the upheaval was such as to rend asunder the Devonian deposits, for we find them lying torn and broken about the base of the hill;"—when in fact this "Ohio hill," as it is called, is only an outcropping of the Lower Silurian, and the Silurian area spreads northward over 100 miles, before reaching the Devonian, and over 50 miles on the east and west, so that the "torn and broken" Devonian at its base is all fancy; moreover the decision that the uplift took place at the close of the Devonian age is not deducible from any facts yet observed. On page 75, it is stated that there were only sea-weeds in the Devonian age,—when New York long since afforded remains of Devonian ferns, and even of trees, and the Devonian of Maine and New Brunswick have more recently yielded numerous species of land plants, some of which Dr. Dawson refers to the *Conifers*, an order of plants which Prof. Agassiz says had no species even in the Carboniferous era. On pages 84, 86, the reader is informed that the genera *Productus* and *Goniatites* have no Devonian species,—when there are many known, a number of them American. On page 77, in speaking of the origin of the bitumen of our bituminous coals, he says, "Plants so *strongly bituminous as the Ferns*, when they equalled in size many of our present forest-trees, naturally made coal deposits of the most combustible quality;"—while, in truth, the Fern or Brake is known to be *never* bituminous, and, moreover, bitumen or petroleum may proceed, as has been abundantly proved, from the decomposition of plants of any kind, and also from animal matters, and has unquestionably been derived from both of these sources in the formation of different bitumen-bearing strata.

These specimens are sufficient without proceeding further. Such imperfections weaken the foundation of some of the arguments, and much impair the usefulness of the "Geological Sketches." When we read them in the Atlantic Monthly, several years ago, we could only suppose that the lectures on which they are founded were delivered without notes or much premeditation, and were intended rather for a vivid presentation of the grand argument than as an accurate exhibition of the facts on which that argument is built; and then, that the reporter's abstracts were sent to the periodical press without the careful revision which they needed, and which, in this collected form, they need all the more. The volume has as its frontispiece an admirable portrait of the author. The woodcuts are very poor.

8. *Geological Survey of Canada: Atlas of Maps and Sections, to accompany the Report of Progress from the commencement of the Survey to* 1863. 42 pp. with six maps, and several sections. Montreal, 1865. (Dawson Brothers.)—This atlas contains a detailed geological map of Canada, and of a portion of the United States, extending so far south as to include part of Virginia, much of Missouri, and west to the meridian of 100°. It is of unusual excellence in every respect, its exactness and beauty and distinctness of coloring being all that could be desired. Sir William E. Logan, through the Survey of Canada has thrown a vast deal of light upon the geology of the United States, and this map makes it available to all interested in the subject. In the extension of the map beyond the limits of Canada, he had the assistance of Prof. Hall, the

best authority in our country. There are some debatable points as to the distribution of the formations; as the limits of the Huronian, and of the Subcarboniferous; but such there must be as long as science is making progress. The other maps and the sections are also admirable in style and character.

9. *Contributions to the Paleontology of Illinois and other Western States;* by F. B. Meek and A. H. Worthen. 20 pp. 8vo, (from the Proc Nat. Sci. Philad., 1865, 245.)—Mr. Worthen, who has had in charge the Geological Survey of Illinois, is now bringing out, with the aid of Mr. Meek forthe paleontology, the Reporton the geology of that State; and the article here issued is in part an abstract of a portion of that Report, the paleontology of which will be exceedingly rich in many departments. This paper contains descriptions of thirty-six new species of Mollusks, and of six of Trilobites, including one of *Dalmania* (Upper Silurian), one of *Lichas*, (Lower Sil.), one *Proetus* (Subcarbonif.), and three of *Phillipsia* (Subcarboniferous).

10. *Observations on the Microscopic Shell-structure of Spirifer cuspidatus* Sowerby, *and some similar forms;* by F. B. Meek. 8 pp. 8vo. (From Proc. Nat. Sci. Philad., 1865, 275.)—Mr. Meek shows in this paper that the shell of the *Spirifer cuspidatus*, both of American specimens referred to this species, or closely related, and of an Irish specimen of this species received from Mr. Davidson, is clearly punctate, contrary to the decision of Dr. Carpenter. He then asks the question whether two types, a punctate having the internal characters of *Syringothyris*, and an impunctate, may not be included under the species, and suggests the importance of observations with reference to this question.

11. *Enumeration of Fossils collected in the Niagara Limestone at Chicago, Illinois, with descriptions of several new species*; by Prof. A. Winchell, and O. Marcy. 32 pp. 4to, with two lithogr. plates. From the Mem. read before the Bost. Soc. Nat. History, vol. I, No. 1.—This memoir treats of fossils of a limestone that had been referred by Mr. Worthen to the era of the Leclaire limestone, a conclusion sustained by the investigations here published. It also proves that the rock is of the age of the Niagara group of New York, but not necessarily of the upper part as had been suggested by Prof. Hall. The memoir closes with a note stating that Professor Hall has relinquished to the authors all claims upon two species described in it for which Mr. Hall had given names in a paper published, after the memoir had been read, in the Report of the Regents. Such an arrangement is bad for science as it sets aside the law of priority—which law must regard strictly time of publication.

12. *Mineralogische Notizen;* by F. Hessenberg. No. 7. 46 pp. 4to, with 3 plates. Frankfort, 1866. (Christian Winter).—Contains excellent measurements and figures of Calcite from Iceland, Hessenbergite, Carnallite, Biotite from Vesuvius, Clinochlore of Zillerthal, Sphene, Titanite, Topaz, Gold, with an index to the seven memoirs which have been published.

13. *The Geology of Tennessee;* by J. M. Safford, A.M. Part I. Physical Geography. 124 pp. 8vo. Nashville, Tennessee, 1861.—Professor Safford commenced the publication of his work on the Geology of Tennessee in 1861, but was compelled to suspend it by the war, after printing this introductory chapter, which only just now has been issued. It treats

very fully of the remarkable topography of the State. We trust that the geological survey and its publications will soon be resumed under Professor Safford. There is no one in the country better fitted for the work.

14. *A Catalogue of the Palæozoic Fossils of North America;* by B. F. SHUMARD, M.D. Part I, Echinodermata. St. Louis, 1866.—Our notice of this valuable work is unavoidably deferred.

15. *Professor Oppel's collection of Jurassic Fossils of Europe and Great Britain.*—By the recent death of Albert Oppel, Professor of Geology and Paleontology in the University of Munich, (of typhoid fever, at the age of 34 years, on the 23d of December last), it has become necessary to his family to sell his very large collection of fossils; all his little fortune having been spent on his education and his various geological journeys. We learn from Mr. Louis Sæmann of Paris (6 Rue de Mézières), who speaks highly of the collection, that it is offered for 10,000 Rhenish florins—4000 to 5000 dollars, and that it is well worth this sum.

III. BOTANY AND ZOOLOGY.

1. *Natural History Transactions and Journals*, considered by the President of the Linnæan Society.—Keeping up the excellent custom which he established upon his accession to the chair, of annually addressing the Linnæan Society, at some length, upon some important topic *apropos* to its pursuits, Mr. Bentham last year (at the Anniversary meeting, May 24, 1865,) took a survey of the Transactions and Proceedings of Learned Societies, and the Journals devoted to Natural History or containing zoological and botanical papers. Not pretending to give a complete bibliography, he nearly confines himself to the libraries of the Royal and Linnæan Societies, brought together at Burlington House. But still the subject is so extensive that, after filling over 60 pages of his printed address with an account of the continental publications of this sort, he is obliged to omit, almost wholly, those of Britain and of America, deferring them, as we trust, to another year. The account is replete with valuable information and excellent suggestions; and we are confident that we do good service to botanists and zoologists generally in directing their attention to a discourse of such practical interest. The latter part of the address discusses at some length the advantages and disadvantages of union or separation of sciences as pursued by learned societies, and in the publication of Transactions and Journals; as well as the different methods which have been proposed or adopted with the view of obviating or diminishing inconveniences and evils which are gravely felt. The Academy in early times embraced Science, Literature, and Art; but these have now, for the most part, been distributed to three separate bodies or branches.

"In the great centers of learning the division of labor has not stopped here. Moral and political sciences have almost universally formed either a distinct section of science, or an independent branch of learning between science and literature. Mathematical and Physical Sciences (Astronomy, Mathematics, Physics, and Chemistry), often associated with Natural History, and still in some Transactions and Journals even included in the general title of Naturkunde, Naturwissenschaften or Sciences Naturelles, have in other cases been quite separated. Geology is the next to be cut off; and Zoology has parted with Botany; and lastly, independently of the numerous associations for the practical application of Natural Science, we have seen separate societies with their Transactions, as well as Journals, for Ornithology, Ichthyology, Entomology, Paleontology, Histology, &c. Men have thus been encouraged to restrict their observations to very limited classes of beings, and to generalize upon the very insufficient data thus obtained, with the same inconveniences which resulted at the outset from generalizing upon observations made in a limited territorial area. Reaction and an attempt at reconcentration have in some instances been the consequence; and it is now a great practical question, which has agitated many academical bodies, and which deserves our own serious consideration, how far we should connect or separate them in our meetings and publications."

On the one hand there is the impossibility, except in a few great capitals, of supporting several special societies, even if the division were most useful to science; on the other there is the great inconvenience of a mixture of physical, metaphysical, and biological papers in the same volume, and the hard fate to the botanist or zoologist of having to buy and to load his shelves with bulky volumes or sets for the sake of a few articles upon the subject he studies. A partial and the only obvious remedy for this,—one which has been generally acted on of late years by botanists at least,—is for the author to secure a reasonable number of extra copies of every considerable paper he contributes to a scientific association, for distribution among his distant fellow-workers, or when this is too expensive to place a small edition on sale. Every scientific society doubtless would, or should, favor this. The American Academy of Arts and Sciences formerly provided every contributor with 100 copies of his memoir, with a view to their immediate and gratuitous distribution among those who especially require them. It now gives 50 extra copies to the author, and retains an equal number from which to supply separate demands. And an author is allowed to print from the types as many more copies as he wishes, at the bare cost of press-work and paper. This Academy publishes memoirs upon all departments of science, and in the same volume or series; but the provision for detached copies is just as requisite in the case of societies which, like the Linnæan, are restricted to Zoology and Botany. Botanists cannot afford room nor purchase-money for zoological matter; and even the different departments of descriptive zoology are now almost independently pursued.

"With regard to the Transactions themselves," Mr. Bentham remarks that, with a view to larger usefulness, "various devices have been resorted to, by which those of the members who consider themselves as patrons or general cultivators of science could exhibit the whole on their tables and shelves as one complete work, whilst the laborers in science might select separate portions without the appearance of being fragments only. Separate volumes, series, parts of volumes, &c., have been devoted to the principal branches; or, again, every separate paper, however short, has its separate title and paging, although stitched up into volumes, with a general title: or a certain number of copies of each paper are printed off with a separate title and paging for separate sale. In some Continental Transactions the separate paging of short papers is carried to such a degree as to entail all the inconveniences of a series of detached pamphlets. The double paging of the separate and of the continuous copies, on the other hand, produces much confusion in quoting references. The most convenient course pointed out by experience, seems to be that, in quarto Transactions including a diversity of subjects, the papers should be separable; but that each should bear an indication of the Transactions and volume from which it is taken; retaining at the same time the original paging in all separate issues, whether of authors' copies or for sale." Where the memoirs truly constitute volumes, it is far better, we think, that the paging should continue unbroken through the volumes. In the Smithsonian Contributions, to be sure, the papers are separately paged; but their collection into volumes is in this case rather incidental. In any case, not only should the original paging of a memoir be retained in the separately issued copies, but they should bear no other. Double paging is very troublesome in reference.

We would further suggest to authors the great convenience to citation and reference of what may be called *catch-titles* to papers of descriptive botany or zoology, consisting of a prominent word or two, by which the paper may be succinctly referred to.

In conclusion we note that the President of the Linnæan Society, having formerly employed the word *biology* in the sense nearly of physiology, now, following the recent lead of the British Association, uses it in the sense of zoology and botany (in their widest sense) combined. *Natural History* (an unfortunately-chosen word in the first instance) includes at least mineralogy, and *natural-historical* is an unmanagable adjective, *Biology* and *biological* are appropriate words in this sense, and supply just what is much wanted. A. G.

2. *Flora Brasiliensis.*—A new issue of von Martius's great work, dated Dec. 1865, consists of fasc. 39 and 40, accompanied by Table of Contents and Order of arrangement of the Monographs of the forty *fasciculi* now published, with an Index of the Genera, &c. In fasc. 39, that excellent collaborator Dr. Eichler, in continuation of fasc. 38, gives the *Capparideæ*, *Cruciferæ*, *Papaveraceæ*, and *Fumariaceæ*, the last two orders comprising each only a single species naturalized in Brazil. They serve, however, to introduce, 1st, a note in which Dr. Eichler, with good reason excludes *Tovaria* from the *Capparideæ* and refers it to the *Papaveraceæ*, and 2d, a dissertation upon the morphology of the flower of *Fumariaceæ*, &c., of which we give a separate abstract. There is a full synopsis of all the South American species of *Cleome* and of *Capparis*, newly arranged. Fourteen plates illustrate the first two orders. In fasc. 40, the veteran editor gives an article on the uses of the *Apocynaceæ*, of which the most interesting item is the account of the new tonic febrifuge furnished by the bark of *Geissospermum Vellosii*; and a new collaborator, Dr. Progel, contributes the *Gentianaceæ*. A. G.

3. *Morphology of the Andrœcium in Fumariaceæ.*—In his *Excursus Morphologicus*, above mentioned, Dr. Eichler enumerates five different theories, which have been proposed in explanation of the peculiarities of the Fumariaceous flower, viz: that of De Candolle, the earliest, that of Bernhardi, that of Gay, and the same as improved by Krause, and that of A. Gray. Neither Bernhardi's nor Gay's view would now be likely

to engage attention; and the question is narrowed down to the two remaining, the first and the latest proposed. The difference relates to the stamens only. In the Candollean hypothesis, which has been generally received, the six stamens present in *Fumaria*, *Dicentra*, &c., are reckoned as four, one before each petal, the stamen which belongs before each inner petal being supposed to be divided into two half-stamens, and so separated as to be placed before the outer petals, one on each side of the unaltered stamen, and usually combined with it into a triantheriferous filament. According to the other view, the six stamens answer to two, viz, those of the first stamineal circle, and the augmentation by which three appear in the place of one was referred to *deduplication*, more properly termed *chorisis*, the suggested analogy being that of a trifoliolate leaf. In the original statement, the writer ventured to "presume that the lateral stamens would be found to arise" thus. Several years later this was confirmed by the late M. Payer, by observation of the development of the andrœcium. Equally were the three stamens of the phalanx found to originate from one semilunar protuberance, before an outer petal, by Dr. Rothrock, then a botanical student at Harvard University. His observations were published in the summer of 1863, in the Proceedings of the Boston Society of Natural History, ix, p. 246. Dr. Eichler, in the recent number of the *Flora Brasiliensis*, also in the Regensburg *Flora*, has demonstrated this anew, and illustrated the common origin of the three members of the phalanx in a manner which would appear to be conclusive. Moreover, since the commencement of the present year, Dr. Buchenau of Bremen has published in the *Flora* his observations upon the development of the flower of *Fumaria officinalis*, with figures, clearly showing the same thing. The supposition of the common origin of each set, which the symmetry and structure of the blossom naturally suggested, having been confirmed by four independent investigators, must be held as established, until called in question by other direct observations. Dr. Eichler intimates that the view which he confirms was originally imperfect in not explaining why the carpels stand opposite the stamineal phalanx. But it was, perhaps, sufficiently obvious that the second circle of two stamens, necessary to complete the full symmetry of the flower, was suppressed. In one of his figures, illustrating the formation of the andrœcium in a *Corydalis*, Dr. Eichler exhibits a slight protuberance before each inner petal, answering to the second set of stamens, but which never develops farther. Dr. Eichler's next point is very neatly made. He wishes to explain why the lateral stamens should have only unilocular anthers. The analogy of a trifoliolate leaf is here at a loss. But Dr. Eichler ingeniously supposes the lateral stamens to be homologous to the stipules of the stamineal leaf; and each lateral stipule, being a dimidiate organ, may be expected when antherimorphous to give rise to a dimidiate anther. We had paid no regard to *Hypecoum;* but we should have inferred that the normal bilocular stamen before each inner petal represented the second dimerous verticil of the andrœcium, which is suppressed in the rest of the order. But Eichler, like Payer (both without sufficient exemplification of the process of development), consider them to be here formed by the confluence of the lateral unilocular (or stipular) stamens on each side into one bilocular stamen.

The Cruciferous flower is illustrated by Eichler in detail, and is explained as dimerous throughout (as in *Fumariaceæ*), except as to the corolla, which is tetramerous and diagonally cruciate, the petals therefore alternating with the sepals; the stamens as belonging to two binary verticils: first, the short ones which are lateral, second, the two median pairs, each representing a single one divided into a pair by chorisis. The sole peculiarity of this view is in regarding the flower as binary rather than tetramerous in plan, with a remarkable exception at one verticil (which however, is not unparalled); and it has the advantage of completely homologizing the Cruciferous with the Fumariaceous flower, and of explaining the lower position of the shorter stamens; and the evolution of the stamens is said accord with this view, while it demonstrates the common origin of the members of the pairs of longer stamens. The polyandry of two species of *Megacarpæa* is of course attributed to chorisis. And the Capparideous flower, in the *Cleome* tribe, follows the same rule, only with more frequent increase of the median set of stamens, and sometimes of the lateral stamens also, as Dr. Eichler's observations upon the organogeny of *Polanisia* appear to show. We presume that Dr. Eichler's observations may be thoroughly relied upon; and his exposition is especially clear and neat. A. G.

4. *Flora Vitiensis: a Description of the plants of the Viti or Fiji Islands, with an account of their History, Uses, and Properties;* by BERTHOLD SEEMANN, Ph.D., F.L.S., F.R.G.S., &c. London: Lovell Reeve & Co. Parts I–III, 4to; plates 1–30, including a map of the islands, and a pictorial view. 1865.—Dr. Seemann, a German botanist naturalized in England, was in the Pacific twenty years ago as botanist in the cruise of the Herald, the results of which were published in a fine 4to. volume. A few years ago, when *Ebenezer Thakombau*, one of the chiefs and self-styled king of the Feejee Islands, proposed to cede these islands to Great Britain, and Col. Smythe was commissioned to visit them and investigate their condition, Dr. Seemann was appointed to accompany him and to report upon their vegetable productions and resources (see this Journal, vol. xxxv, p. 446). The collection of plants made during this investigation, is the basis of the materials of the present Flora, to which several smaller collections, made during the visit of surveying vessels under Belcher, Denham, and Howe, and later by Dr. Seemann's former assistant Mr. Storck, have also contributed. The more extensive collection made in the U. S. South Sea Exploring Expedition under Commodore Wilkes, has not come directly under the author's survey, although many specimens are in the Kew herbarium. The work is to be comprised in ten parts, each of 40 pages of letter-press and 10 colored plates, all in the excellent style which characterizes the late Mr. Reeve's scientific publications; the materials elaborated with Dr. Seemann's accustomed care and ability, and the drawings from the pencil of Walter Fitch. The pages of the volume are enriched with those personal observations of the author upon the living plants, or their useful products, which give to such a work peculiar value; also by appended monographs or sketches of other Polynesian plants. The third part, issued at the beginning of the present year, nearly completes the *Polypetalæ*. We cannot here venture upon any of the numerous remarks

which this work naturally suggests to one who has written almost all that had heretofore appeared upon the phænogamous botany of the Feejee Islands. Much that is new and interesting is brought to light by Dr. Seemann; and still more doubtless remains. An enumeration of the plants figured would naturally include the most interesting accessions. They are a new *Polyalthia; Hibiscus Storckii*, too near *H. Rosa-Sinensis; Pimia rhamnoides*, a new genus allied to *Commersonia; Græffia calyculata*, a new Tiliaceous genus; two new species of *Elæocarpus*, one of them (*E. Storckii*) with strikingly large and showy, bright red flowers; *Calysaccion tinctorium*; *Pometia pinnata*, Forst; *Smythea Pacifica*, a new Rhamnaceous genus, different from Ventilago in its samaroid dehiscent fruit; *Stemonurus Vitiensis; Storckiella Vitiensis*, a remarkable new genus allied to *Cassia; Serianthes myriadenia* of Planchon; *Eugenia gracilipes*, A. Gray, and *E. Grayi*, n. sp.; a new species of *Spiræanthemum*, A. Gray; *Nothopanax multijugum* (*Paratropia*, A. Gray); *Nesopanax* and *Bakerai*, both new Araliaceous genera; the latter 14-androus, the former polyandrous, like the next, viz. *Plerandra*, of which a second species is here figured; a new *Loranthus* and a new *Lindenia*, both showy; a third *Dolicholobium*, but too like one of the old species; *Gardenia Vitiensis; Blumea Milnei; Paphia Vitiensis*, a very showy-flowered new Vaccineous genus; *Ardisia grandis;* and a charming new Apocynaceous plant *Carruthersia scandens*, evidently named for the excellent assistant Curator of Botany at the British Museum. The letter-press of the later plates not yet published. Dr. Seemann here, as well as in his Journal, propounds his novel view that the distinguishing difference between *Araliaceæ* and *Umbelliferæ* lies in the valvate corolla of the former. Æstivation gives valuable characters, especially for genera; but it will hardly be found stable or deemed important enough to transfer *Hydrotyle* to *Araliaceæ* and *Aralia* itself to *Umbelliferæ*, as Dr. Seemann proposes. A. G.

5. *Botany of Australia.*—While the *Flora Australiensis* is steadily advancing, partly through materials and notes forwarded to Kew by Dr. Müller, the labors of the latter in Australia do not flag, and the Colonial Government of Victoria is as active and liberal as ever in promoting publication. We have now before us the following recent volumes of Dr. Müller's publications:

Fragmenta Phytographiæ Australiæ, the fourth volume, 1863–4, with numerous plates, 8vo.

The Plants indigenous to the Colony of Victoria, a second volume, entirely of "Lithograms" with explanatory letter-press, carrying on the plates from 13 to 71, besides 7 supplementary plates, royal 4to, 1864–65. The analyses are very full, the drawing excellent, and the lithography would do credit to almost any country. The descriptive letter-press is deferred to give precedence to the corresponding volumes of the *Flora Australiensis*, which these plates will fittingly illustrate. A. G.

6. *Analytical Drawings of Australian Mosses;* edited by Ferd. Müller. Fascicle I. 8vo. 1865. Twenty plates, with brief explanations of the figures.—The species illustrated have been published by Dr. Hampe of Blankenburg (Brunswick), and the illustrations drawn under Dr. Carl Müller's care, at Berlin, but lithographed and printed at Melbourne. The plates are remarkably good, the typography beautiful.

7. *The Vegetation of the Chatham Islands, sketched by Ferdinand Müller.* Melbourne, 1865. 86 pages and 7 plates.—"If under any circumstances a deep interest is attached to isolated islands, which harbor perhaps the only remnant of the vegetation or animal life of countries ages ago sunk beneath the ocean, this interest cannot be otherwise than most vividly excited in regard to the Chatham Islands, inasmuch as this little group is the last eastward of New Zealand, no further land existing under those latitudes in the wide interjacent oceanic space until the west coast of South America is reached." They had been visited by Dr. Dieffenbach and others. But the present exploration was made by Mr. Henry H. Travers, at the expense of his father, Judge Travers of Canterbury, New Zealand, to whom this interesting little book is dedicated. Of the 129 indigenous species of plants here enumerated and discussed 42 are dicotyledonous, 20 monocotyledonous, and 67 cryptogamous. Only 9 phanerogamous species are peculiar to the group, and one (*Myosotidium nobile*) generically peculiar; nearly all the rest are found in New Zealand, as was to be expected. In the limitation of species, Dr. Müller takes very comprehensive views, as is exemplified in the reduction of nearly a dozen New Zealand *Epilobia*, admitted even by Dr. Hooker as probable species, to *E. tetragonum* of Europe. At the same time he reiterates the expression of his entire confidence in the real objective distinctness and permanent stability of genuine species, insisting that their perfect discrimination is far from hopeless, and that their true distinction never rests on solitary or on faint characters or upon such as admit of exceptions! We admire this hopeful spirit, especially in a botanist of such large experience.

In the conclusion of his preface, Dr. Müller appeals to missionaries, as enjoying unparalleled facilities for scientific researches in lands mainly occupied by savages; and, rendering due acknowledgements for what has already been done by them, adds that, "if the devoted men who carry abroad the *word of God* were more generally cognizant how often it is alone as yet in their power to reveal also many of the marvellous *works of God*,—of which no spot, however desolate and lonely is devoid,—the universal history of nature would be much earlier written, and on the divine labors of the mission throughout the globe would be shed an additional brilliant lustre." A. G.

8. *Revision of the genus Cousinia. Uebers. Zusammenstellung der Arten der Gattung Cousinia Cass.;* von Dr. AL. BUNGE.—One of the Memoirs (now separately printed) of the Imperial Academy of Sciences of St. Petersburgh, issued 1865: the preface in German; the systematic part wholly in Latin. The Oriental Thistle-like genus which Cassini dedicated to the philosopher Cousin, founding it on a single species, increased by DeCandolle, thirty years ago, to thirty-four species, is now in Professor Bunge's systematic revision augmented to 126 species. It is the prominent and characteristic genus of the Assyrian and Caspian region. A. G.

9. *Krok, Monograph of Valerianeæ.* Part I, *Valerianella.* From the Roy. Swedish Acad. Sciences of Stockholm. 1864, pp. 102, with 4 plates of analyses, large 4to.—The prefatory matter is Swedish; but all the systematic part in Latin. An elaborate monograph of *Valerianella*, kept

distinct from *Fedia:* 47 species are described, arranged under five main sections, the fifth, *Siphonella*, Torr. & Gray, being acknowledged as wholly intermediate between *Valerianella* and *Fedia.* Analytical illustrations are given in the plates of all the species, except the rare *V. Nuttallii*, which is probably only a state of *V. longiflora.* A. G.

10. *Scolopendrium officinarum*, the Hart's-Tongue Fern of Europe, was first made known as an American plant by Pursh, in his *Flora*, 1814, who records it as growing "in shady woods, among loose rocks, in the western parts of New York, near Onondaga, on the plantations of J. Geddis, Esq. This species I have seen in no other place but that here mentioned, neither have I had any information of its having been found in any other part of North America." Nuttall, indeed, in his Genera, 1818, gives the habitat, "In the western parts of the State of New York, in the crevices of calcareous rocks, beneath the shade of the Hemlock Spruce (*Abies Canadensis*) and accompanying the *Taxus Canadensis* or American Yew;" his appended *v. v.* implying that he had himself seen it alive. No specimen of his is extant; but from some source, not now recollected, it would appear that his station was "near Canandaigua," which is nearly one hundred miles west of Onondaga. Between 30 and 40 years ago, the late William Cooper discovered the locality at Chittenango Falls, 20 or 30 miles east of Onondaga; and this has remained the only really known station of the plant in North America, until the recent discovery of another (in 1857) at Owen Sound on Lake Simcoe, by Prof. Hincks of Toronto.

We have now to announce the fortunate discovery of a new station in the United States,—one which, if it be not the very locality of Pursh's original discovery, cannot be far from it, being within a few miles of Onondaga, and upon ground which in Pursh's time must have been included in that township. The discovery was made, in March last, by Lewis Foote, Esq., of Detroit, in the township of DeWitt, upon the line of the Syracuse and Binghamton Railroad, about five miles from Syracuse. It was found in a deep rocky ravine, where, upon a hasty survey, it seemed to be plentiful. We are indebted to the lucky discoverer for a dried specimen. A. G.

11. *Musci Boreali-Americani, sive Specimina Exsiccata Muscorum in Americæ Republicis Fœderatis detectorum; conjunctis studiis* W. S. Sullivant et L. Lesquereux. Editio Secunda. Columbi Ohioensium, sumptibus Auctorum, 1865.—The first edition of this most important collection was issued ten years ago, and the sets were almost immediately taken up, as they well might be. For their actual cost—thanks to Mr. Sullivant's liberality and strong desire to encourage a favorite study—was fully twice the price at which they were offered. An account of the work will be found in this Journal for May, 1857, vol. xxiii, new series, p. 438. To this notice we would refer those interested in Muscology, remarking that the statements there made are equally true (*mutatis mutandis*) of the second edition now before us. This bears the date of 1865, the tickets and other letter-press having been printed a year ago. But the sets are only now issued (April, 1866), other engagements having prevented Mr. Lesquereux from giving his whole time during the past year to completing their preparation, which has been a long

and severe undertaking, requiring the microscopical examination of an immense number of specimens, and the patient selection and distribution of the elaborated materials by which each set is made so complete.

This new issue is not a mere reproduction of the former, but is much augmented. While that contained a little over 400 species or marked varieties, this contains 536. Those of the old tickets which are unchanged are reprinted with a new sequence of numbers, which was unavoidable in order to bring the new accessions into their proper places. The novelties which enrich these sets are partly Californian, contributed mainly by the zealous Bolander; partly from the Rocky Mountains, by Mr. E. Hall, and many new eastern species, which have been detected by Messrs. James, Peck, Austin, Clinton and Ingraham, as well as by Mr. Lesquereux himself. A few of these are necessarily rather scantily represented; but the specimens are usually very abundant and choice. In this as in other respects the work is, so far as we know, wholly unrivalled. From data known to us we estimate that the present issue has cost fully $100 per set or copy. They are sold at $35 in gold, or £7 sterling, or 175 francs. Each copy is accompanied by an 8vo pamphlet of 96 pages, being a reprint, in convenient form, of all the tickets, characters of new forms, and index. Applicants will address Mr. Leo Lesquereux, at Columbus, Ohio. A. G.

12. *Mind in Nature or the Origin of Life and the Mode of Development of Animals;* by Prof. H. J. CLARK.—A brief notice of this book appeared in the last number of this Journal, indicating the nature of the work, and some of the leading subjects discussed. To present an adequate review would require a more extended article than is consistent with the space allotted in this Journal.

The first five chapters are devoted chiefly to discussions of the various modes of reproduction and increase among animals, and the analogous phenomena of the regeneration of lost parts, and the persistence of "vitality" in decomposing tissues.

In the first chapter the curious structure and habits of the lowest Rhizopods, *Amœba*, *Difflugia*, &c., are very clearly presented, showing that even in these, the simplest of animals, the functions of prehension, digestion, circulation, locomotion, and a certain kind of nervous sense exist, even while the whole organism apparently consists merely of a minute drop of semi-fluid matter without walls or definite form.

The subject of spontaneous generation is then discussed, and the recent interesting experiments of Prof. J. Wyman are brought forward to prove that this manner or origin of life is one in actual operation.

From those experiments, published in this Journal, July, 1862, he draws conclusions far broader than their author felt justified in doing, and which do not appear to us logical, even if the spontaneous origin of these low forms of life be admitted. On this point remarks have been made by Professor Dana, on page 286. It seems premature, at least, to consider spontaneous generation as actually established by such experiments. If this be the true explanation of the phenomena, why should not the living forms have appeared equally in *all* the flasks? for in some cases they did not appear at all, while in other similar ones they appeared in great numbers. Admitting that the treatment was such as to have utterly destroyed all germs existing in the fluids, and the air admitted into the flasks, can it be said that we know enough about the physical structure and porosity of glass to say that the germs of these almost infinitely minute organisms may not even penetrate its substance? Physicists claim and experiments prove the porosity of all solid bodies, and we do not yet know the limits to the minuteness of animate beings or their germs.

In this connection it should not be forgotten that the power of the best microscopes is limited, and that objects of less than a determinable size, are still invisible. Lines ruled on glass by mechanical means, cease to be resolvable by the best lenses when the distance between them approaches ·00001 of an inch, and there is no good reason to suppose that living germs may not exist far more minute than this.

We have dwelt upon these sources of doubt with regard to such experiments because the leading arguments of the first part of Prof. Clark's work are based almost wholly upon the results of Prof. Wyman's experiments. We would not be understood as asserting that the spontaneous origin of living beings under such circumstances is impossible; but only that we need additional evidence.

Among the most interesting portions of the work are the explanations of the origin and early condition of ovarian eggs, and the changes they undergo as development proceeds. The egg considered as the lowest condition of animal life is shown to consist at first of a mere spherical aggregation of albuminous and oily matters, like a simple cell, but with a bipolar character, i. e. the albumen concentrates at one side of the spherical mass, and the more oily portion of the yolk on the opposite side. While the eggs of Infusoria never attain a more complicated structure than this; in those of higher animals a further change takes place resulting in the formation of the so-called germinal vesicle and germinal dot, which is to be considered only a continuation of the process commencing with the imperfect separation of the albumen from the oily portion in the lowest form of the egg, the difference being only in degree and not in kind. The egg is regarded as an *animal* from the first, but comparable only to the lowest forms of infusorial life. The continued development of the egg or embryo is shown to depend more or less upon secondary causes,—most so among the lowest animals,—and in this respect a comparison is made with those germ-like forms supposed to originate and develop *wholly* through secondary causes.

In this connection the structure of various Infusoria is finely illustrated, and the gradual advance in organization from *Amœba* and similar forms, through sponges, *Actinophrys*, *Polycystinæ*, *Zoöteira* and *Podophrya* upward to the higher Infusoria, is well shown; the object being to show the parallelism between the development of the egg and the zoölogical series, and that there is "no sudden transition from the *condition of an egg* to that of *an animal*." The change induced in the ovarian egg by *fecundation*, without which the egg, in general, cannot develop beyond a certain point, and has no independent life, is apparently not regarded as of so vital importance by Prof. Clark as by most writers, very little being said concerning it. To us this would appear to be the starting point of the new being as an independent existence, rather than the formation of the ovarian egg.

The third and fourth chapters, devoted to the phenomena of reproduction by budding, and by fissiparity, with the curious experiments in artificial division and grafting of Hydra, &c., cannot fail to interest every one. It is accompanied also by lucid descriptions and beautiful figures of Actiniæ, Stentor, Acalephs, such as Hydra, Aurelia, Coryne and Rhizogeton, the tape-worm, Myrianida, &c., which are seldom equalled in popular works. The author well illustrates reproduction without eggs, so well known among the lower animals, as accessory to ovarian generation; but these phenomena do not appear to us to lead any nearer to *spontaneous generation*, for in all cases a parent is necessary to vitalize the separated part, however minute it may be, and we cannot agree with him in comparing artificial division to "decomposition," either in the case of the *Hydra*, *Planaria* or *Amœba*. The latter "may be divided, and even divides itself, more minutely than the Hydra allows; in fact there is no conceivable limit to the minuteness with which it may be cut up," "and yet each subdivision moves and seizes its prey just as does the main stock from which it was separated."

The somewhat analogous phenomena observed several years since by Prof. Clark, in the muscular fibres of Sagitta, sheep, &c., and the ciliated cells of Aurelia, which separate during decomposition of the tissue and move about freely like low forms of Infusoria, are fully described in this connection, and the theory of the spontaneous origin of life in decaying matters is thus reinforced. Could it be shown that any of these detached and moving cells continue to live and either reproduce themselves or develop into any higher forms, the origin of life in the sealed flasks would be really accounted for. Otherwise we cannot agree with the author that "Amœba (and Rhizopoda in general) in one sense a one-celled animal, has scarcely a higher state of vitality than the decomposed sheep-muscle, or Aurelia-cells," (p. 99). Nor can we agree with him in comparing to the decomposing matter in the flasks an undeveloped hen's egg, depending though it may for its development upon heat and air, just as the hatched chick depends upon the same physical causes for continued life and growth, even if "not acted upon by this physical agent, *heat*, it would remain in a low state of vitality, perhaps as low as any decomposing muscle or tendon, and finally it would decay."

The statement that "in the *egg* we have an *uncomposed* substance, and in the decaying muscle we have an animal *returning* to its former *uncomposed* state," certainly does not do justice to the vital principle, latent though it may be, that exists in the egg and only needs the stimulus of heat and oxygen to give rise to the complicated organization of the chick. Nor does it agree with the author's previous statement (see p. 52) that "an egg is not to be looked upon as a distinct *body* which *preëxists* the animal, but rather that it is *the animal itself*, from the moment when it begins to form in the ovary of the parent." "The egg is merely the *first stage of growth of an animal*, and it is not separated from the succeeding phases any more than these latter are from each other." Certainly the condition and fundamental nature of the *egg*, cannot in any sense, be correctly compared to decomposing muscle.

The processes of digesting food and changing it into the living tissues of the body, whether of man or Amœba, is compared to the assumed change of decomposing organic matter in the sealed flasks to living organisms, and the question is asked, "why may not different kinds of animals arise from any decomposed matter?" If the vital force or life-giving principle, whatever it may be, can be shown to exist in such decaying matter, the origin of the organisms could be as readily understood as are the changes of dead food into the living body, under the influence of the vital forces, in the processes of digestion and nutrition. Until then we cannot admit that the comparison is a logical one. The discussion of the *primordial* condition of animals, or the condition in which they were *originally created*, whether in the egg or adult state, is one which may well excite attention, but which we will not here attempt to consider.

Part Second of the work is devoted to a consideration of the structure, relations, and classification of animals, and abounds with excellent descriptions and illustrations of the structure of species from the various classes, and is a very valuable addition to the few popular American works upon the structure of the lower animals. The portions relating to Infusoria and the lowest forms of other groups are particularly valuable. Most of the very excellent illustrations in this, as in other parts of the work, are original, and many are new. The author here adopts the four grand divisions of Cuvier, with modifications, and with many others believes that the Protozoa constitute a *fifth* division, as distinct from the others as those are among themselves, but he regards them as merging gradually into each other, as clouds that touch and mingle somewhat at their borders. The bipolar relations in the organization of all animals, and the *bilaterality* which is equally a fundamental feature of all, are well brought out and illustrated, and it is shown that this is as characteristic of *Radiata* as of the higher groups, and it is claimed, beyond doubt justly, that the more or less radiated appearance is subordinate to bilaterality.

Two chapters are devoted to an examination of various forms of the lower ciliated Infusoria, and to comparisons between them and low vegetable forms, ciliated plant-spores, &c. The *Volvox* is not neglected in this connection, and is left, as it were, suspended between the animal kingdom on one side and the vegetable kingdom on the other. Several new forms are described and figured, and much valuable information added to our knowledge of these beings.

A chapter is devoted to the structural features and characteristics of each of the five great groups, and in each there is much valuable and interesting matter, and many original contributions. The anatomy of Epistylis, Paramecium, Pleuronema, Dysteria, among Infusoria; Metridium and Cereus, Caudina and Asteracanthion among Radiata; Pectinatella, Fredricella, Ostrea, Helix and Loligopsis of Mollusca; is in each case illustrated by original figures and descriptions. The excellent figure (117) given as *Psolus phantapus* seems to us to represent rather *Cuvieria squamata* D. & K. as we have observed it when fully expanded in its native haunts. Possibly an error in the identification of the species has occurred here, but for the author's purpose either form would serve equally well.

The characteristic feature of Protozoa is stated to be *spirality* or *obliquity*, superimposed upon bilaterality. It would seem, however, to be a question whether spirality is not characteristic of *all life*, whether animal or vegetable, and is only more apparent in the Protozoa because not obscured, as in higher animals, by various other relations. The Zoöphyta (Radiata) are said to have "a type of organization in which the various organs repeat themselves, more or less, between the back and the abdominal mid-line of the body; that is to say, they are *laterally repetitive* on each side of an imaginary plane which divides the body exactly into right and left halves." This definition expresses the true relation of parts very accurately. We have hitherto employed a similar one in class lectures,—namely: that the type is characterized by the repetition of similar longitudinal segments or *homologous elements* on the two sides of a longitudinal plane, while in Articulates homologous elements of a different kind are repeated serially along the longitudinal axis.

The idea is precisely the same in each case. The Mollusca are compared in a similar way to the other groups thus:—"The Zoöphytes are from back to front, dorso-ventrally, polymerous; the Articulata are from tail to head uro-cephally, polymerous; and the Mollusca are *monomerous*."

By a detailed comparison between Protozoa and Zoöphyta, Protozoa and Mollusca, Protozoa and Articulata, Zoöphyta and Articulata, and Bryozoa and Zoöphyta, it is shown that there are no actual transitions from one of the five great divisions to another. Some of the curious mimetic forms and embryonic resemblances are illustrated, and in a later chapter some forms, considered as transitions from one *class* to another within the great groups, are described.

The third part of the book is devoted to a brief account of the development from the egg of various kinds of animals. It is here shown that each of the five great divisions has a distinct and characteristic mode of development and growth. The embryology of Podophrya, Paramecium and Stentor illustrates the process in Protozoa; Actinia and Holothuria in Zoöphyta; Lymnæa in Mollusca; Mystacides in Articulata; and Chelydra serpentina in Vertebrata. In connection with the latter the author, as in other parts of the work, lays personal claim to investigations made for and published in Agassiz's Contributions to the Natural History of the United States.

However much other naturalists may differ from our author in many details, and in his generalizations and conclusions, the work cannot but be welcome to every one who, in seeking the truth, desires to see every side of these questions fully and fairly discussed. In no other way can we hope ever to attain the fundamental truths in nature. A. E. V.

13. *The Urine in Health and Disease*, being an exposition of the composition of the Urine, and of the pathology and treatment of urinary and venal disorders; by ARTHUR HILL HASSALL, M.D., Senior Physician of the Royal Free Hospital, etc. 2d ed., 416 pp. 12mo, with numerous engravings. London, 1863 (John Churchill & Sons).—A thorough and complete work on the urine, illustrated by numerous beautiful drawings representing the crystallizations of urinary deposits, tissues, etc., as observed in the field of the microscope.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *National Academy of Sciences.*—The National Academy of Sciences commenced its semi-annual session in Washington, D. C., on the 24th of January last.

The following are the titles of the communications presented during the session:

"On the silver reduction process of Nevada, with statistical tables and metallurgical data, by Prof. B. SILLIMAN."

"On a new general method of volumetric analysis, by Prof. W. GIBBS."

"On sodium amalgam and its applications in saving precious metals, especially gold, by Prof. B. SILLIMAN."

"On the limits and character of the vision of American Soldiers as deduced by the Statistical Department of the Sanitary Commission, by Dr. B. A. GOULD."

"On the primary triangulation of the Coast of New England, by Prof. A. D. BACHE, Superintendent U. S. Coast Survey; communicated by J. E. HILGARD.

"On the relation of Language to Ethnology, by Prof. W. D. WHITNEY."

"On certain mineral districts of Arizona, by Prof. B. SILLIMAN."

"On California petroleum and the products of its distillation, by Prof. B. SILLIMAN."

"Observations on the Annular Eclipse of October, 1865, made at Lebanon, Ill., by Prof. STEPHEN ALEXANDER."

Biographical memoirs of deceased members of the Academy were read as follows: Of the late General Joseph G. Totten, Chief Engineer U. S. Army, by Gen. J. G. Barnard; of the late Prof. Benjamin Silliman, by Prof. Alexis Caswell; of the late Capt. James M. Gilliss, U. S. Navy, Supt. Naval Observatory, by Dr. B. A. Gould.

The office of Vice-president, made vacant by the resignation of Professor Dana (in consequence of the state of his health) was filled by the election of Prof. Henry.

Of the Committees appointed at the request of Departments of the Government to conduct certain investigations, that on Magnetic Deviations in Iron Ships, and that on Experiments in working steam expansively, reported progress.

The Committee on Uniform weights, measures, and coinage, made the following report, which was adopted by the Academy, and ordered to be communicated to the Treasury Department and to the Congressional Committee having charge of the same subject:

"The Committee are in favor of adopting ultimately a decimal system, and in their opinion the metrical system of weights and measures, though not without defects, is, all things considered, the best in use.

The Committee therefore suggest that the Academy recommend to Congress to authorize and encourage by law the introduction and use of the metrical system of weights and measures; and, with a view to familiarize the people with the system, the Academy recommend that provision be made by law for the immediate manufacture and distribution to the Custom Houses and States of metrical standards of weights and measures; to introduce the system into the post offices, by making a single letter weigh fifteen grams, instead of fourteen and seventeen hundredths, or half an ounce; and to cause the new cent and two cent pieces to be so coined that they shall weigh respectively five and ten grams, and that their diameters shall be made to bear a determinate and simple ratio to the metrical unit of length."

The next session of the Academy will be held at Northampton, Mass., commencing on the 7th of August.

2. *Note on Illumination of opake objects under the Microscope;* by H. L. Smith, Kenyon College.—In several scientific Journals of England, the little contrivance first described by me in the September No. of this Journal, 1865, is noticed and variously commented upon. With an apparent unwillingness to acknowledge any merit outside of themselves, the writers of these notices have dwelt especially upon certain *fancied* improvements, made by Messrs. Powell & Leland and Smith Beck & Beck, as the really valuable parts of the invention. Especially is this the case with the slight notice in the January number of the "Quarterly Journal of Microscopical Science," and the more extended one in the January number of the "Intellectual Observer," where the substitution of a glass plate for the metallic reflector, is spoken of in the highest terms. Now if my article had been read, these writers would have seen that this substitute had been tried, and abandoned by me. Even if it *is* an improvement and I have misjudged, still it is not original with the celebrated opticians who are so lauded for the invention. It is not true, as stated in the notice which is quoted from the "Reader" in the last number of this Journal, p. 283, that the metallic reflector cuts off half the pencil; an assertion which is also made in the "Microscopical Journal." Less than one-third, is amply sufficient to give a much stronger illumination than the whole of the glass substitute proposed; and with this great advantage, that the fog, or glare, which attends central illumination, may all be eliminated; and, upon diatoms especially, a vastly superior illumination may be obtained. The improved "Illuminators" are now furnished with an extra movable diaphragm above the illuminating reflector, which, although it diminishes the angle somewhat, greatly improves the definition, by prevention of irradiation when the object is very brilliant; it leaves however the whole angle effective for illumination. I certainly would be the last one to object to any *real* improvement which the English opticians might make; but do protest against being entirely ignored, as in the number of the "Microscopical Journal" for January, 1866, where a contrivance, already described by me, is so carefully alluded to, that no one would for a moment suppose that any credit was due except to Messrs. Powell & Leland, and Smith & Beck; the very slight allusion to the "American contrivance" being a disparaging one, and stating an untruth. How far Messrs. Powell & Leland and Smith & Beck are responsible for this does not yet appear. In justice I must except the notice in the Chemical News which is more candid. It is painful to be obliged to make these remarks, and most sincerely it is to be hoped that no further occasion will be given for complaint. England can well afford to be generous.

3. *New Eruption of Mauna Loa;* by Rev. Titus Coan. (Editorial correspondence, dated Hilo, Feb. 27, 1866.)—Another eruption has recently commenced on Mauna Loa. The light was first seen on the night of the 30th Dec., 1865, at the very summit of the mountain. From that day to the present the eruption has continued with varying intensity. Sometimes the light is quite brilliant, shedding a glow over all the higher portions of the mountain, sending down its reflection upon our

town and landscape, and throwing its ruddy sheen upon the clouds. In the day time the smoke goes up like the smoke of a great furnace.

It is not, however, at all times equally active, and occasionally we imagine that it has become extinct. But we are soon undeceived by new manifestations, sometimes appearing as if the molten lavas were being ejected high in the air.

As yet there has been no lateral outbreak and no longitudinal flow. The eruption is evidently in the vast summit crater Mokuaweoweo, where Wilkes encamped, and the action has been confined to this point.

We have looked for an overflow, or for a cleft in the walls of the crater for the discharge of the lavas, but none may occur. The crater is so deep and ample that the active forces of the eruption will, probably, be expended in the abyss where the fires are now raging.

During this summit eruption we have noticed Kilauea with great interest, and have had numerous reports from there. We do not get evidence of any sympathy between the two craters. Old Pele is, as usual, with no apparent increase or diminution in her activity.

We have had much thunder and lightning this winter, with tempestuous winds, hail and snow. The falls of snow upon the mountains have been frequent and heavy, extending almost to their bases.

3. *American Association for the Advancement of Science.*—We observe, with pleasure, that measures are in progress to revive this Association after a suspension of its operations for nearly six years. An invitation has been tendered to the Association, by the citizens of Buffalo, to make that city the place of holding the first meeting after the revival; and this invitation has been accepted in behalf of the Association by its President, Dr. F. A. P. Barnard, of Columbia College, with the sanction of the Standing Committee. According to present expectation, the meeting will take place about the middle of August; but should the threatened epidemic become seriously prevalent in the country, a later date will be fixed on. When the time shall have been positively determined, circular notices will be issued to the members, by the permanent Secretary, Prof. Lovering, of Harvard University.

The Association, previous to the discontinuance of its annual meetings, proved itself a useful means of promoting a spirit of scientific inquiry in the country, and awakening a popular interest in scientific progress. The suspension of its operations, a misfortune in itself, was one of the consequences of the greater misfortune in which the whole country became involved by the attempt, now at length happily baffled, to overthrow the government. We anticipate both pleasure and profit to the votaries of science in the country from the renewal of those periodic reunions, which always brought with them a social interest superior perhaps to the scientific; and we cannot but hope that the Association may prove to some extent instrumental in healing the wounds created by civil war.

4. *On Magnesia in hydraulic cements;* by H. St.Claire Deville.—At the session of the Paris Academy of the 4th of December last, Deville showed that magnesia, kept for some weeks in pure water sealed up so that the air is excluded, combines with water, and forms a hard and compact crystalline translucent substance, consisting of magnesia 68·3,

water 31·7, or a simple *hydrate of magnesia.* He has made copies of medals, like those of plaster, from magnesia thus hardened under water. Balard's magnesia, calcined at a red heat, he says, has hydraulic qualities which are manifested with a rapidity that is most admirable; though when calcined at a white heat, the property is almost wholly lost. A mixture of pulverized chalk or marble and magnesia in equal parts furnishes with water a paste which is a little plastic, but which after being some time in water affords products "of extreme solidity," and he purposes to use the mixture for making busts of artificial marble. Plaster mixed with magnesia diminishes the hydraulic properties.

On calcining dolomites rich in magnesia at a low temperature, below red heat, the powder solidifies under water very rapidly, and gives a stone of a hardness which is "really extraordinary." If calcined at a somewhat higher temperature so that a little lime is produced in the mass, the hardening still takes place, but the lime forms veins of pure aragonite in the mass, free from magnesia, the fibers of which are seen to be distinct hexagonal prisms under the microscope. When the dolomite is heated to redness, and all the lime is reduced to the state of quicklime the hydraulicity is lost. In the above results, the magnesia is the hydraulizing ingredient, it soldering together the particles of carbonate of lime exactly as in the mixture of magnesia and marble dust.

The magnesian materials obtained by Deville have been exposed for a long time to the action of sea water in the port of Boulogne by Mr. P. Michelot, and have stood perfectly the trial. Deville observes that the results explain the successful trials of Mr. Vicat from mixing magnesia with marine cements. They lead him to hope that we may thus find extensive use for a substance which, through the admirable processes of Mr. Balard, is now furnished at a very low price, and in indefinite quantities.—*Les Mondes*, Dec. 7, 1865.

5. *Meteorites of Aumale, Algeria.*—A fall of meteorites took place on the 25th of August last between 11 and 12 M., in Algiers, in the district of Aumale, and 50 kilometers north of that village. The mass taken to Algiers weighed 6·8 kil., but the whole meteorite is estimated at beyond 25 kil.

On the same day and hour, a second meteorite fell in the region of the tribe of Senhadja, "fraction des Beni-Ouelben," 4800 meters N. 12° E. from the place of fall of the former, in 0° 20′ E. and 36° 27′ N. This second specimen was about as large as the first, and was like it also in having approximately the form of a parallelipiped.

The meteorites consist mostly of a fine-grained ash-gray stony substance, scratching glass easily. In this base small metallic grains are disseminated, part composed of nickeliferous iron; numerous of a yellow bronze color, acting like monosulphuret of iron; some of brass-yellow possessing the characters of ordinary pyrites; black grains of chromiron in regular octahedrons with truncated edges. The specific gravity of the meteorite is 3·65. One marked peculiarity is the presence of salts soluble in water, consisting of chlorid of sodium with some carbonate of soda. The thin crust of the meteorite is dull black, slightly rugose. Within the mass there are planes, nearly flat, which are striated evidently by the friction of the two surfaces.—*Ib.*, Feb. 15.

6. *Large mass of meteoric iron.*—A mass weighing 8287½ lbs. (3,750 kil.) was received last year at the British Museum from Australia.—*Ib.*, Aug. 10.

7. *Remains of the Post-tertiary Mastodon or Elephant in Montana.*—The "Montana Radiator" states that a large molar tooth and a tusk of an elephantine animal have recently been found in the "claim of Dr. Fales" in Last-Chance Gulch opposite the end of Broad street, seventeen feet below the surface, and four feet from the rock beneath. The tusk is 15 feet long, and 4 feet from the smaller extremity it is 27½ inches in circumference; it was found 25 feet farther up the gulch than the tooth.

8. *Artificial Ivory.*—The best imitation of ivory—a kind now much used—is made by dissolving either caoutchouc or gutta-percha in chloroform, passing chlorine into the solution until it has acquired a slightly yellow tint, washing it well with alcohol, then adding, in fine powder, sulphate of baryta, sulphate of lime, sulphate of lead, alumina or chalk, in quantities proportioned to the density and tint desired; then hardening it, and finally subjecting it to heavy pressure. An ivory-like substance is thus made which is of great hardness and will receive a high polish.—*Les Mondes*, Nov. 9, 1865.

9. *Solution of Silk.*—A solution of silk may be made by boiling it with a concentrated solution of chlorid of zinc over an excess of oxyd of the same metal, until it no longer discolors the tincture of litmus. By dialysis, the silk may be obtained again in a colorless inodorous form.—*Ib.*, Jan. 4.

10. *New artificial light for photography.*—Mr. Sayers, of Paris, obtains a light almost equal in power to that of magnesium, and much cheaper, from the combustion of a mixture of 24 parts of well-dried and powdered nitrate of potash with 7 of flowers of sulphur and 6 of red sulphuret of arsenic. The mixture costs only 12 cents a kilogram.—*Ib.*, Jan. 4.

11. *New test for distinguishing Cane sugar from the sugar of Grapes.*—H. LEPLAY observes that the sugar of grapes blackens bichlorid of carbon, while cane sugar does not.—*Ib.*, Dec. 14, 1865.

12. *Petroleum in Archangel.*—A source of petroleum has been found in Russia, in the government of Archangel, near a streamlet which runs into the river Betchora. The oil taken from it can be conveniently brought to the interior of the empire by the ordinary routes to Kama, and from there to the different regions along the Volga.—*Ib.*, Dec. 7, 1865.

13. *Petroleum of Zante.*—A company has been formed for working the abundant sources of petroleum in Zante, one of the Ionian islands, sources which have been flowing, at least, for 2000 years, and which are well described by Herodotus.—*Ib.*, Oct. 2, 1865.

14. *Discovery of Stone-implements on the Island of Elba by Mr. Foresi.*—Nine-tenths of the ancient implements found by Mr. Foresi on Elba are made of kinds of stone not occurring on the island, some consisting of obsidian from Naples, and others of material which has come from a greater distance. It is a question, therefore, whether they were introduced by invaders, or by commerce.—*Ib.*, Oct. 19, 1865.

15. *Polar expedition of Prussia and Austria.*—This expedition leaves this spring, will first go to Spitzbergen, and make Hammerfest, the bay of which never freezes, its base of operations. On Spitzbergen it proposes to explore the coal beds noticed there more than a century since by the Dutch. It will next explore Giles land, and then pass on westwardly as far as possible toward the pole, to resolve the question of the open sea; and reaching Greenland, will explore the coast, going north

ward. Finally the expedition will turn eastward, cross in all directions the sea of Siberia, and if chances are favorable, will return by the polar seas of America. The time allotted for the expedition is eight months.

16. *Geological Survey of California.*—The Legislature of California has recently made an appropriation of 45,000 dollars for the continuation of the geological survey so well begun and carried forward by Prof. Whitney.

17. *Copley Medal.*—The Copley medal for 1865 has been given to the eminent French mathematician, Mr. Chasles.

OBITUARY.

Dr. WHEWELL died on Tuesday, March 10, at twenty minutes past five P. M., at the Lodge, Trinity College. He was born at Lancaster in 1795. His parentage was humble, and it is said that his father intended to devote him to his own handicraft, but he was sent to the free Grammar School of Lancaster, and proceeded in due course to Trinity College. His position in the Mathematical Tripos as Second Wrangler, followed by the acquisition of the Second Smith's Prize, proved the possession of the intellectual powers which he cultivated up to the day when he suffered the accident which has since proved fatal. In due time he became Fellow and Tutor in his college. In 1828 he was elected Professor of Mineralogy, succeeding Dr. Clarke. It was in connection with the British Association (of which he was President in 1841) that he drew up the "Reports on the Tides," and on the "Mathematical theories of Heat, Magnetism, and Electricity," which rank among the first of his mathematical productions. Before this he was chosen to write the "Bridgewater Treatise on Astronomy," which perhaps suggested to him the "History of the Inductive Sciences," published in 1837, followed in 1840 by the "Philosophy of the Inductive Sciences," which are undoubtedly the works by which he will be best known in after years. In 1832 he resigned the Professorship of Mineralogy, but in 1838 accepted the Professorship of Moral Philosophy, which he held till 1855. In 1841, during the Ministry of Sir Robert Peel, he was nominated to the Mastership of Trinity, on the resignation of Dr. Wordsworth. As professor of Moral Philosophy he founded prizes for the encouragement of that study, which he himself always pursued with avidity. He edited Sir James Mackintosh's "Introduction to the study of Ethical Philosophy," published a couple of volumes of his own on "Morality," and among his latest productions were some translations of the "Ethical Dialogues of Plato." Besides University text-books, he published "Lectures on Political Economy," an edition of the works of Richard Jones on "Political Economy," "Architectural Notes on Churches in France and Germany," and "Some Specimens of English Hexameters," published in a book containing similar efforts by Sir John Herschel, the late Archdeacon Hare, and Mr. Lockhart.—*Reader, March* 10.

Mr. WILLIAM THOMAS BRANDE, D.C.L., F.R.S., the well-known chemist of the Royal Mint, died at Tunbridge Wells on Sunday, February 18th, aged eighty, being born in 1786. In 1803 he communicated several papers to Nicholson's Journal, one on guaiacum, which was read before the Royal Society. In 1808 he lectured on chemistry at Dr. Hooper's in Cork Street. Then he was connected with the Medical School in Wind-mill Street, and served as a teacher and demonstrator of chemistry. In 1809 he became F.R.S., received the Copley Medal in 1813, and from 1813 to 1826 was Dr. Wollaston's successor as senior secretary to the society. In 1812 he became a Professor of Chemistry and Materia Medica to the Apothecary's Company, and in 1851 was elected Master. In 1813, on Sir H. Davy's recommendation, he was appointed Professor of Chemistry at the Royal Institution, and delivered lectures for many years in conjunction with Mr. Faraday, and was also associated with him as editor of the Quarterly Journal of Science. In 1825 he was appointed superintendent of the Die Department of the Mint; in 1836 Fellow, and in 1846 Examiner, of the London University. Besides the "Manual of Chemistry," he was author of "Outlines of Geology," "Dictionary of Science and Art," &c.—*Reader*, *Feb.* 24.

Dr. Wm. M. Uhler.—Dr. Uhler, a chemist of some note, and an excellent friend of science, died at Philadelphia on the 27th of November last.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Carte Agronomique des Environs de Paris*, dressée, avec l'autorisation du Ministre de la Guerre, sur la carte topographique de L'Etat-Major, publié conformément a une déliberation de la Commission Départementale, et exécutée d'après les ordres de M. le baron G. E. Haussmann, Sénateur, Préfet de la Seine, par M. Delesse, Ingénieur des Mines du Départment de la Seine. Paris. (J. Dumaine.)—This map, as its title indicates, is designed to show the agricultural features of the region about Paris, embracing a territory of about 556 square miles (English). It is very complete in its details, and exhibits at a glance the most characteristic features of the soil, as well as the topography of the country. The primary division into soils that are calcareous, and those that are not, and again into those rich in humus, and those poor in that substance, are indicated by colors, as on an ordinary geological map. The topography, roads, forests, pastures, gardens, and vineyards are shown in the printing by well known methods. By an ingenious system of lines, dots, or characters, arranged according to certain orders, and printed in colors, the minuter characters of the soil are shown, such as the comparative prevalence of sand, loam, clay, gravel, siliceous or calcareous stones, and carbonic acid; and moreover by letters and figures also in colors, the per-centages of these several ingredients are successfully shown. The map has not only the merit of great ingenuity, but possesses a high value to the agriculturist, and is a text-book in itself. It is executed on a scale of $\frac{1}{40000}$, (about $1\frac{1}{2}$ inches to the mile,) and the mechanical execution is in the best style of the art. It is a most valuable addition to agricultural science, and embodies the results of an immense amount of labor. W. H. B.

2. *Sveriges geologiska Undersökning—Swedish Geological Survey*, under the direction of Professor Axel Erdmann.—The publication of the Geological Chart of Sweden, begun by Royal orders in 1861, has already made much progress. The work is projected on a scale as to magnitude, geological detail and artistic work, that is truly regal. The surface of Sweden is divided into 20 areas, and these areas are quartered; and, for each of the parts thus made, 77 in all, a map is issued measuring

18 by 24 inches in surface, so that the whole chart will cover an area of 231 square feet. The scale is $\frac{1}{50,000}$. The number of maps which had appeared up to November, 1865, is 18. The maps show in every part that they are the result of minute and careful exploration, by able and thorough geologists. Even the outlines of the older and newer Drift, and of the more recent Alluvium, are indicated by colors. Each chart is accompanied by a pamphlet, in 8vo, of 30 to 75 pages, giving details respecting the region represented, with numerous sections, and bearing upon the title page the name of the assistant in the survey who had special charge of that portion of the work. The names on the eighteen parts received by us are V. Karlsson, E. Sidenbladh, O. F. Kugelberg, A. E. Törnebohm, J. O. Fries, A. H. Wahlqvist, C. W. Paijkull, E. Erdmann, D. Hummel, and O. Gumælius.

The price for each chart with the text pertaining to it is two Swedish dollars. An accompanying notice states that they may be procured of the "Bureau de la Recherche Géologique de la Suède," by addressing Mr. Adolf Bonnier, Stockholm, through C. Reinwald, Paris, Longman & Co., London, or K. F. Köhler, Leipsic.

3. *Die Steinkohlen Deutschland's und anderer Länder Europa's;* by Dr. H. B. GEINITZ, Dr. H. FLECK and Dr. E. HARTIG, Professors in the K. polytechn. School in Dresden.—The second volume of this great work on the Mineral Coal of Germany and the rest of Europe, the first of which is noticed in our number for March, has just reached us. It is a quarto volume of 424 pages. Its subjects are The History, Statistics, and applications to the arts, of Mineral Coal. Each is treated with all needed fulness and detail. The last includes chapters on the physical peculiarities and chemical composition of the coals of different regions. The work is illustrated with drawings of machines, apparatus, furnaces, and maps, all handsomely executed, and well adapted to make the work practically useful to the miner and political economist.

4. *Annual of the National Academy of Sciences for* 1865. 130 pp., 12mo. Cambridge, 1866.—Besides the constitution and bylaws, lists of members, and lists of papers presented at the meetings of the year, this Report contains an excellent biographical sketch by Major J. G. Barnard of the eminent engineer General Joseph Gilbert Totten, who died on the 22d of April, 1864.

5. *Report of the Commissioner of Agriculture for the year* 1864. 676 pp., 8vo, with numerous woodcuts. Washington, 1865.—This annual Report treats, among its various articles, of Sorghum, by Wm. Clough; the Game Birds of the U. States, by D. G. Elliot; Oology of New England Birds, by E. A. Samuels; Noxious Insects, by T. Glover; and of many subjects especially interesting in connection with agriculture, horticulture, wool-growing, care of stock, etc.

6. *Reise der osterreichischen Fregatte Novara um die Erde in den Jahren* 1857, 1858, 1859, unter den Befehlen des Commodore B. VON WULLERSTORF URBAIR. *Nautisch-physicalischer Theil.* III (letzte) Abtheilung. 135–490 pp., 4to. With maps. Vienna, 1865. (Carl Gerold's Sohn.)—This part concludes the Nautico-physical Report by Dr. Scherzer of the Austrian Expedition of the frigate Novara around the world. It is occupied with the tables of the meteorological observations, which appear to have been made with great thoroughness and care. They are

accompanied with maps showing the route, and a large chart of the Nicobar Islands.

Three zoological volumes with plates were also issued in 1865, (1) on *Birds*, by Mr. de Palzeln; (2) on *Crustacea*, by Dr. Heller; (3) on *Formicidæ*, by Dr. G. Mayer.

7. *Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College.* No. II. North American Acalephæ; by Alexander Agassiz. 234 pp. royal 8vo, with numerous illustrations. Published by order of the Legislature of Massachusetts. Cambridge, 1865. (Sever & Francis.)—A notice of this very beautiful and excellent work is unvoidably deferred to another number.

Various Memoirs on Species of Mollusca, by Isaac Lea, LL.D. 32 pp., 8vo. From the Proceedings of the Academy of Natural Sciences at Philadelphia, Feb. 1863 to May 1865.—They treat of, Leaia Leidyi; 14 n. sp. of Melanidæ; 11 n. sp. of exotic Unionidæ; 24 n. sp. of Unionidæ; a new Unio and a Monocondylœa; a new genus of Melanidæ; 11 n. sp. of Melanidæ; Planorbis Newberryi; 6 n. sp. of Unionidæ from Lake Nyassa; 6 n. sp. of Succinea, etc.; 13 n. sp. of Melanidæ; n. sp. of Planorbis; 5 n. sp. of Lymnea; 2 n. sp. of Unionidæ from S. Africa; 24 n. sp. of Physa; 6 n. sp. of W. African Unionidæ; 3 n. sp. of exotic Uniones; 8 n. sp. of Unio.

The Living Forces of the Universe, the Temple and the Worshippers, by Hon. Geo. W. Thompson, of Wheeling, West Virginia. 388 pp. 12mo. Philadelphia, 1866. (Howard Challen.)—The author of this work goes into the region of mysteries farther than we can follow him.

Historical notice of the Essex Institute. 44 pp. 8vo. Salem, 1866.

Zoologie, contenant l'Anatomie, la Physiologie, la Classification, et l'Histoire naturelle des Animaux, by Paul Gervais. 448 pp. 8vo, with a large number of woodcuts. Paris. (Hachette.)

Traité pratique d'Analyse Chimique, by F. Woehler.—French translation by Grandeau and Troost. 324 pp. in 18mo. Paris. (Gauthier-Villars.)

Les grandes Usines de France: Etudes industrielles en France et à l'étranger; by Turgan. In small 4to. Paris. (Michel Lévy.)

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