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ERRATA.

P. 20, in Table II, second column, for 55° 41′, *read* 59° 41′.—p. 48, l. 21 from bottom, for 50,000 *read* 10,000.—p. 61, l. 16 from bottom, for "compliments," *read* "complements."—p. 147, first line of note, for *Minoris* read *Majoris.*—p. 218, l. 12 from top, for *Labratory* read *Laboratory.*—p. 273, l. 29 from bottom, for Mogrio, *read* Moigno.

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[SECOND SERIES.]

ART. I.—*Mémoires et Souvenirs de* AUGUSTIN-PYRAMUS DE CANDOLLE, *Ecrits par Lui-même et Publieés par Son Fils.* Geneva and Paris, 1862, pp. 599, 8vo.

DE CANDOLLE was born at Geneva on the fourth day of February, 1778; he commenced his distinguished career as a botanist in Paris in the later days of the French Republic; he continued it at Montpellier until 1816; when he returned to his native Geneva; where he died in September, 1841,—on the fifth day of that month, according the opening paragraph of his son's preface to this volume,—on the twenty-fifth according to the note by the same excellent authority at the close of the Memoir, p. 489. We cannot account for the discrepancy; but the former is without doubt the true date.

The twenty-one years which have elapsed since his death have thinned the ranks of those who knew DeCandolle, either personally or by correspondence. The *Théorie Élémentaire*, the *Organographie*, and the *Physiologie Végétale* have played their part, and have long ago passed out of general use. Yet, thanks to their influence, but more especially to the *Prodromus*, the name of DeCandolle is still perhaps the most prominent one with the cultivators of the science in general the world over,—is associated, not indeed with the profoundest depths, but with a larger amount of botany, than any other name except that of Linnæus. These are the personal memoirs of an industrious, highly useful, prosperous, and honored life. Begun at middle age, perhaps mainly for the writer's own satisfaction, or that of his family, and continued, at considerable intervals down to his last year, and evidently with a growing expectation of future publication,—they have appeared none too soon to secure the most interested, but rapidly narrowing circle of readers. The outer circle, however, is as wide as ever, embracing all the lovers of botany in our day, to none of whom can the name of DeCandolle be indifferent. The memoirs portray, not so much the botanist as the man. Indeed, the perusal was rather disappointing to us in the former regard. We expected to get fresh glimpses of his mind at work upon the problems of the time, and to watch the rise and development of the ideas which brought him fame. That could be had, however, only from letters, diaries, or other contemporary records: these are only reminiscences. On this account, too, and perhaps because the record was made with only a dim and distant view to publication, the narrative somehow has not all the vivacity and sprightliness, nor the ready flow of language, nor the affluence of anecdote, which those who personally knew the writer would have expected. There are, however, many favorable specimens of DeCandolle's powers of delineation, and some amusing anecdotes or interesting recollections of distinguished savans and others.

The family of *DeCandolle* (to retain the style of orthography which is kept up at Geneva, in which the *De* is written as a substantial part of the name) is an old and noble one in Provence; and a branch of it, reaching Naples in the thirteenth century in the suite of the Anjou princes, flourished there, under a name gradually changed from *Candola* to *Caldora*, down to the middle of the sixteenth century. *Augustin-Pyramus DeCandolle* derived one of his baptismal names from his ancestor, Pyramus de Candolle, who, becoming protestant, fled from Provence to Geneva in the year 1591, following an uncle who had already been established there for thirty or forty years. Augustin was the name of his father, in his earlier days a Genevan banker, a member of the state council, military syndic, and, about the time of the outbreak of the French Revolution, *Premier Syndic* of the little republic. Displaced by an earlier *coup d'etat* just as he was about to enter upon the duties of this office, he had retired into the country just in time to escape the worst perils of the woful imitation at Geneva of the reign of terror, in July, 1794, although he was condemned to death for contumacy, and his property in the city for a time sequestrated. The rest of his life was peaceful and long: he attained the age of 84 years, and died in 1820.

Augustin-Pyramus, the writer of this auto-biography, appears to have been remarkable in his boyhood rather for quickness of learning than for scholarship. His early tastes were for belles-lettres and poetry. Specimens of his poetical productions, both of his youth and of maturer years, are appended to the volume.

Of their merit we cannot pretend to judge. At the age of sixteen he happened to attend a few lectures of a short course on Botany, given by Vaucher,—who, living to a venerable age, survived his distinguished pupil. Here he learned the names of the parts of the flower, but nothing whatever of classification, having gone into the country for the summer before that portion of the course was reached. But his curiosity was awakened; and in his leisure hours he began to collect, observe, and even to describe the plants he met with in his rambles, at first without any botanical book whatever to guide him, and without any idea beyond that of amusement or relaxation. The next winter, returning to Geneva and to his college studies, he came to know Saussure, then in his last years and half paralytic. The veteran physicist, while he endeavored to attract the young man to scientific pursuits, discouraged his predilection for botany. That he regarded as quite unworthy of serious attention. Another summer passed upon the side of the Jura, however, and the perusal of Duhamel's *Physique des Arbres*, of the Researches upon Leaves of the pastor Bonnet (a friend of his father), also of Hale's Vegetable Statics, which he painfully translated from the English, and finally the acquisition of the *Linné de l'Europe* of Gilibert—in which the Linnæan artificial classification even then annoyed him by its incongruity with the natural relationships which he already recognized,—these had by this time fixed his fate before he was at all aware of it; and perhaps had even determined in some sort his characteristics as a botanist.

An unexpected opportunity to pass the ensuing winter in Paris opened the way. This occurred through an invitation from Dolomieu, who, while young DeCandolle was herborizing in the Jura, had been mineralogizing in the Alps, attended by two of DeCandolle's school-mates, Picot and Pictet. In the autumn of 1796 the three young men proceeded to Paris, under the auspices of Dolomieu, who secured for DeCandolle a lodging immediately over his own apartments, and presented him to Desfontaines and Deleuze at the *Jardin des Plantes.* No botanical lectures were given at that season of the year; but DeCandolle attended the principal scientific courses then in progress; among them those of Fourcroy and Vauquelin upon Chemistry, of Portal and Cuvier upon anatomy, and of Hauy upon mineralogy. It was at this early period that his acquaintance and life-long intimacy with the excellent Delessert family commenced. By a rather ingenious device he contrived to make the acquaintance of Lamarck, but he gained little thereby in the way of botany, Lamarck being just then wholly occupied with the discussion of chemical theories. When DeCandolle returned to Geneva in the spring of 1797, Lamarck sent by his hands a volume to Senebier, and so he came to know his amiable countryman, who, in ascertaining the capital fact that plants decompose carbonic acid, may be said to have laid the foundation of modern vegetable physiology. The first genus which DeCandolle established (in 1799) was *Senebiera.*

From his narrative it would appear that, during this summer of 1797, the ambitious young botanist of two years' standing, and only 18 years old, had not only conceived the idea of writing an elementary work, but actually traced the plan and wrote some chapters of it! He even states that from this period date the first observations and the conceptions—confused indeed, but correct—of the part which the abortion and the union of organs play in floral structure,—namely, the ideas which principally distinguish the *Théorie Élémentaire*, published fifteen years later. How far these ideas were developed, however, we have no means of ascertaining. One would like to see an extract from this early manuscript, in confirmation.

The following winter he began to study law at Geneva. But with the little State now annexed to the great French Republic, the prospects were not encouraging. A career must be sought elsewhere. DeCandolle determined to study medicine, at the same time prosecuting his botanical studies, so as to have a double chance, by falling back upon the former in case the latter failed to support him.

In this view, he returned to Paris in the spring of 1798, just in time to see his patron Dolomieu set out for Egypt, as one of the savans of that famous expedition, and to decline a pressing invitation to accompany him. Taking a lodging in the *Rue Copeau*, to be near the *Jardin des plantes*, he attended the hospitals and medical lectures, which he disliked, but recompensed himself at the Garden of Plants with the courses of Lacépède, Lamarck, Cuvier, and Hauy, omitting the botanical lectures, as not to his mind, but sedulously examining the plants of the Garden. He renewed his acquaintance with Lamarck, at whose request he wrote a few articles (under the letter P) for the *Dictionaire Encyclopedique.* Lamarck himself by this time had quite abandoned Botany.

It was to Desfontaines that DeCandolle was indebted for an immediate opportunity of beginning his botanical career. It came about thus: L'Heritier, who appears to have been wealthy, had engaged Redouté, the celebrated flower-painter, to prepare drawings of all the fleshy plants in cultivation, it being impossible well to preserve them in the herbarium. The artist undertaking to publish these drawings, applied to Desfontaines for a botanist to furnish the descriptive letter-press. The kind Desfontaines recommended DeCandolle, and moreover offered to direct him in the work. He freely opened to the young botanist his herbarium and library, and allowed him to study by his side; indeed Desfontaines was his botanical master and fatherly friend. The botanical library of L'Heritier, then much the largest at Paris, was naturally at his service, until the death by assassination, soon afterwards, of its singular owner. DeCandolle, thus connecting his name and studies with the work of the unrivalled flower-painter, acquired thereby, as he remarks, more reputation than he deserved, and more instruction than he expected.

In the course of this same summer, of 1798, an invitation from Alexander Brongniart, the mineralogist, (whom DeCandolle had slightly known, through Dolomieu, on his first visit to Paris,) connected him with a small party of naturalists who made an excursion to Fontainbleau. Besides Dejean, the entomologist, then very young, Cuvier and Dumeril were of the party. In the autumn of the same year he visited Normandy, with less celebrated companions, and formed his first acquaintance with marine vegetation. The next year he made a visit to Holland, to consult the gardens and conservatories of that country, the richest in the *plantes grasses*, which then occupied his attention. One result of this journey was that he induced his friend Benjamin Delessert to purchase Burmann's herbarium, and thus to lay the foundation of the important collections and library at the Hotel Delessert which have been so useful to naturalists, and so liberally devoted to their service. During the winter of the following year DeCandolle elaborated the *Astragalogia*, his first independent work of any considerable consequence, and which was published two years later: in this he found opportunity to dedicate to his friend Delessert the Leguminous genus *Lessertia*.

About this time, namely, at the beginning of the century, he became acquainted with Mirbel, who had come up to Paris from the south of France, where he had been a pupil of Ramond. Instead of translating DeCandolle's remarks, we may as well give them in the original.

"Il [Mirbel] savait alors peu de botanique, mais il annonçait de l'esprit et des talents. Je me liai avec lui. Il venait souvent déjeuner chez moi. Nous causions botanique; j'avais deux ou trois ans d'avance sur lui, et j'étais naturellement communicatif; je lui fis parts de plusieurs idées, nouvelles pour lui, et dont quelques-unes l'étaient pour le science. Elles parurent l'interresser, car j'en retrouvai une grande partie dans les éléments de physiologie qu'il publia peu d'années après; telles sont la distinction des feuilles séminales et primordiales, l'importance de l'étude des nervures principales des feuilles, etc. Appelé à rendre un compte succinct de cette ouvrage dans le *Bulletin philomathique*, je me divertis à ne citer que les idées que j'avais suggérées à l'auteur; je n'en revindiquai aucune, et ne sais pas même s'il s'est aperçu de cette petite malice. Je dois dire que je ne prétendis point, même alors, que se fût un plagiat volontaire, mais il arrive souvent dans les sciences qu'on s'appropie, sans s'en douter, ce qu'on a entendu dire.

"Cette circonstance éveilla ma propre attention sur la justice rigoureuse que j'ai désiré rendre a tous: la force de ma mémoire, et surtout le soin que j'ai eu très-jeune de noter les faits et les idées nouvelles que j'entendais dans la conversation, m'ont mis à même de pouvoir, bien des années après une conversation, citer exactement celui de qui j'avais appris un fait ou une opionion quelconque. Cette habitude de justice m'a fait beaucoup d'amis, et j'ai eu souvent des remerciements de gens cités par moi, qui eux-mêmes avaient oublié ce qu'ils m'avaient dit." (p. 91, 92.)

To DeCandolle's credit it must be said, not only that his career was remarkably free from controversies about priority and reclamations, but that his example and precepts, his scrupulous care to render due credit to every contributor, his respect for unpublished names communicated to his own or recorded in other herbaria, and the like, have been most influential in establishing both the law and the ethics which prevail in systematic botany (more fully, or from an earlier period than in the other departments of natural history), and which have secured such general coöperation and harmonious relations among its votaries.

In these early days DeCandolle was a good deal occupied with vegetable physiology;—the results are contained in his papers "on the pores in the bark of leaves," i. e. stomata; on the vegetation of the mistletoe; and on his experiments relative to the influence of light on certain plants, mainly those which exhibit strikingly the change in the position of their leaves at night which has been called the sleep of plants. The account of these experiments, in which he caused certain plants to acknowledge an artificial night and day, when read before the Institute, gave him considerable eclat,—and probably also the compliment of being named one of the three candidates to fill the vacancy in the Academy of Sciences left by the death of L'Heritier. A mere compliment, for the contest, of course, was between Labillardière and Beauvois. In the canvass DeCandolle called upon Adanson, then very aged, and in his dotage more excentric than ever.

If not chosen into the Institute, which indeed he could not pretend to expect, DeCandolle was in that year made a member of that active association,—la pépinière de l'Academie des Sciences,—the *Société Philomathique*, and was soon placed on the committee in charge of its *Bulletin*. This brought him into intimate connection with such colleagues as Brongniart (Alex.), Duméril, Cuvier, Biot, Lacroix, and Sylvestre.

"We met, at each others lodgings, on Saturday evenings, after the session of the society, to read and to discuss the *morceaux* intended for the Bulletin, and when our labor was finished we took tea together and chatted familiarly. As one by one we exchanged the celibate for the married state, our wives were introduced;—then we no longer read our extracts, and at length we gave over making the Bulletin, but we kept up our Saturday evening reunions. It was in consequence of this that Cuvier continued long afterwards his Saturday evening receptions; but I return to the year 1800."

By DeCandolle's account he was by about ten years the youngest member of this *réunion.* Yet he has the name of Biot and Duméril on his list, both of whom survived him for twenty years: and Biot was really not quite four years his senior, and Duméril only five.

As a member of this select circle of intimate friends and zealous *savants,* all then pressing on to the very highest distinction, we may well believe that the ambitious young botanist enjoyed, and improved to the full, such golden opportunities, that he learned something of every branch of natural history, and also —what was no less useful at Paris—"à connaître les hommes et les mobiles cachés de bien des choses."

DeCandolle sketches the following portraits of three of his associates, Duméril, Cuvier, and Lacroix. And first of

"The excellent Duméril. He was the ideal of the frank character which we attribute to the Picards. He was a sincere and devoted friend, always ready to second and render any service to me and mine. No cloud ever threw a shadow over our alliance, which became closer yet when, at a later period, the friendly connexion of my wife with the widowed Madame Say determined the latter to marry Duméril. He was chief demonstrator in the anatomical department at the School of Medicine, but he became professor and member of the Academy of Sciences. Duméril was remarkable rather for the clearness of his ideas, and the variety and accuracy of his knowledge in natural history, than for theoretical principles. He was a practical man, whose elementary works had considerable success, but who, after having had a glimpse of some of the laws of organic symmetry, such as the analogy of the skull to vertebræ, seemed to have collapsed before their immensity. His principal services to science were in the way of teaching, and in the encouragement which he so well knew how to give to the young. The heart in this kind of influence is more essential than the head, and although Duméril's judgment was clear and quick, he was much more remarkable for his moral qualities.

"Cuvier, who was from the beginning the intimate friend of Duméril, was entirely different: and it would be difficult to find two people who were less analogous. Born at Montbéliard and brought up at Stuttgard, Cuvier had something of the gravity and even of the obstinacy of the German. Placed for sometime in an inferior position, he was forced from his youth to make up for it by the dignity of his manner, but the world of *savans,* at least, will never forget his sojourn in Normandy, where he made those beautiful investigations on the molluscs which were the beginning of his fame. Called afterwards to the *Jardin des plantes* as assistant to the aged Mertrud, he owed this position to the friendship of Geoffroy; but he soon surpassed his patron. In consequence of this position he was a member of the Institute from its foundation, and quickly acquired the reputation which results from great talent united to a skillful ambition. At the time when the office of secretary was annual he foresaw it would become perpetual, and arranged in such a manner as to fill one secretaryship almost continually, either himself or by others; so that he found himself in position to have it without contest when it became permanent and well paid. These first steps being taken, all places fell to him as of themselves, and we saw him successively Professor of the Écoles centrales, of the Collége de France, at the Jardin des Plantes, Inspector, then Councillor, then Chancellor of the University, Councillor of State, Baron, Peer of France, &c. &c. His talent, his aptitude for knowing and doing everything, made him skillful in every function; he brought to it method, order, facility for administration, a knowledge of details and of the whole, a sincere love of justice, and a disinterestedness which caused him to be noticed and admired.

Cuvier might justly be compared to Haller, whom he resembled as much as the difference of nation and time would allow. Both astonished by their extraordinary capacity for learning, knowing equally well natural and historical science, greedy of positive facts on all subjects, endowed with wonderful memory and a remarkable spirit of order, capable of great labor, and yet gifted with much facility. But at the side of these admirable qualities it might be observed that neither had an inventive genius; they observed facts well, but never thought to unite them by a theory that would divine or discover others. Their characters corresponded even outside of science: both loved power, and sacrificed precious time to the desire of political advancement; both loved reading to a passion, even at the hours destined ordinarily for meals and domestic intercourse; both were cold and haughty in conversation with those who inspired them with no interest, *piquante* and profound to those whom they thought worthy of it; finally both had a certain contempt for that class of ideas called liberal, and held to the aristocratic party. The great size of their heads gave them a certain physical resemblance. In one word, it would be difficult to find two celebrated men more exactly alike, and the lovers of metempsychosis might say, if the epochs would permit, that the soul of Haller had passed without change into the body of Cuvier.

"To me, personally, Cuvier was well-nigh perfection. . . . . . . Notwithstanding the great difference in our respective views of life and of politics, and even of science in some theoretical matters, our intimacy was never clouded, nor was it disturbed by his quarrel with Geoffroy, although he knew that my opinions inclined towards those of the latter.

"The geometrician Lacroix was a genuine specimen of the philosopher of the eighteenth century, a republican of the school of Condorcet, an enemy to the great and their hangers-on, uniting the gaiety of a child with the moroseness of a disappointed old man,—the ease, grace, and kindness of a warm-hearted gentleman with the gruffness of a grumbler. He was a thoroughly excellent man, but a stranger to the life of the world around him. The character of the misanthrope in Molière, which I supposed purely imaginary, I found completely realized when I knew Lacroix."

An episode of fifteen days, during which DeCandolle, to his great surprise, had political functions to perform,—being appointed one of the three notables of the department of the Léman, in a representation of all the departments of the French Republic, which the First Consul called together,—gives us the first glimpse of Bonaparte in this narrative; and DeCandolle's account of the interviews with him, and with his minister of police, Fouché, is well worth preserving. With this transient exception, we have only the most incidental allusions to public affairs during the eventful years of the Consulate, the Empire, and the Restoration.

We pass by, also, the interesting account which DeCandolle gives of the doings of Delessert and himself, in the establishment and administration of the Philanthropic Society, which grew out of the introduction by them of Count Rumford's economical soups, distributed to the poor. These honorable undertakings brought the two friends into relations with Rumford himself when he came to reside at Paris. Indeed Delessert, as we have had occasion to learn, became one of Count Rumford's executors. The admiration with which Rumford's writings and economical inventions had inspired the two young philanthropists was much diminished upon personal acquaintance.

"It was after his plans," writes DeCandolle, "that we had constructed our furnaces, after his receipts that we made our soups, upon his advice that we were induced to substitute such assistance for gifts of money."

So when Rumford was expected at Paris, they congratulated themselves upon such an acquisition, went to meet him on his arrival, and brought him to dine with them.

"We found him a dry, methodical man, who spoke of benevolence as a discipline, and of the poor as we should not have dared to speak of vagabonds. It is necessary, said he, to punish those who give alms; the poor must be forced to work, &c., &c. Great was our astonishment at hearing such maxims: however we did our utmost to profit by his advice in practical matters. I had a good deal of intercourse with him, one among others odd enough. Mdlle. Rath, a Genevese painter, and like ourselves enthusiastic about Rumford, wished to paint his portrait to be engraved. M. Jay, her relation and my friend, then director of the *Décade Philosophique*, wished to put it into his journal, and asked me for a notice of M. Rumford to accompany it. Knowing little of his former life, I asked M. Rumford himself for a few notes: he promised them, and appointed an interview at his house to give them to me. I went: what was my astonishment when he presented an article entirely complete and quite eulogistic. That was not all; he required me to copy it on the spot, not wishing to leave the manuscript in his writing in my hands. I thought the proceeding rather indelicate, and the distrust not very polite. I deferred however to the wishes of a man for whom I had always had until then the highest respect; I obeyed: I transmitted to the *Décade* the written article, with small additions, and I have never mentioned until after the death of Rumford, not even until now, the secret of its origin, thinking that this trait would not raise him in estimation.

"M. Rumford settled in Paris, where he afterwards married Mdme. Lavoisier, the widow of the celebrated chemist. I saw something of both, and I never knew an odder union. M. Rumford was cold, imperturbable, obstinate, egotistical, prodigiously occupied with the material part of life, and in inventions in the smallest matters. He was engrossed with chimnies, lamps, coffee pots, and windows made after a peculiar fashion; and he contradicted his wife twenty times a day about the management of her housekeeping. Mdme. Lavoisier-Rumford . . . . . was a woman of very decided character. A widow for twelve or fifteen years, she had been in the habit of having her own way, and did not like to be contradicted. Her mind was broad, her will strong, her character masculine. She was capable of lasting friendship, and I could always congratulate myself on her kindness to me. Her second marriage was soon disturbed by grotesque scenes. Separation was better for both than union. He got a pension, which he needed, but which death prevented his long enjoying. She obtained liberty and the title of Countess: both were satisfied. He could now arrange the house at Auteuil as he liked: she continued to receive a select circle at hers."

Of this racy and unflattering sketch, we have only to remark that, however it may have been as to the pension, Rumford's pecuniary means, as shown by his endowments and legacies in this country, were more considerable than DeCandolle supposed.

Appropos to reminiscences of distinguished *savants*, we look forward a year or two in the narrative, and select the following. And first, of a person who was well known to a past generation, and to some who still survive, at Philadelphia.

"Joseph Correa de Serra was then about fifty-five or sixty years old. He was of an ancient family in Portugal, which had produced several literary men. After studying at the University of Coimbra he was transferred to Rome, where he pursued theological studies for a dozen years at the College of the Sapienza, but which he left with a knowledge of many things beside theology. Returning to Portugal, he was made governor to the hereditary Prince, Secretary to the Academy of Sciences, &c., and became a very influential person, both on account of his talents and on account of the position of his pupil, who it was supposed would become king on attaining his majority, as his mother was only regent. Correa was made Minister; and his first act was to overthrow the Inquisition. But the Prince died just as he was coming of age, and Correa was left exposed to the hatred and jealousy of the priests. After a while he obtained permission to go to England, where he lived in the society of the *savants* of which Sir Joseph Banks' house was the centre. Afterwards he removed to Paris, where he also lived among *savants* and men of letters, and where he showed the most noble character when the siezure of Portugal by Bonaparte deprived him of all his resources. He possessed the singular faculty of knowing every thing apparently without labor. It is only the people of the south who can thus combine great facility with profound idleness. The latter prevented his publishing anything beyond small dissertations, quite below his talents; but in conversation all his various knowledge and his ingenious views were charmingly exhibited. In these days Humboldt and Cuvier often came to my lodgings, where they occasionally met Correa. Although their celebrity was far above his, and justly so, on account of their published works, yet Correa always got the advantage over them; and it was by no means the least of the enjoyments of our sociable little dinners to see the sort of deference, and even fear, which Cuvier and Humboldt exhibited in the announcement of their opinions before Correa, who, with the grace and sly maliciousness of a cat, would at once expose their weak sides. Like them, he was familiar with all the historical and natural sciences, and he used his vast stores of knowledge with a severe logic and rare sagacity. He spent many hours in my herbarium; where the subtle perspicacity which he brought to bear at a glance upon plants, often wholly new to him, taught me much of the art of observing, and especially of combining observations in botany. To such talents he joined a lofty soul and a heart devoted to friendship. It was a great grief to me when, at over sixty years of age, he quitted Europe to rejoin in Brazil the king who had persecuted him; but he forgot all his wrongs when his sovereign became unfortunate. Correa died when ambassador to the United States."

The following, of a somewhat later period, is abridged from DeCandolle's account of the *Société d'Arcueil:*—

"Its founder was the excellent and illustrious Berthollet, who then living in his country residence at Arcueil, ... invited thither, once a month, a few young *savants*, by way of encouraging their efforts. His colleagues MM. de la Place and Chaptal, also senators and members of the Institute, were, so to say, Vice Presidents of this little reunion. Humboldt also had a place, and the *parterre* was composed of Biot, Thénard, Gay-Lussac, Descotils, Malus, Amédée Berthollet, and myself. Later, Berard and François de la Roche were admitted. [And finally Arago, Poisson, and Dulong, adds the editor, who notes that the last volume of the *Mémoires d'Arcueil* was published in 1817.] The association was devoted to the physical and chemical sciences. I was admitted in view of the applications of vegetable physiology to chemistry; and I contributed some articles upon this subject to the *Mémoires d'Arcueil*, namely, my Note on the cause of the direction of stems towards the light, my Memoir on the influence of absolute height upon vegetation and upon the geographical or topographical distribution of plants, and, later, one upon double flowers, especially of the *Ranunculaceæ.* The first of these writings was a simple and clear solution [although an incorrect one, as it proves.—Eds.] of a problem which was deemed insoluble; the second reduced to just proportions the exaggerations of Humboldt upon the influence of elevation; the third was an essay connected with the observations of the degenerescence of organs, to which my *Théorie Elementaire* was devoted. . . . . .

"We commonly made our *rendezvous* at Thénard's, and went together to Arcueil, as happy with this run into the country as school-boys out for a holiday. We walked about in this pleasant villa, and relished the society of our leaders. Nothing can fully describe the good-nature and simplicity of M. Berthollet and even of Madame. They were with us as parents with their children, and we made ourselves at home in the house with perfect *abandon.* M. Berthollet was quite fat and very full-blooded. He feared heat so much that he wore clothes only out of respect to society, and at night he slept entirely uncovered upon his bed. 'What,' said we, 'even in winter?' 'Oh,' he answered, 'when it is very cold I spread my pocket-handkerchief over my feet.' This man, so high in social rank and scientific celebrity, bore contradiction unusually well, and loved above all things truth. When the first works of Berzelius upon definite proportions became known at Paris, I was very much taken with them, and although they were in direct opposition to the principles of statical chemistry he sustained, I did not fear to tell M. Berthollet the high opinion I had of them. Far from taking offense at this preference, he encouraged me to study the writings of Berzelius.

"M. de la Place was of quite a different character. He had the dryness of a geometrician and the haughtiness of a *parvenu.* Over and above these defects of manner, he was a man of honor and worth. . . . . He often seconded me, although in truth he thought very little of natural history. In our meetings he often had little quarrels with M. Berthollet, and would think to silence him by saying: 'But you see, M. Berthollet, what I say to you is mathematics.' 'Eh, par Dieu, what I say to you is physics,' answered the other, 'and that is quite as good.' . . . . Humboldt also came from time to time; but he added much of life and interest when he appeared. He affected to pass himself as the creator of the science of Botanical Geography,—to which he has only added certain facts, and the exaggeration of a true theory so as to render it almost false. He never quite pardoned me for having, in the preface to my memoir on the geography of the plants of France, cited those who before him had occupied themselves with geographical botany,—although in this exposition I had, in truth, much amplified his share.

"Among the other members of the society of whom I have not yet spoken, I would chiefly mention Thénard, who was then commencing a career which has since become very brilliant. His activity, his ardor, and his uprightness pleased me very much. . . . I could draw, in an anecdote, the contrast between the characters of Thénard and Descotils. . . . . It was then very difficult to correspond with England, on account of the continental blockade. I happened to be the first to receive, by a letter from Dr. Marcet, the news of Davy's great discovery in decomposing the fixed alkalies. By a happy chance, it reached me on the morning of the day of our meeting. I hastened to our usual rendezvous, and could not wait for the session to impart so important a discovery. I read my letter to the members present. Thénard was enthusiastic; he ran about the room like a mad-man, crying out: 'it is beautiful, it is admirable!' Then turning to me, and laying hold of his arm: 'Look here,' said he, 'I would give this arm to have made this discovery.' Descotils, tranquilly buried in an arm-chair, said also, but in quite another tone: 'It is very fine; but I would not give the end of my little finger to have made it.'"

We pass over all DeCandolle's account of his life and domestic affairs during his residence at Paris, his particular investigations, his excursions, in Switzerland and elsewhere,—even the memorable one in the Jura with Biot and Bonpland, in which he led the party into a position of imminent danger, causing Bonpland to bemoan his hard fate in having to perish on such a mole-hill as the Jura, after having safely climbed Chimborazo (p. 154);—his engagement and marriage (the latter in April, 1802) with Mlle. Torras, of a Genevan family resident in Paris; of the foundation of his herbarium by the fortunate acquisition of that of L'Heritier;—of the first course of lectures which he gave, at the *Collége de France*, as a substitute for Cuvier, during the temporary absence of the latter, giving a course of vegetable physiology in place of one on general natural history;—how he prepared to take the degree of M.D. in order to qualify himself as a candidate for the chair of medical natural history at the School of Medicine, then vacant; but how Richard, who disliked him because he was a pupil of Desfontaines, as DeCandolle says, instigated Jussieu to offer himself for this chair, upon which of course DeCandolle withdrew, but nevertheless wrote and sustained as a thesis for the doctorate, his Essay on the Medical Properties of Plants, compared with their exterior forms and their natural classification. He bore his examination creditably, received his diploma, and, the same evening, a private mock inauguration, which, considering the parties engaged in it, must have been irresistably comical.

> "Duméril invited to his house my family, my comrades of the *Bulletin Philomathique*, and even some of the Professors of the *Ecole de Medicine.* This grave assembly amused themselves in giving me the reception, in full dress, from the *Malade imaginaire.* It was a curious sight to see Cuvier, Lacroix, Biot, and other learned Academicians rehearsing the scene from Molière in the costumes of the Comédie Française. They had smothered me in an immense sugar-loaf paper cap ornamented all over with little lamps all alight. In the motion of bowing I constantly expected to be set on fire. But the acolyte who conducted me would then press a sponge well filled with water borne on the top of the cap, and the water ran down, not upon the lamps, but upon my head,—the audience laughing uproariously at my surprise."

Let us pass on to more serious matters, and rapidly sketch the outlines of the scientific career now fairly and promisingly opening. For the event which fixed DeCandolle in his true field of labor was his arrangement (in 1802) with Lamarck—who had long since abandoned botany—to prepare a new edition of the *Flore Française.* The arrangement was a favorable one to DeCandolle, both financially and scientifically. The new edition was of course an entirely new work, one particularly adapted to DeCandolle's genius, and which gave him at once a wide reputation. Indirectly this work gave origin to the botanical explorations of the provinces of France, under the auspices of the Government, which engaged much of DeCandolle's attention from the summer of 1806 until he ceased to be a French subject.

And now, the death of old Adanson left a vacancy in the botanical section of the Institute, which DeCandolle might hope to fill. But parties and personal dislikes, as it appears, were not unknown nor uninfluential in the Paris of half a century ago. Indeed DeCandolle (let us hope without sufficient grounds) roundly charges lamentable weakness to Lamarck, and less creditable motives to Fourcroy and even to Jussieu, in respect to the nomination and canvass; while of the Abbé Hauy he relates, to his credit, that, upon being approached with the suggestion that his conscience should prevent his voting for a Protestant, he replied that he was very glad of an opportunity to show that he never mixed up religious opinions with scientific judgments. Palisot de Beauvois, the rival candidate, was elected, in spite of the hearty support DeCandolle received from his comrades of the *Bulletin Philomathique* and his eminent associates of the *Société d'Arcueil*, Berthollet, Chaptal, LaPlace, Cuvier, &c.,—to say nothing of his scientific superiority over his rival, which DeCandolle naturally regarded as very great. At that time, according to DeCandolle, Beauvois had produced, "ni la *Flore d'Oware*, ni le *Prodrome de l'Ethéogamie*, ni en un mot aucun de ses ouvrages qui," etc. But in this DeCandolle's memory was perhaps at fault: for, while this election took place in the autumn of 1806, the latter of these works of Beauvois, according to Pritzel, was published in 1805, and the first volume of the former in 1804.

Evidently the disappointment was keenly felt. Membership in the Institute secured not only an assured position but also a comfortable little annuity. This, and the prospective needs of an increasing family disposed DeCandolle to look elsewhere, and to accept, after some hesitation, the botanical chair at the University of Montpellier, which in 1807 became vacant by the death of Broussonet. Hardly was he established there when the death of Ventenat, in the autumn of 1808, made him again a candidate for a seat in the Institute;—again an unsuccessful one, but now chiefly because a considerable number of his particular friends in the Institute required a promise that if chosen he would reside at Paris, which he could not with propriety give. So they voted for Mirbel;—and DeCandolle took root at Montpellier, where he flourished from 1808 to the year 1816.

That DeCandolle, full of ambition and with a good opinion of his abilities, should have disliked to give up Paris is natural; but he himself afterwards records the opinion (which we share) that his removal from the metropolis was the best thing for him, as enabling him to accomplish more for botany. And as to the honors of the Institute, his disappointments were more than made up to him in the sequel by his election as one of the eight foreign associates of the Academy of Sciences.

At Montpellier, DeCandolle was heartily welcomed by his colleagues, by the official personages and by the protestant society of the city,—in those days there was little social intercourse between catholics and protestants in the south of France,—and he gave himself with ardor and success to his new duties. He renovated the botanic garden,—the oldest in France, founded by Henry IV,—and secured additional funds for its support. He built up the botanical school, and developed peculiar talents as an instructor,—with results perhaps up to the average as respects the making of botanists; but Dunal, one of his earliest pupils, was about the only one at Montpellier who achieved a general reputation, and his fell much below expectations. He continued and extended his official botanical explorations of the provinces of France, making annual reports to the Minister of the Interior, and planning a very comprehensive work on the *Statique Végétale de la France*, which, however, owing to political and other changes, was never written. He wrote and published the *Théorie Élémentaire*, which made his reputation as a theoretical botanist, and well exemplifies the characteristics of his genius in this regard,—constructive rather than critical,—quick and ingenious in seizing analogies and in framing hypotheses, rather than sagacious in testing their validity,—content with an hypothesis which neatly connects observed facts, but not so solicitous to prove it actually true, nor urgent to follow it out to ultimate conclusions,—a lucid expositor, and a happy diviner within a certain reach, rather than a profound investigator,—in short, a generalizer rather than an analyzer.[1]

At Montpellier, also, DeCandolle planned his *Systema Vegetabilium*,—a systematic and detailed account of all known plants, arranged under their natural families,—and he there prepared the first volume of this work; thus, with characteristic ardor and courage, but without calculating its immensity, entering upon the grand and most important undertaking of his life, and into that field of labor in systematic and descriptive botany for which he was eminently adapted, by his enterprising disposition and unflagging industry, his capacity for sustained labor, his excellent memory, his spirit of order and method, his quickness of eye, and his great aptitude for generalization.

The overthrow of the Empire, the Restoration, the Hundred Days, and the final fall of Napoleon supervened. DeCandolle's life at Montpellier was troubled and his prospects precarious. He naturally turned to his native Geneva, where he had kept up intimate social relations; and when he had ascertained that a place would be provided for him, he exchanged the comparatively ample emoluments of the chair at Montpellier, for the very humble salary of one at Geneva, encumbered with the duty of lecturing upon zoology as well as botany.

Pending the change he made a visit to England, in 1816, of which a detailed account is given, with reminiscences of the botanists and others whose personal acquaintance he then made. We regret that we have no room left for further extracts: his account

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[1] It is curious that DeCandolle, who early took to the ideas of Geoffroy in anatomy, who founded his morphology of the flower upon the idea of symmetry, and recognized the homology of the floral organs with leaves, and who could have got from the writings of his townsman, Bonnet, enough of phyllotaxy for the purpose, seems never to have thought of connecting the one with the other, nor to have asked himself *why a flower is symmetrical.*

of Brown is expressive of the great respect he entertained for him, and that of Salisbury and of Lambert is amusing.

Settled now at Geneva, at the good working age of 38, the narrative of his steadily industrious and prosperous life, and of his happy surroundings, flows on for nearly 200 pages, down to the sad overthrow of his health by an overdose of iodine in 1836, his partial convalescence and resumption of botanical work in 1837, and ends with the record of the death of his only brother, at the beginning of the year 1841, only eight months before his own.

These 25 years witnessed the publication of the two volumes of the *Systema;* the change of plan to a *Species Plantarum* in a restricted form, more nearly within the limits of a mortal's life and powers; the publication of the *Organographie* and of the *Physiologie Végétale*, and,—not to mention a hundred other botanical and sundry miscellaneous writings, of greater or smaller extent,—of seven out of the present fifteen volumes of the *Prodromus.* Only one botanist of the present century,—and one happily who still survives,—has accomplished an equal amount of work, and good work, in systematic botany.

Our account has run on to such a length that we cannot touch upon DeCandolle's social and domestic life—of which the memoirs reveal pleasant glimpses, nor of his useful and honorable life as a Genevan and Swiss citizen. Nor can we now venture to gather interesting anecdotes from his notices of friends, visitors, pupils,[2] and collaborators; nor notice his methods of working, and his capital arrangements for securing and classifying details and economizing time.

It is not for us to pronounce upon DeCandolle's relative rank in the hierarchy of naturalists. He incidentally once speaks of Brown and himself as rivals for the botanical sceptre. It is natural that they should be compared, or rather contrasted; for they were the compliments of each other in almost every respect. The fusion of the two would have made a perfect botanist. But DeCandolle's facility for generalization, zeal and industry were as much above, as his depth of insight and analytical power were below Brown's. The one longed, the other loathed, to bring forth all he knew. The editor compares DeCandolle's traits of character with those of Linnæus, as delineated by Fabricius, and finds much resemblance. But his impress upon the science, however broad and good, can hardly be compared with that of Linnæus.

A. G.

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[2] In his note about Berlandier, (p. 337, 338) the editor has fallen into a mistake in respect to his collections, acquired of his widow by Lieut. (now General) Couch and sent on to Washingtom. The botanical collection was purchased for distribution by Dr. Short of Kentucky, and the sets of specimens (which were poorly preserved, indeed, but yet very important) were most liberally presented by him to those botanists to whom it was thought they would be most useful.

Art. II.—*Description of a method of Reducing Observations of Temperature;* by Professor J. D. Everett, of Kings College, Windsor, Nova Scotia.

The climate of a place, as regards temperature, involves three principal elements—mean temperature—range—and *date of phase*, using this last term to denote the earliness or lateness of the seasons generally, as regards temperature.

The first of these elements is subjected to measurement by nearly all meteorological observers; the other two, and especially the third, have not received equal attention. These three elements appertain alike to daily and to annual variations, but we shall confine our remarks to the latter.

Annual range (i. e. the range that occurs within the year) has been measured in various ways. Sometimes it is assumed as the difference between the two extreme readings which occur within the year—sometimes as the difference between the two extremes of daily mean temperature—sometimes as the difference between the mean temperatures of the warmest and the coldest calendar month—sometimes as the difference between the mean temperature of a certain number of the warmest calendar months, and that of an equal number of the coldest.

The two latter modes of measurement are open to serious objection from the unequal manner in which they apply to different places. It is obvious that the range, if estimated as the difference between the warmest and the coldest calendar month, will (*cœteris paribus*) appear greatest when the maximum and minimum fall precisely in the centres of the two months, and if this condition is more nearly fulfilled at one of two places compared than at the other, the comparison will be unequal. The same remark applies when the mean of three (or any other number of) warm months is compared with that of the same number of cold ones, and the error will (in proportion to the deduced range) be as great as in comparing single months.

The element of "date" which thus interferes with the determination of range from monthly means, is, for its own sake, well worthy of careful investigation; but meteorologists generally content themselves with loose estimates of its amount, and with the exception of the article Meteorology in the new edition of the Enc. Britannica, I am not aware that any work in the English language contains directions for computing it.

We propose to describe a method of deducing both "range" and "date" from the mean temperatures of the twelve calendar months. The method, though it is in fact a modification of that described in the article above mentioned, was not thence derived, but was based on a more elaborate method employed by

Professor W. Thomson of Glasgow, and reduced to its present form by the writer.

It virtually consists in removing the irregularities which characterize the actual curve of temperature at a given place, for any particular year or group of years, so as to obtain in its stead a regular curve which can be expressed by a simple mathematical formula. In the reduced curves thus obtained for various places —or what amounts to the same thing, in the formulæ which express them, we have a definite measure both of the comparative earliness of the phases of temperature and of the amounts of annual range as estimated by a comparison of the warmer half of the year with the colder.

The curve which is thus adopted as the standard of reference is what mathematicians call the "curve of sines," or a "simple harmonic curve," and is expressed by the equation

$$y = A_0 + A_1 \sin(x + E_1)$$

where A_0 denotes the mean temperature of the year, A_1 the amplitude, or greatest departure of the curve from the line of mean temperature, which will be the same above this line as below, and will therefore be equal to half the annual range, and E_1 expresses the "date of phase" being greater in proportion as the phases are earlier. The curve has one maximum and one minimum in the year; which are precisely half a year asunder, and exactly midway between these are the two points where the curve intersects the line of mean annual temperature, corresponding to these two days, one in Spring and the other in Autumn, whose temperatures are on the average the same as the mean of the year.

The curve for a year will consist in fact of four precisely similar portions, the part which is above the line of mean temperature being precisely similar to that which is below, and each of these halves being bisected symmetrically by the points of maximum and minimum temperature respectively.

It is not of course pretended that the actual temperature of any place fulfills these conditions; but merely that when a uniform standard of reduction is to be applied to a number of places (in the temperate or frigid zones) such a curve as we have described is adapted to the purpose. While possessing the necessary amount of uniformity, the curve at the same time admits of infinite variety in respect of its amplitude (i. e. the extent of its departure from a straight line) which may be increased or diminished, without limit, according as we wish to represent a climate where the annual range is great or small.

It is not necessary in practice to draw the curves in question, but merely to calculate the values of the constants A_0 A_1 and E_1, the manner of doing which will be shown further on. We may merely remark in passing, that the labor of deriving these three constants from the monthly means, is less than that of deriving the monthly from the daily means.

The constant A_0 as already stated, is the mean annual temperature.

The constant E_1 represents the interval from that day in Autumn which forms the boundary between the warm and cold halves of the year to the 15th of January, the scale of representation being such that 360° corresponds to an entire year.

The constant A_1 (or the amplitude) is approximately equal to the difference between the mean temperature of the year and that of the warmest or coldest group of 30 days. More accurately it is proportional (but not equal) to the difference between the mean temperatures of the warm and cold halves of the year, bearing to this difference the constant value of 1:1·2879. In speaking of the warm and cold halves of the year, I suppose the year divided at two opposite points, that is to say two points which are six months asunder, in such a manner that the greatest possible amount of heat shall be contained in one half, and (consequently) the greatest possible amount of cold in the other.

In the definition here given of E_1 and in the second of the definitions of A_1, not only *annual* harmonic variations, but also *half-yearly*, are taken into account.

As a specimen of the manner in which the proposed method of reduction may be employed for comparing climates, I subjoin a table[1] showing its results as applied to all those stations of the Scottish Meteorological Society which have furnished observations of temperature for the three years 1856–7–8. The data are the mean temperatures of the stations for each calendar month, on the average of the 3 years above named, as given in the Society's Report for the quarter ending June 30th, 1859.

The names of stations are entered in the order in which they appear in the Society's Reports, being nearly that of latitude, proceeding from north to south.

The first column of numbers contains the values of A_0 or the mean annual temperature, obtained in the usual manner.

In the second and third columns are the values of A_1 and E_1 (amplitude and epoch) determined in the manner already explained.

The fourth column shows the number of days and tenths of a day by which each station is earlier or later (as regards the phases of the temperature) than the mean of all; days earlier than the mean being denoted by the sign +, and days later than the mean by the sign −.

The fifth column exhibits the difference between the mean temperatures of the warm and cold halves of the year.

The numbers in the fourth column have been obtained from

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[1] Table I.

those in the third by taking the difference between the value of E_1 for each particular station, and its value for the mean of all, and converting it into days at the rate of 1° to $1\frac{1}{72}$ day, (since 360 : 365 : : 72 : 73.)

The numbers in the fifth column are proportional to those in the second, and have been obtained from them by the formula log. $A_1 + \cdot 1099 =$ log. n, (since ·1099 is the logarithm of 1·2879.)

TABLE I.—*Results for three years*, 1856–8.

Stations.	Values of A_0	Values of A_1	Values of E_1	Days earlier + later − than mean.	Difference between warm and cold half.
Stornoway	46·4	8·99	75° 34′	− 3·8	11·6
Culloden	47·5	10·17	80° 57′	+ 1·6	13·1
Elgin	47·2	10·33	79° 24′	+ 0·1	13·3
Castle Newe	44·2	10·83	80° 29′	+ 1·2	13·9
Braemar	44·9	10·89	79° 6′	− 0·2	14·0
Aberdeen	45·9	10·69	78° 50′	− 0·5	13·8
Fettercairn	46·9	11·56	83° 22′	+ 4·1	14·9
Arbroath	46·6	11·09	79° 53′	+ 0·5	14·3
Barry	47·7	10·54	78° 24′	− 1·0	13·6
Kettins	45·8	11·20	80° 39′	+ 1·3	14·4
Callton Mor.........	47·2	10·37	80° 37′	+ 1·3	13·4
Greenock..........	48·4	10·97	76° 37′	− 2·7	14·1
Baillieston	46·6	11·59	80° 28′	+ 1·1	14·9
Edinburgh.........	49·0	10·71	77° 6′	− 2·3	13·8
Dalkeith...........	48·3	12·02	79° 25′	+ 0·1	15·5
East Linton........	47·3	10·66	76° 16′	− 3·1	13·7
Thurston..........	47·0	10·74	71° 43′	− 7·7	13·8
Yester	46·2	11·55	83° 56′	+ 4·7	14·9
Thirlestane	45·1	11·83	80° 46′	+ 1·4	15·2
Milnegraden	47·0	11·08	78° 43′	− 0·6	14·3
Bowhill	44·2	11·17	82° 9′	+ 2·9	14·4
Makerstoun	46·8	10·65	77° 22′	− 2·0	13·7
Drumlanzig	47·0	11·96	81° 1′	+ 1·7	15·4
Kirkpatrick	46·5	10·85	81° 5′	+ 1·8	14·0
Means	46·7	10·94	79° 20′		14·1

TABLE II.—*Results for single years.*

Stations.	Values of E_1.			Values of A_1.		
	1856.	1857.	1858.	1856.	1857.	1858.
Bressay (Shetland)..	....	55° 41′	73° 43′	...	7·8	8·6
Sandwick (Orkney) .	....	62° 2′	75° 49′	...	8·6	8·3
Tongue.............	....	72° 29′	84° 19′	...	9·7	9·1
Stornoway.........	81° 50′	72° 3′	73° 27′	8·6	9·4	9·1
Culloden	80° 29′	74° 56′	87° 25′	9·8	10·4	10·4
East Linton	76° 4′	68° 27′	84° 2′	...	...	...
Thurston	70° 56′	62° 10′	82° 40′	...	...	...
Yester	87° 4′	....	....	...	...	...

To find the centres of the warm and cold halves of the year, we may proceed as follows: The mean value of E_1 for all the stations is 79° 20′. To reduce to the beginning of the year, subtract 15°, since our reckoning has been taken from the middle of the first month. This leaves 64° 20′, which is the interval from the beginning of the cold half to the end (or beginning) of the year. The complement of this or 25° 40′ is the interval from the beginning of the year to the centre of the cold half, which again is 180° distant from the centre of the warm half.

25° 40′ corresponds to 26 days (nearly)
205° 40′ " " 209 " "

The 26th and 209th days of the year are January 26th and July 28th, which are therefore the centres of the cold and warm halves of the year, for the mean of the stations. The corresponding dates for any particular station, will be later or earlier than these by the amounts shown in the fourth column.

An expeditious method of finding the centre of the cold half is to assume the complement of E_1 as representing the interval from Jan. 15th to the required centre. Thus the complement of 70° 20′ is 10° 40′ corresponding to 11 days nearly, hence the centre of the cold half is 11 days later than January 15th. This determination it will be observed coincides with that above given. In like manner the centre of the warm half will be 11 days later than July 17th.

By taking the sum and the difference of A_0 and A_1 we should obtain approximately the mean temperatures of the warmest and coldest groups of 30 days; or if the difference between the temperatures of these two periods is required, it can be found by simply doubling A_1. These determinations are however only first approximations, and this is my reason for omitting them, all the numbers contained in the Table being second approximations at least.

With the joint purpose of testing the powers of the method, and comparing different years, I have calculated the values of A_1 and E_1 for single years for a few of the Society's stations, including three (the first three) which are not contained in the former table. The results are given without any reservation in Table II.

Bressay (Shetland) appears to be the latest of the Society's stations, being about 13 days behind the mean of the 24 stations included in Table I. Sandwick (Orkney) precedes Bressay by about 2 days, and this interval is preserved nearly constant from 1857 to 1858, although the absolute times differ by nearly a fortnight. The amplitudes are also less for these two stations than for any others, the amplitude (and consequently the range) at Bressay being only about four-fifths of the average derived from the 24 stations. The extreme lateness of Thurston (near Dunbar) seems to be borne out by the results from single years, as appears from a comparison with the neighboring station, East Linton. The extreme earliness of Yester cannot be so satisfactorily tested, as the interpolations (in defect of observations) at this station are numerous during the years 1857–8. In the year 1856, which is entirely free from interpolation, Yester appears to have been 16 days earlier than Thurston, and 11 earlier than East Linton, a remarkable difference, considering that all three places are in the same county (East Lothian). Comparing one year with another, it appears that the seasons were latest in 1857, being fully a week later than in 1856, and at some places about a fortnight later than in 1858. At Thurston the difference between the last two years amounts to nearly 21 days. All the inferences as to dates contained in this paragraph, are derived from mere inspection of the values of E_1 bearing in mind that a degree nearly corresponds to a day, and that the phases are earlier in proportion as E_1 is greater.

As an instance of the convenience afforded by the present method, for comparing the climates of different countries, I subjoin the values of A_0, A_1 and E_1 for Edinburgh, and for Albion Mines, N. S., the former derived from the monthly means of the late Mr. Adie's observations, embracing a period of 40 years, for which I am indebted to a paper by Principal J. D. Forbes, as epitomised in the Ed. New Phil. Journal for July, 1860, the latter from 11 years observations by Mr. Henry Poole, Manager of the mines. The monthly means themselves are—

For Edinburgh.

36·69 37·99 40·61 44·83 50·27 55·66 58·27 57·44 53·73 47·47 41·21 36·60

For Albion Mines.

19·85 19·90 27·41 37·38 48·58 58·14 66·10 65·19 56·05 46·28 35·59 24·47

from which are derived the following values of mean temperature, amplitude, and epoch:

Edinburgh,	$A_0=46{\cdot}9$	$A_1=10{\cdot}8$	$E_1=83°\ 27'$
Albion Mines,	$A_0=42{\cdot}1$	$A_1=23{\cdot}0$	$E_1=78°\ 13'$

Hence, cleared of technicalities, the relation between the two climates may be expressed by saying that the village of Albion Mines is on the average of the year about 5° colder than Edinburgh, that its range is rather more than double, and that its seasons are on the average 5 days later. No such definite information is obtained by inspecting the monthly means.

With the view of ascertaining the amount of error entailed by assuming (as our method does) that the calendar months are all of equal length, I have calculated the values of A_0 A_1 and E_1 for Edinburgh in four different ways, my data being the mean temperature of Edinburgh for every day in the year, as contained in the number of the Phil. Journal above referred to, viz:

1st. When the last 2 days of January and first 2 days of

March are reckoned part of February, giving February 33 days, and leaving January and March only 29 days each.

2d. When the last 3 days of February are reckoned part of March, so that January will have 31 days, February 26, and March 34.

3d. When the last day of January and first of March are reckoned part of February, so that January will have 30 days, February 31, and March 30.

4th. When calendar months are adopted, giving January 31 days, February 29, and March 31.

The resulting values of A_0 A_1 and E_1 are as under.

Days.	Days.	Days.		A_0	A_1	E_1
Jan. 29,	Feb. 33,	March 29,	gives	46·91	10·87	83° 37′
" 31,	" 26,	" 34,	"	46·88	10·81	83° 19′
" 30,	" 31,	" 30,	"	46·90	10·78	83° 33′
" 31,	" 29,	" 31,	"	46·90	10·78	83° 27′

Here a difference of 7 days in the length of February causes a difference of ·03 in the mean temperature, ·06 in amplitude, and 18′, or about $\frac{1}{3}$ of a day, in date. From the last two lines it appears that the difference between giving February 29, and 31, days does not affect either mean temperature or amplitude, to two places of decimals, and only affects date by about $\frac{1}{10}$ of a day.

Apart from the small error arising from treating calendar months as twelfth parts of a year, conclusions deduced from monthly means are as accurate as those from daily means, the correction necessary for reducing monthly to daily results being extremely simple and easy of application, the value of E_1 being the same for both, and the values of A_1 differing in the constant ratio of 1 : 1·0115.

I shall not attempt to show in detail the advantages which meteorology may be expected to derive from the extensive application of the method of reduction here proposed. The superiority of definite measures to mere general estimates, is recognized in every branch of statistical enquiry, yet no such measure is usually applied to "date of phase," and the measures commonly used in determining range are subject to an error which affects different places very unequally.

The determination of the "date of phase" will furnish a precise measure of the retarding effect of the sea, and also of the different varieties of soil. The general effect of the interchange of heat between the soil and the air must obviously be to retard the air temperature, but I am not aware that different soils have ever been compared in this respect.

The laws which connect date of phase with extent of range also offer an interesting field of investigation. Generally speaking, the causes which retard the former diminish the latter.

In the application of meteorology to agriculture, date of phase cannot, without serious error, be overlooked. The earliness of crops at one place as compared with another, must necessarily depend upon this element as well as upon mean temperature and range, and it will be interesting to ascertain how much of the effect is due to each of these causes.

Thus far we have endeavored to describe in general terms the objects and principles of the proposed method of reduction. The remainder of this paper will be devoted to the mathematical investigation on which the method rests.

By taking observations of temperature at any place for a sufficiently long series of years, it would be possible to ascertain the average temperature of each day in the year, and if the mean daily temperatures thus found were projected into a curve, its course would be free from those sudden and irregular deviations which characterize the curve of temperature for any particular year.

Such a curve would admit of being expressed, to any required degree of accuracy, by an equation of the form

$$y = A_0 + A_1 \sin(x + E_1) + A_2 \sin(2x + E_2) + A_3 \sin(3x + E_3) + \&c.$$

x and y being the coördinates of any one point in the curve, and A_0 A_1 E_1, &c. being constants. The coefficients A_1 A_2 A_3, &c., are the *amplitudes* of the terms in which they occur, and E_1 E_2 E_3, &c. are *epochs*. The term which involves A_1 and E_1 attains one maximum and one minimum in the space of a year, it is therefore called the annual term. The term involving A_2 and E_2 attains one maximum and one minimum in half a year, it is therefore called the half yearly term; and in general the term $A_n \sin(nx + E_n)$ goes through its entire cycle of values in the $\frac{1}{n}$th part of a year. We assume of course that a year is represented in arc by 2π, or the entire circumference.

For places in the temperate zones the amplitudes of successive terms in the above series diminish so rapidly, that for ordinary purposes all terms involving A_3 and higher coefficients may be neglected.

The mean daily temperatures for any single year or for the average of a few years are too irregular to admit of being expressed with accuracy by any simple formula, but it is possible to represent by a few terms of the above series the probable curve of annual temperature as deduced from the actual daily temperatures even of a single year. It is one object of the present communication to show how this may conveniently be done.

We shall now proceed to the solution of the following problem.

Given the temperatures at twelve equidistant points in the year, it is required to deduce the values of the constants in an expression of the above form which shall be applicable to them.

The general term in the expression is $A_n \sin(nx+E_n)$. Let this be assumed equal to $P_n \cos nx + Q_n \sin nx$. This assumption gives

$$A_n \sin E_n = P_n, \quad A_n \cos E_n = Q_n$$

whence
$$\frac{P_n}{Q_n} = \tan E_n, \qquad A_n^2 = P_n^2 + Q_n^2.$$

The transformed series is

$$y = A_0 + P_1 \cos x + Q_1 \sin x + P_2 \cos 2x + Q_2 \sin 2x + \&c.$$

Let the given temperatures be denoted by

$$y_0 \; y_1 \; y_2 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; y_{11}$$

Then if the time 0 correspond to the temperature y_0, the times, or values of x, corresponding to the 12 given values of y are respectively 0°, 30°, 60°, ... 330°.

Let the sines of 0°, 30°, 60° and 90°, be denoted by the abbreviations S_0, S_1, S_2 and S_3. Then we have

$$\begin{aligned}
y_0 &= A_0 + P_1S_3 + Q_1S_0 + P_2S_3 + Q_2S_0 + P_3S_3 + Q_3S_0 + P_4S_3 - Q_4S_0 \\
y_1 &= A_0 + P_1S_2 + Q_1S_1 + P_2S_1 + Q_2S_2 + P_3S_0 + Q_3S_3 - P_4S_1 + Q_4S_2 \\
y_2 &= A_0 + P_1S_1 + Q_1S_2 - P_2S_1 + Q_2S_2 - P_3S_3 - Q_3S_0 - P_4S_1 - Q_4S_2 \\
y_3 &= A_0 + P_1S_0 + Q_1S_3 - P_2S_3 - Q_2S_0 - P_3S_0 - Q_3S_3 + P_4S_3 - Q_4S_0 \\
y_4 &= A_0 - P_1S_1 + Q_1S_2 - P_2S_1 - Q_2S_2 + P_3S_3 + Q_3S_0 - P_4S_1 + Q_4S_2 \\
y_5 &= A_0 - P_1S_2 + Q_1S_1 + P_2S_1 - Q_2S_2 + P_3S_0 + Q_3S_3 - P_4S_1 - Q_4S_2 \\
y_6 &= A_0 - P_1S_3 - Q_1S_0 + P_2S_3 - Q_2S_0 - P_3S_3 - Q_3S_0 + P_4S_3 - Q_4S_0 \\
y_7 &= A_0 - P_1S_2 - Q_1S_1 + P_2S_1 + Q_2S_2 - P_3S_0 - Q_3S_3 - P_4S_1 + Q_4S_2 \\
y_8 &= A_0 - P_1S_1 - Q_1S_2 - P_2S_1 + Q_2S_2 + P_3S_3 + Q_3S_0 - P_4S_1 - Q_4S_2 \\
y_9 &= A_0 - P_1S_0 - Q_1S_3 - P_2S_3 + Q_2S_0 + P_3S_0 + Q_3S_3 + P_4S_3 - Q_4S_0 \\
y_{10} &= A_0 + P_1S_1 - Q_1S_2 - P_2S_1 - Q_2S_2 - P_3S_3 - Q_2S_0 - P_4S_1 + Q_4S_2 \\
y_{11} &= A_0 + P_1S_2 - Q_1S_1 + P_2S_1 - Q_2S_2 - P_3S_0 - Q_3S_3 - P_4S_1 - Q_4S_2
\end{aligned}$$

Subtracting y_6 from y_0, y_7 from y_1, y_8 from y_2, &c., all the terms which contain P_2 Q_2 P_4 and Q_4 will disappear. Similarly, adding y_6 to y_0, y_7 to y_1, y_8 to y_2, &c., all the terms which contain P_1 Q_1, P_3 and Q_3 will disappear.

Let
$$\begin{aligned}
y_0 - y_6 &= k_0 \\
y_1 - y_7 &= k_1 \\
y_2 - y_8 &= k_2 \\
y_3 - y_9 &= k_3 \\
y_4 - y_{10} &= k_4 \\
y_5 - y_{11} &= k_5
\end{aligned}$$

Also let
$$\begin{aligned}
k_0 \quad &\times S_3 = l_0 \\
(k_1 - k_5) \quad &\times S_2 = l_1 \\
(k_2 - k_4) \quad &\times S_1 = l_2 \\
k_3 \quad &\times S_0 = l_3
\end{aligned}$$

And let
$$\begin{aligned}
k_0 \quad &\times S_0 = m_0 \\
(k_1 + k_5) \quad &\times S_1 = m_1 \\
(k_2 + k_4) \quad &\times S_2 = m_2 \\
k_3 \quad &\times S_3 = m_3
\end{aligned}$$

It will be found that the sum of l_0, l_1, l_2 and l_3 is $6P_1$, and the sum of m_0, m_1, m_2 and m_3 is $6Q_1$. Hence P_1 and Q_1 are found as in the arithmetical example below; and E_1 and A_1 are obtained by the equations,

$$\tan E_1 = \frac{P_1}{Q_1}, \quad A_1^2 = P_1^2 + Q_1^2, \text{ or using } E_1 \text{ as a subsidiary angle, } \quad A_1 = Q_1 \sec E_1.$$

To find P_2 and Q_2, proceed as under.

Let

$$\begin{aligned} y_0 + y_6 &= K_0 \\ y_1 + y_7 &= K_1 \\ y_2 + y_8 &= K_2 \\ y_3 + y_9 &= K_3 \\ y_4 + y_{10} &= K_4 \\ y_5 + y_{11} &= K_5 \end{aligned} \qquad \begin{aligned} (K_0 - K_3) \times S_3 &= L_0 \\ (K_1 - K_4) \times S_1 &= L_1 \\ (K_2 - K_5) \times (-S_1) &= L_2 \\[1ex] (K_0 + K_3) \times S_0 &= M_0 \\ (K_1 + K_4) \times S_2 &= M_1 \\ (K_2 + K_5) \times S_2 &= M_2 \end{aligned}$$

Then will

$$\begin{aligned} L_0 + L_1 + L_2 &= 6P_2 \\ M_0 + M_1 + M_2 &= 6Q_2 \end{aligned}$$

whence E_2 and A_2 can be obtained by the equations

$$\tan E_2 = \frac{P_2}{Q_2} \qquad A_2 = Q_2 \sec E_2.$$

To find P_3 Q_3, P_4 and Q_4 we have

$$\begin{aligned} k_0 + k_4 - k_2 &= 6P_3 \qquad & K_0 + K_3 - \tfrac{1}{2}(K_1 + K_2 + K_4 + K_5) &= 6P_4 \\ k_1 + k_5 - k_3 &= 6Q_3 \qquad & (K_1 + K_4 - K_2 - K_5) \times S_2 &= 6Q_4 \end{aligned}$$

whence E_3 A_3, E_4 and A_4 can be obtained as above.

In the following example, the values of P_1, Q_1, E_1 and A_1, are found for Halifax, N. S., on the assumption that the mean temperatures of the calendar months, may be regarded as identical with the temperatures of 12 equidistant points in the year. The numbers in the first column are the mean temperatures of the months January to June, those in the second column are the mean temperatures of the months July to December.

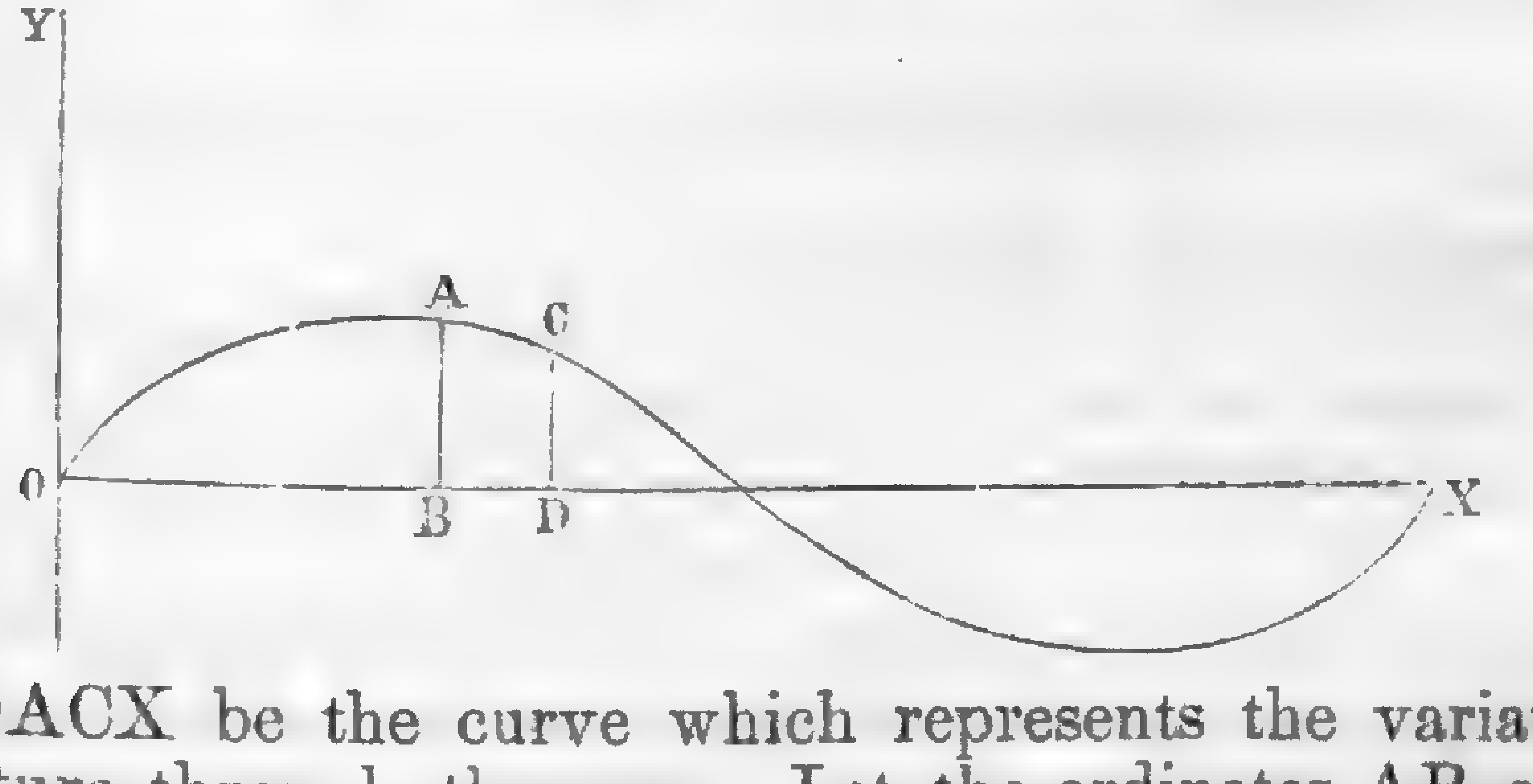
I.	II.	III. = (I.—II.)	IV. (two last in III.)	V. = (III—IV.)	VI.	VII. = (V × VI.)	VIII. = (III + IV.)	IX.	X. = (VIII × IX.)
23·9	64·9	−41·0		—41·0	S_3	−41·00	−41·0	S_0	·00
23·2	65·1	−41·9	+30·6	−72·5	S_2	−62·79	−11·3	S_1	− 5·65
30·1	58·3	−28·2	+10·5	−38·7	S_1	−19·35	−17·7	S_2	−15·33
38·9	48·2	− 9·3		− 9·3	S_0	·00	− 9·3	S_3	− 9·30
48·3	37·8	+10·5			6	−123·14		6	−30·28
58·4	27·8	+30·6			$P_1 =$	− 20·52		$Q_1 =$	− 5·05

$$E_1 = \tan^{-1} \frac{P_1}{Q_1} = 76° \; 10, \quad A_1 = Q_1 \sec E_1 = -21{\cdot}14.$$

The coefficients A_2, E_2 and those belonging to higher terms are of comparatively little practical use, and it will not be necessary to append examples of the process for obtaining them, as there is no difficulty in the application of the formulæ.

The last edition of the Encyclopaedia Britannica has an article on "Meteorology" by Sir John Herschel, in which the attention of meteorologists is called to the great practical utility of the mode of reduction above described, which has been for some time known but has been little used. The formulæ which Sir John Herschel there gives for deriving the values of the constants from monthly means, are in reality identical with those above given, though the identity is not at first sight obvious. He asserts that the values thus obtained are the most probable values, as derived from the application of the method of least squares. Also that "it is a peculiarly valuable property of these expressions, that if the approximation be stopped at any one term, ... then should it be considered afterwards desirable to carry it a term further, ... it is not necessary to recompute the former coefficients, their values remaining unaltered."[1]

Instead of using the temperatures of 12 equidistant days, as the basis of calculation, there are obvious advantages in employing the mean temperatures of the 12 months which compose the year; but it will be necessary to apply a correction to the results thus obtained; for it is not true, even on the average of a long series of years, that the mean temperature of a month is the same as that of its middle day. We shall proceed to investigate the nature and amount of the correction which must be applied, deducing by the way some interesting relations between the mean and instantaneous values of variable elements.



Let OACX be the curve which represents the variations of temperature through the year. Let the ordinates AB and CD represent the temperatures at the beginning and end of an interval of time represented by BD. It is obvious that the mean temperature of this interval will be obtained by dividing the area ABCD by the distance BD.

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[1] Of the theorems to which the remainder of this article is devoted, I believe I have the honor to be the first discoverer. They were first published by me in the Edin. New Phil. Journal for July, 1861. A correction for the difference between the mean temperature of a month and the temperature of the middle of the month had been applied (unknown to me) by Professor (now Principal) J. D. Forbes, in a paper read March 25th, 1860, (Trans. R. S. E., vol. xxii, Part II), accompanied by the remark that the correction has not usually been made. But the method there employed was only approximate and was based on different principles from that here described.

First let us suppose the equation of the curve (or the expression for the temperature in terms of the time) to be

$$y = a \sin x.$$

Let $2c$ denote the length of the interval BD, and let x' be the value of x for its middle point. Then the values of x for points B and D will be $x'-c$ and $x'+c$, and the area ABDC will be the integral of ydx taken between these limits,

$$= a(\cos \overline{x'-c} - \cos \overline{x'+c})$$
$$= 2a \sin x' . \sin c$$
$$= 2 \sin c . y'$$

if y' denote the value of y for the middle point of BD.

Hence the area bounded by two ordinates whose mutual distance is given, varies directly as the ordinate drawn midway between them. The areas of portions of the curve below the line OX must of course be reckoned as negative.

Dividing the expressions for the area by $2c$ we obtain

$$\frac{\sin c}{c} y'$$

which is therefore the mean value of y for the given interval.

Let $c = \frac{\pi}{m}$, then 2π denoting a year, the given interval $2c$ will be the $\frac{1}{m}$th part of a year. Hence the mean temperature of any $\frac{1}{m}$th part of a year is to the temperature of its middle point as $\sin\frac{\pi}{m} : \frac{\pi}{m}$. If the given interval is the $\frac{1}{12}$th part of a year, this ratio becomes sin 15° : arc 15° or 1 : 1·0115.

These conclusions have been drawn on the supposition that the expression for the temperature is $y = a \sin x$. They will still be true if the expression be

$$y = a \sin (x + E)$$

for this change only amounts to removing the origin of coördinates along the axis of x and does not alter the values of the ordinates.

If the expression for the temperature be

$$y = A + a . \sin (x + E)$$

the ordinates will be greater than before by the constant quantity A, which represents the mean temperature of the year; hence the temperatures will require to be diminished by the mean of the year in order that the above conclusions may be applicable. The following theorem will hold in all three cases, viz:—

The difference between the mean temperatures of any two equal portions of the year will be less than the difference between the temperatures of their respective centres, in the constant ratio of $\sin\frac{\pi}{m}:\frac{\pi}{m}$, each of the portions being supposed to be the $\frac{1}{m}$th part of a year, where m may be either a whole number or a fraction.

Hence the annual range as shown by the curve of monthly mean temperatures will be less than that exhibited by the curve of daily mean temperatures in the ratio of sin 15°: arc 15°.

Strictly speaking, instead of "daily mean temperatures," I ought to say "instantaneous temperatures;" but the difference is so small as to be quite inappreciable, since the former are to the latter nearly in the ratio of sine to arc of 30 minutes or of 1 to 1·000013.

Assuming then that the expression for instantaneous temperature is

$$y=\mathrm{A}+a\sin(x+\mathrm{E})$$

the mean temperature Y_m of any $\frac{1}{m}$th portion of a year will be given by the equation

$$\mathrm{Y}_m=\mathrm{A}+a\,.\,\frac{\sin\frac{\pi}{m}}{\frac{\pi}{m}}\sin(x+\mathrm{E})$$

x being the time for the centre of the portion. Hence if the instantaneous temperatures follow a simple harmonic law, the mean temperatures of equal intervals of time will also follow a simple harmonic law. For the mean temperature of any period of $30\frac{5}{12}$ days we have

$$\mathrm{Y}_{12}=\mathrm{A}+a\,.\,\frac{\sin 15^\circ}{\text{arc }15^\circ}\sin(x+\mathrm{E}).$$

Secondly, let the expression for instantaneous temperatures be

$$y=\mathrm{A}_0+a_1\sin(x+\mathrm{E}_1)+a_2\sin(2x+\mathrm{E}_2).$$

The expression for the area bounded by two ordinates whose distance is $2c$ will as in the former case be the integral of ydx between the limits $x'-c$ and $x'+c$

$$=2\mathrm{A}_0c+2a_1\sin c\sin(x'+\mathrm{E}_1)+2a_2\frac{\sin 2c}{2}\sin(2x'+\mathrm{E}_2)$$

and dividing by $2c$ we obtain for the mean value of y the expression

$$\mathrm{A}_0+a_1\frac{\sin c}{c}\sin(x'+\mathrm{E}_1)+a_2\frac{\sin 2c}{2c}\sin(2x'+\mathrm{E}_2).$$

Hence the mean temperature of any $\frac{1}{m}$th portion of a year is given by the equation

$$Y_m = A_0 + a_1 \frac{\sin\frac{\pi}{m}}{\frac{\pi}{m}} \sin(x+E_1) + a_2 \frac{\sin\frac{2\pi}{m}}{\frac{2\pi}{m}} \sin(2x+E_2).$$

Let $m = 2$ and we have for the mean temperature of a half year

$$Y_2 = A_0 + a_1 \frac{1}{\frac{\pi}{2}} \sin(x+E_1),$$

the third term vanishing, since $\sin \pi = 0$. Hence the half yearly term produces no effect upon the mean temperature of a half year (as is also obvious from general considerations), and the amplitude of the half yearly means is to that of the annual term for daily means, as the radius of a circle is to a quadrantal arc.

The range of the half yearly means, being double of the amplitude, is $a_1 . \frac{2}{\frac{\pi}{2}}$ which being divided by $a_1 . \frac{\sin\frac{\pi}{12}}{\frac{\pi}{12}}$ the amplitude of the annual term for monthly means, gives as a quotient $\frac{1}{3\sin\frac{\pi}{12}}$ the numerical value of which is 1·2879. Hence if the amplitude A_1 deduced from monthly means be multiplied by this number, the product will be the difference between the temperatures of the warmest and coldest halves into which the year can be divided.

Lastly, let the expression for instantaneous temperatures take the general form

$$y = A_0 + a_1 \sin(x+E_1) + a_2 \sin(2x+E_2) + \quad . \quad . \quad . \quad . \quad + a_n \sin(nx+E_n)$$

It will be found by proceeding as in the previous cases, that the expression for the mean temperature of the $\frac{1}{m}$th of a year is

$$Y_m = A_0 + a_1 . \frac{\sin\frac{\pi}{m}}{\frac{\pi}{m}} \sin(x+E_1) + a_2 \frac{\sin\frac{2\pi}{m}}{\frac{2\pi}{m}} \sin(2x+E_2) +$$

$$+ a_3 . \frac{\sin\frac{3\pi}{m}}{\frac{3\pi}{m}} \sin(3x+E_3) + \ldots\ldots + a_n . \frac{\sin\frac{n\pi}{m}}{\frac{n\pi}{m}} \sin(nx+E_n).$$

Hence if $A_1, A_2, A_3 \ldots\ldots A_n$ denote the amplitudes deduced from monthly means, we have

$$A_1 = a_1 . \frac{\sin 15^\circ}{\text{arc } 15^\circ},\ A_2 = a_2 \frac{\sin 30^\circ}{\text{arc } 30^\circ},\ A_3 = a_3 \frac{\sin 45^\circ}{\text{arc } 45^\circ},$$

and generally

$$A_n = a_n . \frac{\sin n \times 15^\circ}{\text{arc } n \times 15^\circ}.$$

Conversely,

$$a_1 = A_1 \frac{\text{arc } 15^\circ}{\sin 15^\circ} = A_1 \times 1{\cdot}0115$$

$$a_2 = A_2 \frac{\text{arc } 30^\circ}{\sin 30^\circ} = A_2 \times 1{\cdot}0472$$

$$a_3 = A_3 \frac{\text{arc } 45^\circ}{\sin 45^\circ} = A_3 \times 1{\cdot}1107$$

$$a_4 = A_4 \frac{\text{arc } 60^\circ}{\sin 60^\circ} = A_4 \times 1{\cdot}2092$$

&c. &c.

Hence, to reduce monthly to daily results it will simply be necessary to multiply the amplitudes A_1, A_2, &c., as above indicated. The logarithms of the multipliers for A_1, A_2, A_3 and A_4 are as under.

$$\log. \frac{\text{arc } 15^\circ}{\sin 15^\circ} = {\cdot}0049725$$

$$\log. \frac{\text{arc } 30^\circ}{\sin 30^\circ} = {\cdot}0200286$$

$$\log. \frac{\text{arc } 45^\circ}{\sin 45^\circ} = {\cdot}0456049$$

$$\log. \frac{\text{arc } 60^\circ}{\sin 60^\circ} = {\cdot}0824980.$$

ART. III.—*Remarks upon the Article of Prof. J. D. Everett;* by E. LOOMIS, Professor of Natural Philosophy and Astronomy in Yale College.

IN the preceding article, page 18, Prof. Everett has adopted the formula

$$y = A + a \sin (x + e);$$

to represent the annual fluctuation of temperature at any place, and he remarks that according to this formula "the curve has one maximum and one minimum in the year, *which are precisely half a year asunder;* and *the curve is bisected symmetrically at the points of maximum and minimum temperature.*"

In order to determine whether these assumptions are conformable to nature, and if not, whether the error of the assumptions is important, I will compare them with observations of temperature made at several different stations. I first take the observations made at Greenwich, embracing 43 years, from 1814 to 1856, as reduced by Mr. James Glaisher. The following Table shows the mean temperature of each day in the year.

Days of the month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	36°·5	37°·2	40°·1	43°·6	50°·0	56°·4	61°·5	62°·5	58°·8	53°·5	46°·4	41°·7
2	36·4	37·0	40·0	44·1	50·5	56·6	61·4	62·3	58·6	53·4	46·2	41·8
3	36·4	37·3	39·9	44·5	50·9	56·8	61·4	62·2	58·5	53·1	46·1	41·7
4	36·3	37·7	39·9	44·8	51·3	57·1	61·5	62·1	58·4	53·0	45·9	41·5
5	36·1	38·4	40·0	45·1	51·6	57·1	61·6	62·0	58·2	52·8	45·7	41·4
6	36·0	39·0	40·1	45·4	51·8	57·2	61·7	62·0	58·0	52·5	45·5	41·1
7	35·8	39·2	40·1	45·5	51·9	57·3	61·8	62·0	57·8	52·3	45·1	40·7
8	35·5	39·2	40·1	45·5	51·8	57·4	61·7	62·0	57·7	52·1	44·8	40·6
9	35·4	39·0	40·2	45·4	51·6	57·5	61·5	61·9	57·6	51·9	44·5	40·5
10	35·7	38·7	40·3	45·1	51·4	57·7	61·5	61·8	57·5	51·7	44·3	40·4
11	35·6	38·5	40·5	45·0	51·3	58·0	61·6	61·7	57·4	51·4	44·0	40·2
12	35·6	38·3	40·6	44·9	51·3	58·3	61·7	61·6	57·3	51·0	43·9	40·0
13	35·6	38·2	41·0	45·2	51·4	58·5	61·8	61·5	57·2	50·5	43·5	39·6
14	35·6	38·0	41·3	45·5	51·8	58·8	61·7	61·5	57·0	50·1	43·3	39·7
15	35·5	38·1	41·5	45·7	52·2	59·0	61·7	61·4	56·7	49·8	43·0	40·0
16	35·5	38·1	41·7	46·0	52·6	59·3	61·7	61·4	56·5	49·6	42·6	40·3
17	35·9	38·2	41·8	46·2	52·8	59·4	61·7	61·3	56·3	49·4	42·4	40·1
18	36·3	38·3	41·8	46·4	53·1	59·5	61·7	61·0	56·0	49·2	42·2	39·9
19	36·5	38·4	41·8	46·5	53·3	59·6	61·7	60·9	55·9	49·1	42·2	39·5
20	36·8	38·5	41·9	46·7	53·6	59·8	61·6	60·8	55·6	49·1	42·2	39·0
21	37·1	38·5	41·9	47·0	53·8	59·9	61·5	60·6	55·5	48·9	42·0	38·4
22	37·3	38·6	41·9	47·5	54·1	60·0	61·5	60·4	55·4	48·6	41·7	37·9
23	37·5	38·9	42·0	47·6	54·3	60·2	61·5	60·3	55·3	48·3	41·4	37·4
24	37·8	39·1	42·1	47·6	54·4	60·4	61·6	60·3	55·0	47·9	41·0	37·0
25	38·0	39·5	42·2	47·6	54·6	60·6	61·8	60·2	54·9	47·5	40·8	36·5
26	38·3	39·7	42·3	47·6	54·7	60·8	62·1	59·9	54·7	47·4	40·9	36·4
27	38·3	39·8	42·4	48·0	54·9	61·0	62·3	59·7	54·5	47·2	41·1	36·5
28	38·1	40·0	42·6	48·5	55·2	61·3	62·5	59·6	54·3	47·0	41·5	37·0
29	37·9		42·8	49·1	55·4	61·5	62·5	59·4	54·0	46·8	41·6	37·3
30	37·6		43·0	49·5	55·7	61·5	62·5	59·1	53·8	46·6	41·6	37·4
31	37·3		43·4		56·1		62·5	59·0		46·5		37·6

From this Table we perceive that the maximum temperature occurs on the 30th of July. The minimum occurs sometime between Jan. 9th and 15th; we will call it Jan. 12th. The interval from the minimum to the maximum is 199 days, and from the maximum to the minimum 166 days. The difference is 33 days; that is, the first principle assumed by Prof. Everett is in error by *more than a month.*

In order to determine whether the curve is symmetrically divided at the point of maximum temperature, I will compare the temperatures for 30, 60 and 90 days before and after July 30th. The results are as follows:

June 30,	61°·5	Aug. 29,	59°·4	Difference	— 2°·1
May 31,	56 ·1	Sept. 28,	54 ·3	"	— 1 ·8
May 1,	50 ·0	Oct. 28,	47 ·0	"	— 3 ·0

Thus we see that the temperatures for 90 days before and 90 days after the maximum, instead of being equal, as they should be according to the assumption of Prof. Everett, differ by three degrees; which is *one ninth part of the entire annual range.*

In order to decide how far the preceding conclusions may be peculiar to the climate of Greenwich, I will make the same comparison for three stations in Germany, according to the materials furnished by Prof. Dove, viz. Berlin from 110 years observations, Danzig from 81 years observations, and Breslau from 64 years observations. The averages are taken for intervals of 5 days, and the temperatures are expressed in degrees of Reaumur's thermometer.

Mean temperature for each five days of the year.

	Berlin.	Danzig.	Breslau.		Berlin.	Danzig.	Breslau.
Jan. 1–5	−1°·24	−2°·67	−3°·02	July 30–4	14°·54	12°·94	13°·77
6–10	−1·74	−2·96	−3·51	5–9	14·89	13·36	14·47
11–15	−1·20	−2·46	−3·46	10–14	14·87	13·50	14·26
16–20	−0·62	−2·04	−2·54	15–19	15·14	13·68	14·34
21–25	−1·02	−2·36	−2·37	20–24	15·18	13·94	14·55
26–30	0·06	−1·68	−1·76	25–29	15·50	14·16	14·35
Feb. 31–4	0·21	−1·72	−1·20	Aug. 30–3	15·49	14·18	14·71
5–9	0·16	−2·00	−1·32	4–8	15·17	14·04	14·53
10–14	0·44	−1·36	−1·47	9–13	14·99	13·66	14·38
15–19	0·52	−1·12	−1·07	14–18	14·56	13·24	14·26
20–24	1·07	−1·02	−0·44	19–23	14·04	12·90	13·84
25–1	1·39	−0·52	0·00	24–28	13·86	12·52	13·41
March 2–6	1·75	−0·36	0·39	Sept. 29–2	13·55	12·10	13·14
7–11	1·84	−0·48	0·56	3–7	13·13	11·40	12·14
12–16	2·36	−0·01	0·83	8–12	12·35	10·80	11·82
17–21	3·22	0·52	1·47	13–17	11·94	10·04	10·68
22–26	3·23	0·54	1·84	18–22	11·24	9·34	10·27
27–31	4·16	1·28	2·85	23–27	10·52	8·72	9·93
April 1–5	5·18	2·16	3·78	Oct. 28–2	9·40	7·56	9·22
6–10	6·20	3·12	5·10	3–7	8·93	7·08	8·69
11–15	6·92	3·78	5·71	8–12	8·18	6·20	7·78
16–20	7·25	4·58	6·26	13–17	7·36	5·36	6·83
21–25	8·07	5·20	7·15	18–22	6·76	5·08	6·33
26–30	8·63	5·80	8·28	23–27	5·82	4·20	5·83
May 1–5	9·27	6·48	9·00	Nov. 28–1	5·16	3·66	4·64
6–10	9·97	7·16	9·90	2–6	4·79	3·72	3·86
11–15	9·56	7·66	9·72	7–11	3·97	2·74	3·31
16–20	10·83	8·68	10·59	12–16	3·30	2·14	2·21
21–25	11·84	9·08	11·48	17–21	2·65	1·04	1·92
26–30	12·30	9·84	11·50	22–26	1·92	0·56	1·31
June 31–4	13·08	10·60	12·20	Dec. 27–1	1·87	0·78	1·00
5–9	13·35	11·26	13·05	2–6	1·50	0·28	0·68
10–14	14·00	11·84	13·28	7–11	0·67	−0·48	0·10
15–19	14·03	12·00	12·82	12–16	0·39	−0·70	−0·87
20–24	13·73	12·26	13·11	17–21	−0·18	−1·12	−1·33
25–29	14·37	12·50	13·48	22–26	−0·24	−1·74	−1·78
				27–31	−0·74	−1·98	−2·03

From these observations we see that at Berlin the maximum temperature occurs July 29, and the minimum January 8th.

The interval from minimum to maximum is 202 days; and from maximum to minimum 163 days. The difference is 39 days.

Comparing the temperatures for 30, 60 and 90 days before and after the maximum we find

June 29.	14°·44	Aug. 28.	13°·74	Difference	−0°·70 R.	= −1°·58 Fah.
May 30.	12 ·61	Sept. 27.	10 ·07	“	−2 ·54	= −5·71 “
Apr. 30.	8 ·89	Oct. 27.	5 ·56	“	−3 ·33	= −7 ·49 “

At Danzig the maximum temperature occurs July 30; and the minimum Jan. 8th. The interval from minimum to maximum is 203 days, and from maximum to minimum 162 days. The difference is 41 days. Comparing the temperatures before and after the maximum we find

June 30.	12°·76	Aug. 29.	12 ·27	Difference	−0°·49 R.	= −1°·10 Fah.
May 31.	10 ·30	Sept. 28.	8 ·02	“	−2 ·28	= −5 ·13 “
May 1.	6 ·21	Oct. 28.	3 ·88	“	−2 ·33	= −5 ·24 “

At Breslau the maximum temperature occurs July 31; and the minimum Jan. 10th. The interval from minimum to maximum is 202 days; and from maximum to minimum 163 days. The difference is 39 days. Comparing the temperatures before and after the maximum we find

July 1.	13°·71	Aug. 30.	13°·19	Difference	−0°·52 R.	= −1°·17 Fah.
June 1.	12 ·06	Sept. 29.	9 ·36	“	−2 ·70	= −6 ·07 “
May 2.	8 ·86	Oct. 29.	4 ·88	“	−3 ·98	= −8 ·95 “

The results at these three stations accord remarkably well with each other, and we must regard them as indicating the law of climate for that part of Europe. These results also accord pretty well with those obtained at Greenwich; but the decrease of temperature in autumn is more rapid at the German stations than it is in England. The average temperature at the three German stations 90 days after the maximum, is less than the temperature 90 days before the maximum, by 7°·23 Fahrenheit, which is nearly *one fifth* of the annual range of temperature.

If we institute a similar comparison for the southern part of the United States, we shall find the same want of symmetry in the curve which represents the annual fluctuations of temperature. Thus at Savannah, Ga., according to 21 years of observations, the minimum temperature occurs about December 20th, and the maximum about July 20th; making an interval of 7 months from minimum to maximum, and of 5 months from maximum to minimum.

We conclude then that any formula which supposes the curve of annual temperature to be symmetrically divided at the point of maximum, does not represent climates like those above specified, with that degree of accuracy which science requires.

Art. IV.—*Upon Natural and Artificial Section in some Chætopod Annelids;* by W. C. Minor.

The circumstances of spontaneous fission have been observed in so few species of annelids at present, as to make every additional observation of value, even though only confirmatory of what is already known upon that subject. This consideration, and the fact that all views of its nature in the *Oligochæta* seem to be based upon the observations of one species—*Stylaria proboscidea*,—have tempted me to publish the following brief investigations, however they may want of any very special novelty to give them value.

It is now nearly one hundred years since the distinguished Danish naturalist, Otto Fr. Müller, studied the phenomena of spontaneous fission in the fresh water Naids,[1] and his able little work, *Von Würmen des sussen und salzigen Wassers*, Kopenhagen, 1771, largely devoted to that subject, shows that he failed only where the imperfect means at his command led him astray. The multiplication by artificial section had been observed before that, both in the Naids and other animals, and had awakened a good deal of general interest; but the multiplication by spontaneous fission seems to have been very nearly if not wholly disregarded at that time. Nor has its occurrence in the fresh water worms received, since then, the investigation that it seems to demand. For with the exception of a discussion by Schultze and Leuckart upon some of the particulars, and, the significance of this phenomenon in relation to budding, some ten years ago, and a sweeping denial of its occurrence, or at least of its vital and systematic nature, by Dr. Williams, about the same time, no one, so far as I am aware, has published any extended observations upon the fissiparity of the fresh water Naids since the time of Müller.[2] And yet the statements of Dr. Williams, in regard to both artificial and spontaneous fission, are such as to suggest at once the importance of a reëxamination of the whole subject; while the great interest given to this question by the remarkable speculations of Steenstrup, together with the interesting varieties of the phenomenon as observed in the marine worms by

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[1] Trembley had discovered it long before this, as he observes in his *Mémoires p. s. à l'hist. d'un genre de Polypes d'eau douce*, 1744;—and Roesel, in his *Insekten belustigungen*, describes the united parent and bud; but the former did no more than observe the fact, and the latter wholly misunderstood what he saw.

[2] Gruithuisen remarks in his *Anatomie der gezüngelten Naide*, (*Nov. Act. Nat. Cur.* T. xi, p. 243,) only that it is uncommon to find a Naid without buds of the second generation, and refers to Müller for the details of their formation. Since writing this, I have seen in Leuckart's valuable yearly report in the *Archiv. f. Naturgeschichte* for 1861, a notice of Claus's observations on fission in *Chætogaster*, which, so far as there given, I can confirm.

Quatrefages, Edwards, Frey and Leuckart and others, seem to demand a more complete knowledge than we as yet possess of its occurrence in the fresh water group.

I may here remark that the European species chiefly studied hitherto, *Stylaria proboscidea*, has not come under my observation, nor am I aware that it has been found in America. Four species of Naids common in this vicinity, *Stylaria* (Pristina) *longiseta, Nais rivulosa*, and *Dero limosa*, found in fresh water, and a marine *Enchytræus, E. triventralopectinatus*, have been the principal subjects of my investigation. In regard to the first of these, it may be questioned whether our species is identical with that described by Ehrenberg, (*Symbolæ Physicæ*,) as *Pristina longiseta*, for his description is too brief to be of specific value. As, however, the characters given by D'Udekem, in his *Nouvelle Classification des Annélides Sétigères Abranches*, (*Mémoires de l'Acad. Royale de Belgique*, 1859, T. xxxi,) apply equally to the American species, I am compelled to regard it as the same.[3] The second species, *Nais rivulosa*, already described by Leidy, (*Journal Acad. Nat. Sci. Phila.*, 1850, vol. ii, pt. 1°, p. 43,) very closely resembles the European *Nais elinguis*, with which D'Udekem regards it as identical. The third species, *Dero limosa*, has also been described by Leidy, (*Proc. Acad. Phila.*, 1857, vol. v, p. 226) and though overlooked by D'Udekem, appears to be distinct from the European form of the same genus. The fourth, *Enchytræus triventralopectinatus*, I have not been able to identify with any species described in works at my command, and have therefore named from the three anterior pairs of ventral combs after which the dorsal combs begin. This character appears to distinguish it from *E. socialis*, if I may judge from the figure given by Leidy (*Jour. Acad. Phila.*). It has no eyes. The pharynx extends nearly to the fourth ventral or the first dorsal combs, from which a narrow esophagus continues to a little back of the sixth ventral combs. Here a gradual enlargement of the alimentary canal occurs, ending abruptly just back of the eighth, in a narrow twisted tube; and this last gradually enlarges, at the ninth ventral combs, into a moderate sized alimentary canal, in

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[3] D'Udekem remarks: "Je n'ai pas adopté le genre Stylaria admis par Lamarck et Ehrenberg, parce que cette espèce ne diffère des autres Nais que par l'allongement très grand de la lèvre supèrieure. Ce charactère n'étant accompagné d'aucune modification importante dans la form des autres organes, je ne puis le considérer comme assez tranché pour servir à former un genre nouveau." There is however a marked difference in the form and position of the cordiform anterior enlargement of the alimentary canal, which even the statements and figures of Müller and Gruithuisen indicate, between the Naids with a long upper lip or proboscis and those with a short one, and the manner of fission differs in these two groups as will be shown. Lamarck's genus *Stylaria* is therefore a good one. Ehrenberg's division of this genus however, based upon the absence of eyes, is unfounded, for I have seen *Nais rivulosa* lose them without any other apparent change, and Agassiz has stated that this occurs as a part of the normal development in many Naids.

which I observed nothing specially marked. The entire length of this Naid was about $\frac{3}{8}$ inch.

The occurrence of spontaneous fission in *Stylaria* (Nais) *proboscidea* is described as follows by Müller. "If a virgin Naid, as I may call it, with 16 or more pairs of hair combs or 20 or more pairs of hook combs [there are four pairs of hook combs anterior to the first hair or dorsal combs as in *Nais* and *Dero*] be carefully observed it will be seen that its anal ring slowly elongates and after some days appears to be transversely marked within into rudiments of future rings.[4] In each of these divisions beneath the skin, germs of hooks and hairs appear, and the pulsations of the artery are evident, while the food forces a way through them. The hooks and hairs gradually come through the skin in succession from before backward, while the rings enlarging, the Naid increases considerably in length. While in this way new segments and their contents are forming within the anal ring, on the other side [anteriorly] of it, a strongly marked transverse line, different from those just mentioned, appears, and extends across the whole width of the animal. The angles formed at the sides of the body project, and on the top a slight projection is evident which gradually becomes a distinct proboscis, while, finally, eyes appear back of this fission. Thus the Naid becomes a mother." . . . "Frequently one may see in the anterior half of the elongated anal ring of the mother Naid a second ring formation similar to the one just described." . . . "This is not all. Hardly has the second bud acquired the length of one mature ring than a third bud appears before it, and I have even seen a fourth." . . . "Further, not only may a parent and its four offspring thus appear, but the buds themselves may give rise to new buds; their terminal joints forming new buds as they themselves were formed. Hence we may find a parent with its children and grand-children attached to its body." (op. cit. pp. 34, 36.)

Müller afterwards gives his observations upon a single Naid from the 20th of May to the 9th of June. During this time, it gave off the buds observed posterior to the 17th pair of combs, after which a formation of rings began, without any trace of separation, until the body was elongated to over 40 pairs of combs. About this time a fission occurred between the 21st and 22nd pairs of combs. Fission occurring in this way after an elongation of the body I shall speak of as the "renewal of fission." Further observation of individual Naids led him to

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[4] Schultze considers Müller in error as to the position at which fission takes place, because he describes it as occurring in a segment and not between two. The difference of statement however is simply verbal, as Müller speaks of "die Zwischen-Räume der Borsten oder die Gelenke," p. 26, and in many other places shows very plainly that such is his meaning.

conclude that each bud is formed one joint anterior to its predecessor, that there is thus a gradual reduction of the parent segments till a certain point; that then a reformation of rings takes place, and an elongation of the body of the Naid to recommence this circle of fission.

Schultze, in his article, *Über die Fortpflanzung durch Theilung bei Nais proboscidea* (*Archiv f. Naturgeschichte*, 1849, T. xv, p. 293,) confirms the statements of Müller as to the passage over of one of the parental segments to each bud;[5] though he is not fortunate enough to observe the recommencement of fission in the elongated Naid. He observes also (p. 301) that, contrary to what Steenstrup had supposed from the analogy of marine worms, there is no relation to metagenesis in the phenomena of budding in this Naid, for he had never seen generative organs in the separated buds. He had however never been able to keep these buds long alive. He also had seen (p. 304,) sexual organs in the parent while budding, though he had never seen well developed sperm and ripe eggs present during this process.

The phenomena of fission in *Stylaria longiseta*, so far as I have observed them, confirm the statements of Müller and Schultze in substance; for there is nearly always a passage over of one parental ring to each bud, and since fission takes place, as I have seen, while the parent has eggs and sperm, and I have never seen the fullest development of the latter in the buds, I cannot believe that there is any such metagenetic relation in this process as has been observed in *Syllis* and allied genera.

In *Nais rivulosa*, however, the facts are somewhat different. For in several continued observations of individual Naids, extending in one case over twelve weeks, I have known, but once or twice of a passage of the parental rings into the bud; while, after an elongation of the parent body, I have very uniformly seen fission recommence in the point at which buds were given off before, or at some point posterior to it, and once anterior, and finally, although I have seen fission taking place between each of the rings from the 15th to the 22d, I have not been able to discover that it does so in any order. But here, as in *Stylaria longiseta*, I have found no metagenesis in the fission.

The facts obtained in regard to fission in *Dero limosa* are unfortunately meagre; the comparative slowness of the merismatic function making the only two series of observations carried out proportionately unfruitful. In none however of the succeeding buds, from Aug. 15th to Oct. 10th, was there any carrying off of parental segments by the separating parts, nor was there anything like metagenesis observed.

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[5] **Leuckart at first doubted the correctness of this view, (*Über die ungeschlechtliche Vermehrung bei Nais proboscidea, Wiegm. Arch.* 1857,) but has since been convinced of its justice.**

My observations upon *Enchytræus triventralopectinatus* are similarly scanty, but are just sufficient to confirm and extend the facts observed in the two other short-lipped Naids. In all the cases observed, the separation was of a part wholly new formed, without inclusion of the older segments of the parental body.

It is evident from the above facts, that in *Stylaria longiseta*, as Müller and Schultze have shown is the case in *S. proboscidea*, the point of fission moves regularly forward, ring by ring, and more commonly in the former Naid from the 16th to the 12th pairs of hook combs; though the extremes between which I have known it to occur are the 17th and 10th. To judge from Müller's account it occurs further back in the latter Naid. Further, that in *Nais rivulosa*, and, as far as I know, in *Dero limosa*, and in *Enchytræus triventralopectinatus,* all of which have short upper lips, the buds are given off at one point, though that point may vary in different Naids of the same species, or in one and the same Naid at different times. In the latter case the variation occurs as part of a peculiar form of fission of which I shall speak again. Both "parting" (theilung), and "budding" (knospenbildung), occur then in the Naids, and it may be added that the former appears to be peculiar to the genus *Stylaria* or to the proboscis-bearing forms.

I may here remark that the distinction made by Schultze and others between "theilung" and "knospenbildung," though convenient, does not seem to me a fundamental one. The mere inclusion of a portion of parental tissue in the bud does not of itself make an essential distinction between this and a wholly new-formed, but otherwise similar, bud; nor have I been able to see any histological or functional differences. The very fact that individuals, having the same genetic relations to the parent stock, are in one Naid, *N. rivulosa,* always or commonly produced by the so-called "budding," and in another genus, *Stylaria,* by the so-called "parting," leads to this view. Nor, as I think, though observations are largely wanting in that direction, have the two yet been shown to be functionally different in true metagenetic processes. They are two varieties of one process; and it would be interesting in many ways to know exactly how the various species of Naids, already known, follow distinctly the one or the other plan, or tend to merge them yet more completely as one.[6]

A little detail will show how closely identical the two forms of bud-formation are. In "parting"—"theilung"—as has already, to a great extent, been described by Schultze, we find that from

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[6] I have known "budding" to intercalate once in a series of fissions in *Stylaria longiseta* (May 31), and I have also known "parting" to interrupt a series of buddings in *Nais rivulosa* (Sept. 25), which leads me to expect that in some Naids both processes may be regularly present.

the parental ring, as a fixed point, there is a continuous ring-formation and elongation backward; and that anteriorly to it there is a limited elongation of the general body, also by ring-formation from before backwards. There is, then, unlimited growth backward from the fixed point, and a limited or defined growth backward toward the fixed point from the place of fission. The parental included ring, the most anterior of the series, is here the fixed point. In "budding"—"knospenbildung"—the most anterior ring of the series also, though a wholly new-formed one, becomes the fixed point, from which, by continuous ring-formation, the Naid elongates backward, and toward which a limited series of ring-formations proceed from the point of fission.[7] The resemblance between the two is perfect; and as the fixed point is not related to specializations of the alimentary tube, as I at first supposed, and is in *Stylaria proboscidea*, where it occurs by "parting," four hook-combs back of the mouth, as it is in *Nais* and *Dero*, where it occurs by budding, while in *S. longiseta* it is six hook-combs back, the genetic relations of the two processes, in these genera at least, are completely one. But, as I have already said, though the distinction appears unessential in the genera I have examined, the terms are convenient and as merely descriptive terms are used here.

The "commencement of fission" was observed in a large proportion of the buds given off from the individuals of *Stylaria* and *Nais* which were under observation, and the result is given in the following table.

Stylaria—between	12–13	combs in	none.	*Nais*—between	17–18	combs in	3
	13–14	"	2		18–19	"	3
	14–15	"	12		19–20	"	4
	15–16	"	9		20–21	"	3
	16–17	"	1		21–22	"	3

It is evident that fission does not begin at a fixed point, nor have I been able to discover any relation between the place of its occurrence and the time of the year, temperature, &c.

Now, while fission may take place by gradual reduction of the Naid *Stylaria*, between the 10th and 11th hook-combs, the commencement of fission has not been known forward of the 13th. In *Nais rivulosa*, also, fission has been observed as far forward as the 15–16th, while its commencement has not been noted anterior to the 17th hook-combs. This is all the difference between the commencement of fission and continued fission, notwith-

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[7] There is an interesting analogy between this process in the Naids and the embryonic growth of *Terebella*, as described by Milne Edwards. He has remarked, *Obs. sur le développement des Annélides*, *Ann. des Sci. Nat.*, 1845, 3me Série, T. iii, that the first defined part is not the cephalic, nor the anal, but the esophageal, and that growth takes place both anterior and posterior to this by succession from before backward. Other speculations and analogies suggest themselves here, but are in our present knowledge wholly premature.

standing the fact that whether the former is introductory to a series of "partings" or of "buddings," its bud resembles that produced by what I shall call the "renewal of fission."

That the "renewal of fission," in a Naid elongated after reduction by fission, is a somewhat peculiar form of fission would hardly have been known from observations on *Stylaria* alone.[3] The following summary will illustrate this. In *Stylaria longiseta* one example (April 16) was reduced to 10 rings, grew out but little, and divided between the 12–13th. When again reduced to 10 rings it grew out much longer but renewed fission at the same point as before. It was then reduced to 11 rings, and growing out, again divided between the 12–13th. One of its buds (May 14) began fission between the 15–16th, was reduced to 12 rings, then grew out and recommenced fission between the 14–15th, and was being reduced again when lost. In another case, the Naid was reduced to 12, grew out and renewed fission at the 14–15th, was again reduced to 12, and growing out again renewed fission at the same point. It was a third time reduced to 12, and growing out again, a third time, renewed fission between the 14–15th hook-combs. It was then reduced to 11, when very unfortunately lost. In *Nais rivulosa*, an example, that had been giving off buds just back of the 19th ring, increased to something like 33, and then again renewed fission between the 19–20th. Another example that had given off buds at the 15th, grew out to over 35, and then renewed fission at the 15–16th. After two or three buds had been given off, it again elongated, and then renewed fission between the 20–21st hook-combs.

Now, while in *Stylaria* the "renewal of fission" appears to differ from the commencement of fission, with which I believe it is essentially homologous, only by not occurring as far back, which may be owing to the want of fuller observation, and while in this genus it might be supposed to be merely a means of continuing the process of "parting," which must otherwise soon cease: we find that it occurs in *Nais rivulosa* without any change of the point of budding, without any apparent necessity, without performing the very function that we might judge from *Stylaria* was its peculiarity. And what is more, it also occurs in *Nais rivulosa* for the performance of this very function. This fact suggests something more than a physiological meaning in the "renewal of fission." While the phenomena connected with it seem to show that the distinction between this, the "renewal of fission," and other forms of fission is more than a difference of function, I am far from claiming that there is any fundamental

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[3] Yet Müller seems to notice these two forms of fission, and says that "though at first view different they are fundamentally the same." Op. cit. s. 88.

difference, like that between metagenetic and monogenetic fissions. I may add that I have not been able to discover that the point of its occurrence bears any relation to the number of buds already given off.[9]

The sum of the preceding observations tends to show, that the "renewal of fission" has some special characters that suggest a wider enquiry as to its true nature; that the two forms of fission already known as "parting" and "budding" both occur in the Naids, and occur so as to prove their morphologic and physiologic identity; that "parting" appears to characterize the Naids with a prolonged upper-lip—the genus *Stylaria*, while "budding" appears to characterize those with a short one—*Nais*, *Dero*, *Enchytrœus*, and *Chætogaster*, according to Claus; that the bud produced by both these processes is identical with the parent; that as the buds are here, so far as I know, identical with their parents in function and structure, there is no metagenetic fission; and that therefore fission in these Naids, whether by "parting" or by "budding," is correlative to genesis in the great function of maintenance of the species, and not a mere step in the history of the individual.[10]

It may be worth while to refer briefly here to the power of reproduction from injuries commonly attributed to these little beings, especially as Dr. Williams, in his *Report on the British Annelida*, (*Rep. Brit. Ass. Adv. Sci.*, 1851, p. 247), after quoting a summary of Bonnet's well known experiments, says: "On the authority of hundreds of observations, laboriously repeated at every season, the author of this report can declare with deliberate firmness, that there is not one word of truth in the above statement." It may be presumed from this, that Dr. Williams felt the necessity of thorough and very careful investigations, before contradicting the statements so often repeated upon this subject; and I cannot doubt that his experiments have uniformly failed.

[9] There are some other differences to be considered in a future paper upon the histologic nature of fission.

[10] "From the analogy of the two species, Arenicola and Nais, on which the author's observations have been chiefly conducted, the conclusion may be deduced that the 'fission of the body' in every other species of Annelida in which it occurs has for object in like manner to protect and incubate the ova." . . . "It becomes the last act of the parental worm, since the portions into which the body is sub-divided by fission *never take food*." . . . "It is a catastrophe, in which every autumn involves the whole community."—Williams, *Rep. Brit. Annel.*, pp. 249-250.

I should be far from wishing to extend the conclusions I have made to all other Annelids by mere analogy, but my observations are, at least, wholly incompatible with a general application of Dr. Williams's statements to the Naids.

The exact circle of life and its duration, I have not determined, nor do I feel certain that any of the general statements—see Leidy, *Flora and Fauna within living animals*, on *Stylaria fossularis*, and Williams at large—are absolutely correct. For I have known the process of fission to go on in winter, when the Naids were kept in a warm place; while I have also seen, what appeared to be a loss of this power, as shown in badly formed and incomplete buds, occurring in the warmer parts of the year.

But from the almost uniform success of my own, I should wonder that they have done so, had not others reported complete or partial failures in similar experiments.—See Dugès, *Ann. des Sci.* 1828, 1^{re} Série, T. xv. It must be remembered, however, that such evidence is wholly negative, and cannot weigh with the positive statements of observers like Müller, Réaumur and Dugès.

In regard to my own observations, I may state, in brief, that in *Stylaria*, *Nais*, and *Dero*, I have hardly ever failed to have the head reproduced, and that the anal end has not only been reproduced in these genera, but I have seen it reproduced in *Enchytræus*, in *Lumbricus*, in *Fabricia*, and even in a *Nereis* common on our coast.[11] That in the vast majority of these cases I have seen food taken again; and, in all, I have seen the incurrent anal stream, which ceases while either end is closed, recommence. From these and other observations, I am inclined to believe that this power is far more general in the class than is yet supposed.

That this power plays a part in the natural economy of life, the healing fragments of Naids that I have found in our pools is a proof. When saved from the attacks of *Chætogaster*, even the shortest, headless, and almost immovable, fragments may go on to as full a recovery as when preserved by the observer. In one instance, I found, Aug. 21st, what was apparently five segments of some Naid's trunk, the two ends of which had closed and elongated. This had been preserved for some time, for the sur esophageal brain was well formed anteriorly, and the germs of hook combs were well defined posteriorly. It went through a rapid growth, developed eyes about the 22nd, opened the newly formed mouth about the 23rd, was supplied with food, and growing long divided between the 15–16th hook-combs and then gave off 5 buds in succession at that point till Oct. 8th, when it was lost.

The thin film with which the Naids line the jars in which they are kept may be seen to serve, there at least, as a protection against the attacks of the prowling carnivorous *Chætogasters*, and once beneath this, a fragment, like the one just referred to, may be preserved till the eyes and mouth are formed—a period usually of a fortnight. And though we should hardly have expected a mere piece of five segments to be preserved as this was, even though endowed with the power of recovery, yet we cannot regard so extended and remarkable a function as this appears to be, as useless or inoperative in the natural course of Naid-life.

[11] Careless observations made a number of years ago led me to think that the Nereids are destitute of the power of recovery from injuries, and Williams states that they always sloughed away ring after ring, in his experiments. Réaumur remarks: "Les expériences que j'ai fait faire sur des millepieds de mer, d'une toute autre longeur, sur de ces millepieds longs de sept à huit pouces, n'ont pas eu le même succès: mais les essais n'ont peutêtre pas éte encore assez répétés ni assez suivis."—*Mem. pour s. à l'hist. des Insects*, T. vi, p. 59. Thinking the latter statement very probable I retried the experiments during the past year, with more care, and in every case with success.

ART. V.—*Remarks on the Temperature of the two extreme Seasons in the Temperate Zones as affected by the Variations in the Sun's Distance and in its Angular Velocity in the Ecliptic;* abridged from a treatise on Astronomy, (in course of preparation,) by WILLIAM DENNIS, Philadelphia, Pa.

THE eccentricity of the earth's orbit being about $\frac{1}{60}$th of its mean distance from the sun, the whole variation in its distance, or the difference between its greatest and least distances, must be about $\frac{1}{30}$th of the mean: and from Kepler's law for the equal description of areas by the radius vector of the earth (or other planet), it follows that the velocity of the earth's motion in its orbit, or the consequent angular motion of the sun in the ecliptic, varies inversely as the square of this distance. Then, since a numerical quantity increased by a small fraction of itself has its square increased by (a little more than) the double of that fraction, it is evident that as the distance varies by about $\frac{1}{30}$th of its mean value, the variation in the velocity must be about $\frac{1}{15}$th of its mean.

Again, the amount of light and heat received from the sun in a given time, following the general law of influences emanating as from a centre, also varies inversely as the square of its distance, and therefore follows precisely the same law that governs the variation of the sun's angular motion in the ecliptic. Hence we conclude,

1. That the whole variation in the rate at which light and heat are received from the sun, or in other words, the difference of rate at its greatest and least distances, amounts to about $\frac{1}{15}$th of the mean rate.

2. That the amount of light and heat received from the sun while passing through *a given arc* of the ecliptic is the same in every part of its annual course; its greater distance in one part being exactly compensated by the longer time occupied in passing through the supposed arc in that part; and *vice versa.* Now the present position of the line of apsides is such that the perihelion or minimum distance of the earth from the sun occurs about the first of January, or near our winter solstice, and the aphelion or maximum distance about the first of July, or near our summer solstice; and as the solstices are the middle points of the northern and southern portions of the ecliptic respectively, it happens that nearly all that part of the ecliptic in which the sun is nearest the earth is passed over while the sun is south of the equator, and that part in which it is most remote, while it is north of that line. But since the ecliptic is divided by the equinoctial into equal portions (or arcs) it follows from the second of the conclusions just stated, that the sun communicates to

the earth the same amount of heat while over its north hemisphere or north of the equator, that it does while south of it: for although it is considerably nearer while south yet it is nearly eight days longer at the north, and this additional *time*, according to what has been shown, completely makes up for the greater *distance*. It may be worth while to note in passing that an indication or measure of the actual extent of the loss of heat sustained by the sun's increased distance is furnished by the fact that it requires about $7\frac{3}{4}$ days of the sun's influence for its compensation. The north and south hemispheres may therefore be regarded as receiving equal shares of heat in the period of a *complete year*, and popular writers on astronomy seem to have contented themselves with exhibiting this fact without examining, very carefully at least, how the different seasons of the two hemispheres respectively are affected by the manner in which these shares are distributed;—an inquiry in some respects more interesting perhaps than that concerning the equality of the shares themselves.[1] It is the effects of the variations in the sun's distance and in its angular motion in the ecliptic upon this distribution and consequently upon the extreme seasons in the temperate zones, that are now to be considered.

It will be sufficiently accurate for our present purpose, and will tend to simplicity of statement, to suppose the duration of the summers and winters of the two hemispheres to be determined by the sun's passage through those two quadrants of the ecliptic that have its perigee and apogee for their middle points respectively: these limits will assign to them two periods of which one extends from about the middle of May to the middle of August, and the other from the middle of November to the middle of February, fully including the extremes of both seasons. Now it was remarked in a preceding chapter that the earth is receiving heat from the sun and parting with it by radiation at all seasons, and that when at any given place or latitude the gain by the one process exceeds from day to day the loss by the other, a gradual elevation of the general or average tempe-

[1] "Now the perihelion of the orbit is situated nearly at the place of the northern winter solstice, so that were it not for the compensation just described the effect would be to exaggerate the difference of summer and winter in the southern hemisphere, and to moderate it in the northern. . . . As it is, however, no such inequality subsists, but an equal and impartial distribution of light and heat is accorded to both."—Herschel, *Outlines of Astronomy*, London, 1849. It will presently appear that the exaggeration and moderation here referred to are produced to some extent notwithstanding the compensation.

Arago, (Pop. Astron., London, 1858), illustrating this compensation, remarks: "Thus the two warm seasons of our atmosphere (spring and summer) are certainly somewhat colder than the warm seasons of the southern hemisphere, but they are at the same time of longer duration." Had he employed the cold seasons in the illustration it would have run thus,—they are certainly somewhat milder at the north, "*but* they are at the same time" *shorter;* which, instead of being a compensation, would of course make them milder still.

rature takes place: when the loss exceeds the gain a gradual reduction must of course result. It is by these two processes respectively that the high heat of summer and the severe cold of winter are produced. As it follows directly from the law of compensation just explained that the same amount of heat is received from the sun during each of the two winters (northern and southern) and also the same amount during each of the two summers, the question of the effects of the variations under consideration turns upon the influence which they shall appear to have upon that gradual elevation, and that gradual reduction of temperature from which, as just stated, the extremes of these two seasons result. It will enable us to estimate more correctly the extent and importance of these effects to observe how they are concentrated, so to speak, upon these two seasons. Thus the sun is not quite 7¾ days longer north of the equator than south of it in the tropical year, while it is 4¾ days, or more than ⅗ths of this whole difference, longer in the north or apogee quadrant than in the south or perigee quadrant of the ecliptic: the northern summer is therefore 4¾ days longer than the southern and the northern winter shorter than the southern by the same amount. Again, the whole change in the sun's apparent semidiameter, which is the index of its change of distance, amounts to 32″, but in the apogee quadrant it varies from its minimum (about July 1) and in the perigee quadrant from its maximum (Jan. 1) only about 5″: in fact its mean semidiameter while in either of these arcs does not differ from the extreme limit belonging to that arc but about 1″·5. To this it may be added, as not without a bearing on the same point, that the controlling cause itself of the change of seasons has its influence in like manner concentrated upon these quadrants; for while the maximum declination of the sun is but 23½° its mean declination while in these two arcs is about 20⅔° or its mean distance from the tropics respectively less than 3°. Let us now keep in view the following particulars:—

1. The sun is at its perigee at midwinter and at its apogee at midsummer, using those terms with reference to the north hemisphere.

2. It dispenses the same amount of heat while passing through the apogee quadrant of the ecliptic, (summer, north—winter, south), as while in the perigee quadrant, (winter, north—summer, south) but is 4¾ days longer in the former than in the latter.

3. While in these quadrants it varies but little in the one from its maximum, and in the other from its minimum distance; and its declination is on an average near the maximum in both.

4. The high heat of summer and the severe cold of winter are the results of a gradual accumulation of heat in the earth's sur-

face, (including the atmosphere and objects on the surface,) and a gradual reduction of its temperature by loss or waste in those two seasons respectively, and not *direct* results of the gain or loss from day to day. Then, since opposite seasons occur at the same time in the two opposite hemispheres, we evidently have the following results as consequences of the variations in question *with the present position of the line of apsides.*

North Hemisphere.	*South Hemisphere.*
Summer cooler from the sun's being more distant.	Winter colder from the sun's being more distant.
" hotter for being longer.	" " for being longer.
Winter warmer from the sun's being nearer.	Summer hotter from the sun's being nearer.
" " for being shorter.	" cooler for being shorter.

Directing our attention first to the summers we find in these the two conditions of time and distance opposed in their influence: in the northern summer the sun is more distant but the time longer; in the southern the sun is nearer but the time shorter: but as the same amount of heat is received in each, we have only to consider whether its being received in a longer or shorter time will be most favorable to accumulation. If all the heat were retained there would of course be no difference, but as a large portion is lost each day (at night) by radiation, and this continues in the northern summer for a *longer time*, it seems to follow that the accumulation must be greater in the shorter or southern summer. It is true that the radiation during the night will be more rapid where the days are hotter, as those of the short summer must necessarily be, but the loss by increased radiation does not equal the gain arising from the more rapid reception, for if it did there would be no accumulation in summer. If the supply, supposing its rate constant, were continued indefinitely, a limit would doubtless be reached at which, a very high temperature having been produced, the loss or radiation would become equal to the supply, but that the heat of summer is very far below this limit is clearly shown by the fact that the accumulation continues for about a month after the summer solstice, that is, after the supply has begun to decline. We are justified then in concluding that in the short summer of the south not only are the days hotter and the force of the sun's direct rays considerably greater, but that, other conditions being the same, the accumulation of heat or average temperature will reach a higher point.

Referring again to the statement of results on a preceding page, and turning our attention now to the winters, we at once perceive that in these the conditions of time and distance are not, as in the summers, opposed to each other in their effects but combined, so that instead of one being compensated by the other they both conspire to produce the same result. The cold of winter not being, like summer heat, produced by the sun but by radiation or loss of heat in spite of the sun's influence, (a point that seems not to have been sufficiently attended to by some writers,) it happens that the two conditions referred to have a different relation to each other in the two opposite seasons, being as just stated opposed to each other in the one case while in the other both contribute towards the same result. Thus in our northern winter not only is the sun near its minimum distance throughout the whole period in which the principal reduction of temperature takes place and during which it is most rapid, but the period itself is materially shortened. For these combined influences there seems to be no effective compensation, and it can hardly be doubted that the present arrangement gives to our northern winters a character very considerably different from that which they would present were the position of the line of apsides reversed. It is remarked by Herschel, in reference to the southern summer, that "$\frac{1}{15}$th is too considerable a fraction of the whole intensity of sunshine not to aggravate in a serious degree the sufferings of those who are exposed to it." But in this case not only is the winter reduction of temperature counteracted by the addition of this 'considerable fraction' to the supply, but the *time* of rapid reduction is shortened by about $\frac{1}{19}$th of its whole amount. Under these circumstances it becomes a matter of some interest to know that although the perihelion of the earth's orbit has a progressive motion yet the rate is so extremely slow that it would require about 50,000 years for the perihelion and aphelion to change places, and we may therefore congratulate ourselves that things are as they are, without the least concern as to what a reversed position of these points would produce. Indeed, such changes by their very slowness provide against all the inconveniences that at first sight might be supposed likely to result from their accomplishment.

In the southern winter the two conditions also combine, but their joint effect in this case takes the opposite direction. The cooling process by which the temperature is gradually reduced at this season has its rate increased by the increased distance of the sun, and the time during which this high rate continues is extended. While therefore the effect of the present position of the earth's orbit is to make the winters of the north milder, its tendency to make those of the southern hemisphere more severe is equally decided: and could a comparison of the two be instituted on the basis of actual observation under conditions in any tolerable degree similar the contrast would doubtless be striking. But circumstances of geographical position seem to render such a comparison impracticable. The small portions of the two continents extending into the south temperate zone are so surrounded by oceans, especially on the cold or polar side, as to render their position in effect insular, and the influence of insular position upon climate, particularly when the surrounding waters are broad oceans, is too well known to be insisted on. The actual difference between a northern and a southern summer, under similar circumstances of situation, would probably be equally striking; for although the more rapid supply of heat at the south is, as we have seen, in some measure counteracted by its shorter continuance, yet $\frac{1}{15}$th of the sun's heat is a much larger quantity in summer than in winter, and being moreover added when the heat is at its maximum instead of minimum, its direct effect would necessarily be much more marked. It is possible that, owing to the greater stillness of the atmosphere in summer, the influence of geographical position may be less effective at that season than in winter; however that may be, the testimony of travellers and from other sources clearly indicates, not only a hotter sunshine, but hotter days in Southern Australia than are ever observed in the north temperate zone.[2]

ART. VI.—*On the Solution of Ice formed on Inland Waters;* by B. F. HARRISON, M.D., U. S. A., of Wallingford, Conn.

FROM the first settlement of this country, the people residing near some of our inland waters have observed that the great fields of ice, which covered these waters during the winter, have broken up at the approach of spring and disappeared so suddenly, as to excite the astonishment of all who beheld it. At the meeting of the American Association for the Advancement of Science, held at Springfield, Mass., General Totten stated that he had known the ice to disappear from the whole surface of Lake Champlain in a single night, when the ice was many inches in thickness, though it had previously lost much of its solidity.[1]

In the year 1859, for the purpose of investigating this subject, I commenced a series of observations on the waters and ice of a little lake about one mile long by half a mile broad and twenty-

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[2] The following paragraph was extensively circulated in the public papers a few years ago. Some expressed doubts respecting the accuracy of the figures, but no explanation, so far as I observed, was offered. As Adelaide is situated near the coast (lat. 35° S.), the wind spoken of was doubtless from the *interior*, and that circumstance in connection with what has been here set forth, would fully explain the high heat described.

Australian Heat.—The Sumpter (S. C.) Watchman publishes the following extract from a private letter, dated Adelaide, Feb. 18, 1858:—"I can assure you we have nearly been roasted alive: we have had ten days and nights of the hottest weather remembered for several years past. The heat at noon in the shade was 136° to 146°, according to situation, and during the night, it was never less than 94° to 106° in-doors. The hot wind never ceased blowing, and the innumerable deaths from *coup de soleil* have been appalling in the extreme."

[1] See General Totten's article in this Journal, [2], xxviii, 359.

five feet deep, situated in latitude a little less than 42½° N., on the borders of New Haven and Middlesex counties, in the state of Connecticut. On the north and east the lake is sheltered by trap hills rising abruptly to the height of two or three hundred feet, and on the south and west there are long rolling hills of no great elevation, so that the south and southwest winds alone sweep unimpeded over its surface. The surface drained by the lake is small, probably not exceeding twice its own surface—there are some small springs and little streams flowing into it, but probably none of them are sixty rods in length. These circumstances render the lake entirely exempt from those influences which are exerted by large flowing streams, and which also lead to an annual change of level of 16 or 18 inches. The lake has an outlet through which a small stream flows except in some of the driest seasons.

Sept. 3, 1859, I found the temperature of the water at the surface of the lake 71° F. Nov. 2d it was 48° F. Dec. 31st, 1859, I visited the lake again and learned that it had been covered with ice since Dec. 5th. I found the ice at the time of this visit pretty uniformly 7 inches thick. I selected two stations, one 5 or 6 rods from the shore, the other near the centre of the lake and observed the temperature at different depths as shown in the following table.

Temperature of water 5 or 6 rods from shore.			Station near centre of the lake.	
Dec. 31, 1859. Ice 7 in. thick.	Depth below surface.	Temperature.	Below the surface.	Temperature.
Mean temperature of the waters of the lake 35°·1 as determined from the most reliable experiments.	Under the ice.	33° F.	Under the ice.	33° F.
	6 feet.	34°	6 feet.	33°
	12 "	34°	12 "	34°
	22 "	38°	18 "	37½°
			25 "	39½°
Jan. 23, 1860, ice 10 or 11 in. thick.	Under the ice.	34°	Under the ice.	34½°
Mean temperature of the lake from the most reliable of these experiments, 38°·7 giving a rise since Dec. 31st of 3°.6.	3 feet.	38°	3 feet.	37°
	6 "	39°	6 "	38½°
	12 "	40°	12 "	39½°
	18 "	40°	18 "	40°
	23 " bottom.	42°	24 "	41½°
			25 " bottom.	43½°
Feb. 15, 1860, ice 14 or 15 in. thick.	Under the ice.	33½°	Under the ice.	33°
Mean temperature of the water at both stations 39°·4. Rise in temperature for the last 23 days 0°·7.	3 feet.	41°	6 feet.	40°
	12 "	41°	12 "	40½°
	18 "	41½°	18 "	41½°
	23 "	42°	24 "	42°

The mean temperature of the atmosphere from Dec. 31st, 1859, to Jan. 23d, 1860, was 26°·3. The fall of water for the same time was 2·17 inches, which included the water obtained by melting snow, which fell to the depth of 10 inches.

The mean temperature of the atmosphere from Jan. 23 to Feb. 15 was 26°·4. The fall of water for this period was 1·36 inches, including six inches of snow. The observations of Feb. 23d were made with great difficulty, as the temperature of the atmosphere was only 18° F., and the water on the thermometer when brought to the surface was quickly converted into ice so that it was difficult to keep it clear.

March 6th, 1860, I found that the lake had been open at the borders for three or four days. One-fourth to one-third of the lake was now free from ice, and the remainder of the ice was rapidly disappearing: one-fourth or one-third of the ice which I found on the lake disappeared during two hours while I remained in sight of the lake. With the aid of a boat I found the temperature of the lake, in the middle of the open water, to be 42° from the surface to the bottom. Near the edge of the remaining field of ice the temperature was 41° from the surface to the bottom. Close to the edge of the ice the temperature varied from 34° to 38°. The mean temperature of the lake at this time may be considered about 41°·5 F.

July 11th, 1860, I found the temperature of the lake at the surface 73°·5. Aug. 18th, 1860, the temperature of the surface of shallow water near the shore was 77°; near the centre of the lake the surface water was 75°; at a depth of 15 feet, 74°; at the bottom (24 feet), 73°.

Sept. 15th, 1860 (at $5\frac{1}{2}$ P. M.), surface water 67° to 68° with no perceptible difference from the surface to the bottom.

Oct. 27th, 1860. Clear and warm all day—no wind. Observations were made at 4 P. M. Temperature of the surface of the lake 54°·5; 6 ft. below the surface 53°; at 12 ft., 53°; at 18 ft., 52°·5; at 24 ft., 52°·5.

Dec. 6th, 1860. There was no ice on the lake and the temperature was 42°·5 from the surface to the bottom.

Dec. 17th, 1860. The lake was covered with ice 6 in. thick. Temperature of the surface under the ice, 34°.

At a depth of 6 ft. $35\frac{1}{3}$°, at 12 ft. $35\frac{1}{3}$°.
" " 18 " $35\frac{2}{3}$°, " 24 ft. (bottom) $36\frac{2}{3}$°.

The mean of the whole is 35°·4; but it is probable that the observation at the surface was affected by the agitation of the water in cutting the ice;—if we put the temperature of the surface at $32\frac{1}{2}$° the mean will be 35·°1. The temperature of the air at 2 P. M. was 35°.

Jan. 5th, 1861, the ice was 10 inches thick. Temperature of the water immediately under the ice $32\frac{1}{2}$°.

At a depth of 3 ft. 36°, at 6 ft. 37°.
" " 9 ft. 37½°, " 12 ft. 38°.
" " 15 ft. 38°, " 18 ft. 38°.
" " 21 ft. 39°, " 24½ ft. (bottom) 40°.

Mean temperature of the lake 37°·33. The mean temperature of the air since Dec. 17th, 26°·78. Amount of water fallen, 4·24 inches, of which there were 1½ inches of melted snow. Rise of mean temperature of the lake in 19 days, 2°·23, although the mean temperature of the air had been nearly eleven degrees lower than the temperature to which the lake attained.

Jan. 23d, 1861, found the ice on the lake 16 or 17 inches thick. Temperature of water at the surface under the ice 31°·5.

At a depth of 3 ft. 35°·5, at 6 ft. 38°·33.
" " 9 ft. 38°·5, " 12 ft. 38°·5.
" " 15 ft. 38°·5, " 18 ft. 38°·67.
" " 21 ft. 39°·5, " 24 ft. 40°·5.
" " 25 ft. 40°·5,

Mean temperature of the lake 37°·95.[2] Mean temperature of the air since Jan. 5th, 22°·88. Amount of water fallen during the interval, 2·19 inches, including the water from 11 inches of snow. Rise in the mean temperature of the lake, 1°·7.

Feb. 1st, 1861. Thickness of the ice not noted. Temperature at the surface of the water under the ice 33°.

At a depth of 3 ft. 34°·5, at 6 ft. 38°·5.
" " 9 ft. 39°, " 12 ft. 38°·75.
" " 15 ft. 39°, " 18 ft. 39°·25.
" " 21 ft. 40°, " 24 ft. 40°·25.

Mean temperature of the lake 38°. Mean temperature of the atmosphere since Jan. 23, 22°·9. Rise in mean temperature of the lake in 9 days, 0°·62. Water fallen, 1·29 inches, part of which was from 8 inches of snow melted.

Feb. 27, 1861. Ice 9 inches thick. Temperature of surface water 35°.

At a depth of 3 ft. 40°·5, at 6 ft. 41°.
" " 9 ft. 41°·5, " 12 ft. 41°·66.
" " 15 ft. 41°·66, " 18 ft. 41°·66.
" " 21 ft. 41°·66, " 24 ft. 41°·75.
" " 27 ft. 41°·75.

Mean temperature of the lake 40°·8. Rise in temperature of the lake since Feb. 1st, 2°·8. Water fallen, 2·9 inches—no snow. Mean temperature of the air for the same period, 31°·48, but for the last half of the period the mean temperature was 35°

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[2] The temperature of the open air at this time was 15°, which probably diminishes the observed temperature at the surface. If we call the surface temperature 32° the mean will be 38°.

or 36°. After the last observations, I did not visit the lake for a long period, but I believe the ice disappeared early in March. Such a result might have been anticipated as the temperature of the air had already risen several degrees above the freezing point and the water beneath the ice (which was nowhere broken) contained heat sufficient to dissolve one and three-fourths times as much ice as then covered its surface.

In considering the causes of the phenomena here recorded, it becomes important to take into consideration the temperature of the earth's surface in this latitude, and the variations of temperature for a short distance below the surface. The mean temperature of the earth at all depths short of one hundred feet is very little higher than the mean temperature of the atmosphere. But while the successive seasons impart their varying temperatures to the surface, these temperatures are so slow in finding their way to the depths below, that it is nearly January before the temperature of July has reached to its greatest depth, and hence at that point the seasons are reversed. At these greater depths, the differences between the seasons is exceedingly small, diminishing as the depth increases nearly in a geometrical ratio, so that while the mean daily temperature of the atmosphere varies 40° or 45° between winter and summer, at the depth of 25 feet the variation of temperature is only two degrees, and at 50 feet only one-fifth of a degree.

I have ascertained that the water in the lake, where my observations have been taken, attained, during the warm season, a temperature throughout its depth above the mean temperature of the air for the season, although I have not examined the water at different depths with sufficient frequency to decide whether it is constantly so during the warm season. This temperature, as might be expected, in its progress falls behind the season, but I have not observed precisely how much.

Having ascertained these facts it necessarily follows that the earthy basin in which the lake rests is heated up, during the warm season, to as high a temperature as the same extent of uncovered earth. At the approach of the cold season, the waters will not only part with the heat acquired during the summer, but the earth below the lake will have as much heat to part with as any other equal surface of land.

Open water, exposed to the wind, parts with its heat not only by radiation and conduction, but by transportation or convection, that is, the water which is chilled at the surface sinks while the warmer water rises, until the surface reaches its maximum density, 39°·2 F. (=4° C.). When the surface becomes covered with ice the process of cooling proceeds much less rapidly. But when the ice has covered the surface of the lake, and all agitation of its waters has ceased, the earthy bed still continues to impart its redundant heat to the superincumbent waters. My observations show that the basin of the lake is in much the same relation with the heat of summer that it would be if there were no water in it—that is, it receives about the same mean temperature; but in winter the case is widely different. The bottom of the lake is never cooled below 39°, and even this temperature is considerably lower than would be reached at an equal depth (25 feet) in the solid earth, where, if the authorities are correct, the temperature should not fall below 46° for our latitude. The lake in winter has assimilated itself to the solid earth in that it has attained its maximum density and its surface is converted into solid ice; both the ice and the water in this condition are so slow conductors of heat that very little can escape into the atmosphere. Under these circumstances, the tendency to the equilibrium of heat in the earth will raise the temperature at the depth of 25 feet (the bottom of the lake) to its usual amount at that depth from the earth's surface, and that too quite independent of any accumulation of summer heat. Thus we find another source of heat below the lake, which we may expect to augment the temperature of the waters under the ice. It thus happens that the bottom of the lake attains the mean temperature of the atmosphere in the warm season, and that it always is maintained at a temperature 20° above the mean of the coldest months.

Water attains its maximum density at 39°·2 F., from which point it is said to expand by a change of temperature in either direction; yet my observations appear to show that water in large masses may be heated up to 42° without disturbing its equilibrium. I have often found the temperature of 42° at the bottom of the lake (25 feet) when the surface was 33°, and 39° was found only 6 feet below the surface. A mass of water with its maximum density at a distance from its surface of only one-fourth part of its depth would doubtless have its equilibrium very easily disturbed by any agitation, as of the wind, and thus bring the warmer water of the bottom into contact with the ice at its surface. I do not claim that all the ice is dissolved in this manner, I only propose to show that, when the solution has commenced, natural laws bring into action an amount of reserved heat sufficient to finish the solution in a very short time.

When, on the approach of winter, the process of cooling commences it proceeds much more rapidly in the waters of the lake than in the earthy bed on which it rests;—the heat escaping from the water by radiation, evaporation, conduction and convection, the colder water at the surface sinking and the warmer rising, until the water of the lake attains its greatest density, after which the surface water expands as it cools and soon freezes, producing a covering of ice which protects the water from agitation by the winds. The process of heating from below then commences, and, according to my observations in the winter of 1859 and 1860, this process proceeds more rapidly for the first few weeks than afterwards. From Dec. 31st, 1859 to Jan. 23d, 1860, the mean temperature of the lake rose 3°·6, and in the next 23 days only 0°·7. During both these intervals, the mean temperature of the atmosphere was about 26°, from which it appears that the increase of temperature was not due to the atmosphere. The rise of temperature could not have been produced to any notable degree by the sun's rays, for the ice was opake with air bubbles, and it was also soon covered with snow; this was especially true in the latter part of the winter, when the heat again increased more rapidly, and was always found to be greatest in the mud at the bottom of the lake. During the 20 days ending March 6th, 1860, the mean temperature of the lake rose 2°·1, but the mean temperature of the air was 35°·25, and 2·5 inches of rain had fallen, a part of it from the southeast, and quite warm; a large amount of heat had also been expended in the solution of ice, so that we have no data for estimating accurately the supply and expenditure of heat during this period. From Dec. 31st, 1859, to Jan. 23, 1860, the temperature of the lake rose 3°·6 (from 35°·1 to 38°·7), and as the mean temperature of the air was only 26°·3, we may be sure that the accession of heat took place entirely from below.

Taking the mean depth of the lake at 22 feet, or 264 inches, a rise of 3°·6 would be equivalent to a rise of one degree through a depth of $3·6 \times 264 = 950·4$ inches; and since the latent heat of water is 142°, this amount of heat would melt a layer of ice $950·4 \div 142 = 6·69$ inches thick over the entire surface of the lake.

The observations made during the winter of 1860 and 1861 show similar results. In the first interval of 19 days, the mean temperature of the lake rose 2°·23, while the mean temperature of the atmosphere was 26°·78. During the second interval (18 days), the mean temperature of the lake rose 0°·7, while the mean temperature of the atmosphere was 22°·88. During the third interval (9 days), the temperature of the lake rose 0°·62, with an atmospheric temperature of 22°·9. During the fourth interval (26 days), the temperature of the lake rose 2°·8, with the mean temperature of the atmosphere 31°·48; but during the latter half of this period the mean atmospheric temperature was 35° to 36°; no snow, but 2·9 inches of rain fell; it was warm for the season. Since with an atmospheric temperature of 31°·48 there could have been little or no loss of heat, and during the latter part of the period there should have been some gain from above, it was to be expected that more heat would accumulate, including that from below, than during other periods. In the first interval of observations the accumulation of heat was as rapid as in the last, although the temperature of the atmosphere was much lower,—so low, indeed, as to cause a constant loss of heat from the waters of the lake even by bad conductors. The water was at no point found as high as 42°, not even at the bottom, although it was as high as last year.[3]

The observations made during the summer and autumn of 1860 show that the water at the bottom of the lake (at a depth of 25 feet,) attains a temperature above the mean of any month in the year in this latitude. How much of this heat is imparted to the earth, or to what depth it penetrates, I have had no means of observing. The rapidity with which the water receives heat, after the surface is covered with ice, is as conspicuous this season as it was the last. From Dec. 17th, 1860, to Jan. 5, 1861, (19 days), the temperature of the lake rose 2°·23. From Jan. 5th to the 23d, (18 days), the temperature of the lake rose only 0°·7, with a difference of only two degrees in the mean temperature of the atmosphere. From Jan. 23d to Feb. 1, (8 days), there was no perceptible change, but from Feb. 1st to the 27th the temperature of the water rose 2°·8; the temperature of the atmosphere had in the mean time risen too high to allow any loss of heat in that direction, and even sufficiently high to supply heat.

On the approach of spring, when the rains and the increasing heat of the atmosphere have thinned the ice and opened some holes so that the winds may agitate the waters, this great store of heat accumulated in the lower strata of waters, which now have their unstable equilibrium disturbed, begins to be applied to the ice, which under such circumstances could not be expected to resist solution more than a few hours.

It should be remembered that the mean temperature of the earth at a depth of twenty feet is sufficient to supply a large amount of heat to the bottom of the lake in winter, independent of any accumulation during the warm season.

Similar observations were continued in the winter of 1861–'62, with results so exactly coincident with the preceding, that their presentation could be of no other value than to confirm the conclusions which have here been given.

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[3] The thermometer used in the winter of 1860 and '61 gives temperatures a fraction of a degree lower than the thermometer used the previous year. The observations for the summer and autumn of 1860 and winter of 1861 were made with a self-registering thermometer constructed by James Green of New York.

ART. VII.—*Caricography;* by C. DEWEY.

(Continued from vol. xxxii, p. 41.

No. 277. *Carex turgescens*, Tor. Boott's Illust., No. 221.

Spica staminifera conica terminali erecta brevi-pedunculata cylindracea, squamis oblongis acutis sub-albis tecta; pistilliferis 2 vel 1–3 ovatis suboblongis laxifloris approximatis vel distantibus, superiore sessili et inferiore sæpe longe et exserte pedunculata, bracteatis et luteolis; fructibus *tristigmaticis* 3–12 ovato-conicis teretibus sub-triquetris vel ovato-oblongis rostratis brevi-bifidis multi-nervatis glabris ore subciliatis maturitate perdivergentibus, squama ovato-acuta vel sub-obtusa paulo—duplo longioribus; culmo erecto longo pertenui foliis angustis rigidis longiore.

Culm 2–3 feet high, erect, stiff, very slender, longer than the narrow rigid leaves; bracts narrow and leaf-like, the upper sometimes surpassing the culm, sometimes the lower or both; pistillate spikes 2, sometimes 3, the upper near the staminate and sessile, the lower remote, and the third often more remote and exsert long-pedunculate, ovate or oblong and short, pale or yellowish, rather loose-flowered; stigmas 3; fruit ovate-conic or triquetrous, terete and rostrate, sub-inflated, short-bifid, nerved, glabrous, roughish at the orifice, diverging, and when mature more divergent, twice or more longer than the ovate acute and sub-obtuse scale; plant pale or light green.

Florida, *Dr. Chapman;* North Carolina, *Rev. M. A. Curtis*, and in the States south and west of the latter—*Chapman.*

Note. This is the plant originally described by Dr. Torrey, Mon., p. 419, but not much *turgescent* ever; and C. turgescens, vol. iii, p. 356 and No. 212 of this Journal, 1847, is C. Halei, *Carey*, 1858, a very different plant; though the descriptions of the two in the *Illustrations* are very near each other. C. Halei has *very inflated* fruit, truly *turgescent*, even more than C. intumescens, *Rudge*, or C. lupulina as noted in Boott. Illust. The C. Halei, vol. ii, p. 248, 1846, is a very different plant, as elsewhere explained.

278. *C. Rossii*, Boott, Fl. Bor. Am., No. 119 and Illust. No. 242, 1860.

Spica staminifera solitaria terminali erecta brevi-cylindracea pauciflora cum squamis oblongis mucronatis; pistilliferis subternis 2–4 ovatis oblongis erectis laxifloris, suprema vel 1–2 staminiferae approximata sessili, inferioribus distantibus longo-exserto-pedunculatis subradicalibus; fructibus *tristigmaticis* ovalibus 2–6 floriferis et alternis sub-longo-rostratis infra teretibus et stipitatis bifidis bicostatis pubescentibus squama ovata lanceolata subcuspidata paulo longioribus.

Culm 5–8 inches high, erect, very slender or capillary, longer than at the base and bracteate-leafy; staminate spike single, erect, short, and few-flowered, having 1–2 sessile pistillate spikes below and near it, while one or two pistillate spikes rise from towards the base, long-pedunculate and sheathed below; stigmas 3; fruit 2–6, *alternate* and loose, oval on oblong short spikes, pubescent, sub-long-rostrate, bifid and bicostate, tapering at the base so as to be stipitate; pistillate scale ovate-lanceolate and subcuspidate, sometimes reddish on the back, a little longer than the fruit especially on the lower spikes.

New Mexico, *Fendler*, from whose collection it is just received. Rocky Mountains, *Drummond.* Many years ago I named this plant as Dr. Boott had published it in the Fl. Bor. Amer. and now see, by his Illust. No. 242, in 1860, its correctness. I have also the same collected more than 20 years since at the outlet of Lake Sandford, Essex County, N. Y., and sent to me as C. umbellata, which it somewhat resembled, but having pubescent and two-ribbed, *not nerved*, fruit.

Though Dr. Boott seems to doubt whether this plant is "more than a lax variety of C. umbellata," it has such characters that "future observers" will not probably doubt its specific claims. If C. umbellata must have umbellate spikes at the root, this can not be that species. By some little change in the description, C. umbellata, C. alpestris and C. Rossii, might be united.

279. *C. Grayi*, Carey, in Sill. Journ. 1847. Boott, Illust. No. 148,—C. intumescens var. globularis, Gray in Ann. Lyc. N. Y.

Spica staminifera unica gracili cylindracea pedunculata; fruciferis 2, vel interdum singula, globosis densifloris per-amplis approximatis foliosi-bracteatis pedunculatis; fructibus *tristigmaticis* ovato-conicis tereti-rostratis multi-nervatis perinflatis divergentibus vel deflexis glabris et laevibus bidentatis squama ovata acuta vel cuspidata triplo longioribus; foliis et bracteis glabris culmo multo longioribus.

Culm 15 to 25 inches high, or more (Carey), erect, stiff, robust, smooth, but rough above lower pistillate spike, leafy below, and both leaves and bracts longer than the culm, and rather wide; terminal spike staminate and cylindric, slender; pistillate spikes two, sometimes one, approximate and pedunculate, scarcely vaginate or sheathed, large, globose or capitate, with many (15–35) flowers; fruit large and close divergent or reflexed; stigmas three; fruit ovate-conic inflated, terete-rostrate bifurcate smooth and sleek, many-nerved (20–30), thrice longer than the ovate and acute or cuspidate scale.

Oriskany, and along the Mohawk and Wood Creek, N. Y., *Dr. Gray;* Columbus, Ohio, *Sullivant;* Menard Co., Mid. Ill., *E. Hall, Esq.* To these localities must be added in this State, the vicinity of Rochester. Hunting for Carices on the 13th of June, in a grove cleared of underbrush, with Dr. F. V. Hayden of Washington City, he discovered C. Grayi, a strong and robust plant as described above. We also found several others of much interest and yet to be mentioned. The specimens from Mr. Hall had the fewest and the most fruit before seen.

This species is well characterized, and deserves, as it has received, an honored name, which is likely to endure. Yet, it is obvious that a trifling enlargement of the characters of C. intumescens, *Rudge*, would include under that name, C. Grayi, C. Halei, *Carey*, C. lupulina, and perhaps C. turgescens. Now, these are separated by such *properties of plant and fruit* as have separated C. cephalophara and C. Leavenworthii.

Note 1. Near the species above, grew C. Hitchcockiana, in large clusters, as from one root, to the number of twenty to fifty culms, scabrous, as are the leaves and sheaths also, and by no means easily confounded with C. oligocarpa, Schk.; known also long before the true oligocarpa had been known by me.

C. Careyana, *Dew.*, grew beside the last in clusters with many culms, prostrate toward maturity and as it were radiating from the central root to the circumference of a circle three feet in diameter, or more. The shortness of the culm leaves strongly contrasted with those of the preceding which much surpassed the culm.

Not far from these was abundant, in a wet place, C. lupulina, far less advanced, while at considerable distance were flourishing C. intumescens, *Rudge*, and C. lupulina, in close proximity, and little more advanced than C. Grayi.

C. Deweyana, *Schw.*, was also found in one dense matted oval turf of three feet in length and two in breadth, with the host of culms (hundreds at least) lying prostrate in all directions, light green; a plat of vegetable life more beautiful had never occurred to me.

C. marginata, *Muhl.*, so finely described and figured in Schk., but now held to be a var. of C. Pennsylvanica, *Lam.*, is also abundant here, with only radical leaves which are longer than the culm, while those of the latter are stated to be not half so long as the culm. The spikes of the former are few-fruited, and sometimes only one or two fruit or none matured, while the latter bear many more fruit. C. marginata should be a var. of the other; C. Pennsylvanica, *Lam.*, var. marginata.

Note 2. *C. alpestris*, Allion.—The description of this species, by both Wahlemberg and Willdenow, was given in vol. vii, p. 268, of this Journal for 1824. Though the application there was an error, the description is correct, and designates a species well known in Europe. The following variety has been found in Texas and farther west, and is here described as

280. *C. alpestris*, Allion, var. *tripla*, Dew.

Staminate spike terminal, oblong, short-pedunculate; pistillate spikes two or three, rarely one, near the staminate, the upper sessile and the others more or less pedunculate, while from sheaths near the root rise one to often three filiform peduncles, each with a pistillate spike at the apex, and the lowest or radical peduncle the longest and nearly equalling the culm; all the pistillate spikes short-oblong, loose and few-(3–10-) flowered; stigmas 3; fruit oval-triquetrous, tapering at both ends, sometimes rather obovate, distinctly nerved, short rostrate and beak sometimes deflected, subpubescent or scabrous, sub-alternate, sometimes equal to or longer than the oblong acuminate or mucronate scale; culm 3–8 inches high, slender, about the length of the narrow, rough, or scabrous-pubescent radical leaves.

Sometimes the radical peduncles have equal length, like those of C. umbellata, to which the plant was referred in vol. xxxi for 1861; but, if the umbellate spikes give the character, then this may belong, as mentioned by Dr. Boott, to C. alpestris; perhaps it is intermediate between the two species. It differs from the European form in its fruit bidentate and not with one-lobed orifice, longer rostrate and longer tapered below, and less obovate.

The figure of C. alpestris in Schk., like that of C. oligocarpa, does not fairly exhibit the form of the upper part of the fruit, except the beak is seen in a peculiar position. It was in this position that I first saw the resemblance to the fruit of C. oligocarpa and learned to designate the species.

Mountains of New Mexico, *Wright ;* Mountains of Texas, *Mr. Buckley.* Neither the species nor variety before found in our country.

Remarks and Corrections.

C. monticola, vol. xxxi, 1861, is C. triquetra, Boott, in Trans. Lin. Soc.; though it seemed to differ too much from his description, and was evidently new. See vol. xxxiii, 1862.

C. Wrightii, vol. xxxi, 1861, differs so much in its spikes and fruit from the description of C. microdonta, Tor. Mon., a stranger to me, that I look for more means of comparison.

The same remarks are true of C. Nebraskensis, vol. xviii, 1854, held by Dr. Boott to be C. Jamesii, Tor.; though I hope it will prove to be the plant named in honor of an old friend, Dr. E. James.

C. laevi-conica, vol. xxiv, 1857, with fruit slender and long-conic, entirely *smooth* and *hairless*, seems too far removed from a species which has broad conic fruit covered with hair, to be called a *variety* of *C. trichocarpa, Muhl.*: Boott's Illust. No. 142.

C. Thurberi, vol. xxxi, 1861, called C. hystricina by Dr. Boott, though it appeared too different, will probably come under that species in its enlarged characters.

C. Haydenii, vol. xviii, 1854, is too far removed from any specimens of C. aperta, *Boott*, that I have seen; so that it is properly renamed, if it is C. aperta, *Carey*.

C. riparia, Curtis. *C. lacustris*, Willd., var. *laxiflora*, Dew.

Staminate spikes 5–6, the highest and lowest longer than the others, all slender cylindric; pistillate spikes 3–4, long and loose-flowered for 3–4 inches in length and the lowest part very sparse-flowered, the lower long-pedunculate and excurved or nodding more or less, and the scale oblong-lanceolate or ovate-cuspidate, longer to shorter than the larger fruit; often pistillate spikes staminate at the summit.

Nebraska—*Dr. Hayden*, and also in Florida.

Though C. lacustris was said by Schk. to be *very like the preceding*, C. riparia, the two have not been united generally in our country because specimens were found to suit one or the other description. As many intermediate forms have been noticed, botanists will be glad to adhere to the union adopted by Dr. Boott, Illust. No. 268. I had contended that specimens in New England answered entirely the description of C. riparia of Europe, a point now admitted, as well as of C. lacustris; both being the same. See Boott's Illust., p. 112, right column.

ART. VIII.—*On the identification of the Cattskill Red Sandstone Group with the Chemung*; by Prof. A. WINCHELL, (in a letter addressed to Prof. Dana.)

University of Michigan, Ann Arbor, 10th Dec., 1862.

Dear Sir:—The announcement by Col. Jewett[1] of the grounds of his disbelief in the existence of the Cattskill group, within the State of New York, is producing a sensation among geologists: but it seems to me that no one who has recognized the Carboniferous aspect of the fauna of the Marshall group of Michigan and its equivalents at the West, can feel a particle of surprise at this announcement; especially if he has been in the habit of admitting the equivalency of these western rocks with the Chemung of western New York. You will remember that as long ago as last March, in referring the rocks of Michigan to their New York equivalents in compliance with your request to do so, I expressed my conviction of the equivalency of the Marshall and Chemung groups, and of their common Carboniferous character, and entirely omitted the Cattskill in consequence of my disbelief of its existence as a distinct group, and serious doubts about the Devonian character of the Old Red Sandstone of New York. These doubts originated in the winter of 1859–60, and have since been confirmed by observing the close analogy of many Marshall fossils with Old Red Sandstone species—leading me to include within the Marshall (Chemung) group the American representation of that *so-called* Devonian horizon of the Old World. I may also be permitted to allude to the interesting coincidence of my having last summer communicated to others the opinion that as the "Cattskill group" was the only serious obstacle to the elevation of the New York Chemung, with its western equivalents, into the bounds of the Carboniferous system, so that obstacle would yet be proved to be imaginary through the observations of some geologist who would show that it does not in reality overlie the Chemung.

Researches in the rocks of this age, to which I have given special attention for the past eighteen months, have furnished me with the data for some interesting conclusions, which I shall soon be prepared to present in detail; but the great interest belonging to the questions affected by my investigations, will perhaps justify me in saying at this time, that the following results are reached:—Species common to Michigan and Rockford, Ind., 7;—common to Michigan and Burlington, Iowa, 7;—common to the three localities, 3;—common to Rockford, and Missouri, 6;—common to Burlington and Missouri, 8;—common to Burlington and Ohio, 2;—common to Burlington and New York, 3;—besides

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[1] This Journal, Nov. 1862, (xxxiv, 418).

an almost universal generic identification, establishing fully the equivalency of the Chemung, Marshall, Ohio, Rockford, Burlington and Chouteau strata. The evidences that these localities are all of Carboniferous age are: 1st, The fact that, of the 135 species now known from the yellow sandstones of Burlington, no less than 40 ascend into the base of the Burlington limestone, while two rise to the upper portion of it, and one recurs in the Coal Measures. 2d. The fact that, of the known species of this horizon, at least 9 occur in the Coal Measures, or upper part of the Carboniferous limestone; while 3d, multitudes of species are clearly the local representatives of European and American Carboniferous types.

Prof. Hall's recent declaration in the Canadian Naturalist, that large areas of the rocks of New York hitherto regarded as Chemung do really fall within the limits of the Hamilton group, will at once account for the Devonian aspect of *some portions* of the Chemung fauna, as heretofore understood; and thus tend to confirm a broad generalization, and complete the adjustment of American to European Palæozoic formations.

ART. IX.—*On the Cause of the Annual Inundation of the Nile;* by WILLIAM FERREL.

IT is remarkable that the source of the Nile, and the cause of its annual inundation, notwithstanding its historic importance, have remained unknown even to the present time. Several expeditions in modern times have ascended the White Nile, which is the principal branch of the Nile, with a view of discovering its source; but the furthest point yet reached, it seems, is in latitude 3° 50′ north, and longitude 31° east. The late discovery by Captain Speke of lake Nyanza, having its southern limit in latitude 2° 30′ south, and longitude 33° 30′ east, and said by the natives to extend in a northern direction 300 miles, renders it probable that it is the source of the Nile, but it is by no means certain.

Of the theories which have been advanced to account for the annual inundation of the Nile, the last, I believe, is that set forth by Sir R. I. Murchison in his annual address before the Royal Geographical Society in 1859.[1] Taking it for granted that lake Nyanza is the source of the Nile, this theory attributes its annual inundation to the abundant discharge of water from this lake during the rainy season; but it seems to me that this theory is not tenable. According to Captain Speke the rainy season only a little south of this lake, is from November to March, and consequently cannot vary much from this period at the lake; but

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[1] See this Journal, Geographical Notices, vol. xxviii, p. 411.

the water in the lower part of the Nile, does not begin to rise until the latter part of June. Hence the water would be about seven months in flowing from this lake to the lower part of the Nile, notwithstanding this lake is about 4000 feet above the level of the sea. This would give a velocity for the flow of the water considerably less than one mile per hour, which is far less than the velocity of rivers generally, especially at the times of inundation.

In order to account for the Nile's inundations, it is necessary to understand the causes of the rainy seasons, and the laws which govern them, in the region of the sources of the Nile, and its principal tributaries. Although we know but little of these from direct observations in the region itself, yet I think we may have a pretty correct idea of them from the observation of the laws which prevail generally at other places in the same latitude. It is well known that there is a belt surrounding the earth near the equator where the northeast and southeast trade winds meet, in which an enormous amount of rain falls daily. In the regions of the trade winds on each side of this belt, which embraces nearly one half the surface of the globe, very little rain falls; but the vapor is carried to the latitude where the trades meet, where the ascending currents carry it up to a point where it is condensed, and hence nearly all the rain which would otherwise fall over the whole regions of the trade winds, falls in a narrow belt only a few degrees wide. This belt is not stationary, but vibrates with the seasons nearly 1000 miles in latitude, having its most northern position in mid-summer, and its most southern in mid-winter, of the northern hemisphere. In the Atlantic ocean the middle of this belt, when farthest north, is about the latitude of 12°, and when farthest south, it is a little south of the equator, and it is about 8° wide. Hence in the latitudes occupied by the belt, when in its extreme positions, there is one rainy season annually, continuing about five months at places near the inner limits of this belt when in its extreme positions. The width of this rainy belt, the range of vibration, and the amount of rain which falls, may be considerably modified by the continents, and especially by high mountain ranges, but still there can be no very material change in the seasons, or the laws which regulate them. Hence in South America when the rainy belt occupies its most northern position about the first of August, the watershed of the Oronoco receives an immense amount of rain, and an inundation takes place, which, near the mouth of the river, is at its maximum in September. In like manner, when this belt occupies its most southern position about the first of February, all the tributaries which flow into the north side of the Amazon becoming flooded by the immense amount of rain, an inundation follows in that river, which is at its maximum toward the mouth about the last of March, or about two months after the middle of the rainy season.

The annual inundation of the Nile, it seems to me, can be very satisfactorily accounted for in the same manner. Wherever the source of this river may be, it can have little effect in causing the inundation, for it must be a very small part of all the tributaries which make up the Nile; and it is to the sources of the principal tributaries that we must look for the cause of the inundation. We have seen that at the southern part of lake Nyanza the rainy season is from November to April, as it should be, if there is a vibrating rainy season there, as observed at other places near the equator, and hence we have reason to conclude that in mid-summer of the northern hemisphere it prevails 12° or 15° north of the equator. The extreme northern position of the north side of the rainy belt doubtless coincides with the southern limit of the great African desert, and the deserts of Arabia, which, but for the narrow strip rendered fertile by the irrigation of the Nile, would be one continuous desert, caused by the absence of rains in the belt of the trade winds. The rainy belt, therefore, from May to November, must be between the parallels of about 5° and 17° north latitude. If now we examine a map of this region, it is seen that the great water-shed drained by the Blue Nile, and its tributaries, embracing nearly all of Abysinia, and also several important tributaries of the White Nile, is situated principally between these latitudes. Hence the immense amount of rain falling in this region during the rainy season, must cause an inundation of the Nile, just as it does of the Oronoco or of the Amazon. From what has been stated, the middle of the rainy season here, must be about the first of August, and the greatest height of the lower parts of the Nile is about the first of October, so that the flood would have about two months to descend. From what we know of the usual velocity of the currents of other rivers generally, this would be just about the time required.

The rainy belt from November to May is perhaps mostly south of the equator, and the source of the Nile or some of its tributaries must extend into this belt during this season, else the Nile, flowing more than 1000 miles through a rainless region, from which it does not receive a single tributary, however small, could not be supplied with water. This is an argument in favor of the hypothesis that the Nile has its source in lake Nyanza; but I think the water-shed of that lake, would not be more than sufficient to supply the Nile at low water, and that if ever the Geography and Meteorology of this region shall be well understood, the cause of the inundation of the Nile, will be found in latitudes farther north, as stated above.

Cambridge, Mass., Dec. 12, 1862, Nautical Almanac Office.

Art. X.—*On the higher subdivisions in the Classification of Mammals;* by James D. Dana.

The precise position of Man in the system of Mammals has long been, and still remains, a subject of discussion. There are those who regard him as too remote from all other species of the class to be subject to ordinary principles of classification. But zoologists, generally, place him either in an independent order, (or subclass, if the highest divisions be subclasses,) or else at the head of the order containing the Quadrumana. Science, in searching out the system in nature, leaves psychical or intellectual qualities out of view; and this is right. It is also safe: for these immaterial characteristics have, in all cases, a material or structural expression; and when this expression is apprehended, and its true importance fully admitted, classification will not fail of its duty in recognizing the distinctions they indicate.

Cuvier, in distinguishing Man as of the order *Bimana*, and the Monkeys of the order *Quadrumana*, did not bring out to view any profound difference between the groups. The relations of the two are so close, that Man, on this ground alone, would be far from certain of his separate place. No reason can be derived from the study of other departments of the Mammals, or of the animal kingdom, for considering the having of two hands a mark of superior rank to the having of four.

Prof. Owen, in his recent classification of Mammals,[1] makes the characteristics of the brain the basis of the several grand divisions. But, as he admits, the distinctions fail in many cases of corresponding to the groups laid down: and although the brain of Man (his group *Archencephala*) differs in some striking points from that of the Quadrumana, yet no study of the brain alone would suggest the real distinction between the groups, or prove that Man was not coördinal with the Monkeys. In fact, the nervous system is a very unsafe basis of classification below the highest grade of subdivisions—that into subkingdoms. The same subkingdom may contain species with, and without, a distinct nervous system, and a class or order may present very wide diversities as to its form and development,—for the reason, that the system or plan of structure in species is far more authoritative in classification than the condition of the nervous system.

The fitness of the parts of the body of Man for intellectual uses and his erect position have been considered zoological characteristics of eminent importance, separating him from other Mammals. But even these qualities, although admitted to be of

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[1] This Journal, vol. xxv, pp. 7, 177, 1858—cited from the Journal of the Proceedings of the Linnæan Soc. of London, for Feb. 17 and Ap. 21, 1857.

real weight, are not, to many zoologists, unquestionable or authoritative evidence on this point.

But, while the structural distinctions mentioned may fail to establish Man's independent ordinal rank, there is a characteristic that appears to be decisive,—one, which has that deep foundation in zoological science required to give it prominence and authority.

The criterion referred to is this:—that while all other Mammals have both the anterior and posterior limbs organs of locomotion, in Man the anterior are transferred from the *locomotive* to the *cephalic* series. They serve the purposes of the *head*, and are not for locomotion. The *cephalization* of the body,—that is, the subordination of its members and structure to head-uses—so variously exemplified in the animal kingdom, here reaches its extreme limit. Man, in this, stands *alone* among Mammals.

The author has shown elsewhere[2] that this cephalization is a fundamental principle, as respects grade, in zoological life. He has not only illustrated the fact, that *concentration of the anterior extremity of the body and abbreviation of its posterior portion* is a mark of elevation; but further than this, that *the transfer of the anterior members of the thorax to the cephalic series* is the foundation of rank among the orders of Crustaceans. In the highest order of this class—that of the *Decapods*, (containing crabs, lobsters, shrimps, etc.), *nine* pairs of organs, out of the *fourteen* pertaining to the head and thorax, belong to the head—that is, to the senses and the mouth. In the second order, that of the *Tetradecapods*, there are only *seven* pairs of organs, out of the fourteen, thus devoted to the head,—two of the pairs which are mouth-organs in the Decapods being true legs in the Tetradecapods. In the third or lowest order, that of the *Entomostracans*, there are only *six*, *five*, or *four* pairs of cephalic organs; and besides, these, in most species, are partly pediform, even the mandibles having often a long foot-like branch or extremity, and the antennæ being sometimes, also, organs of prehension or locomotion.

Two of the laws bearing on grade, under this system of cephalization or decephalization, have been stated; its connection with (1) a concentration of the anterior extremity and abbreviation of the posterior extremity, and the reverse; and with (2) a transfer of thoracic members to the cephalic series, and the reverse. There is a third law which should be mentioned to explain the relations of the Entomostracans to the other orders; namely, (3) that a decline in grade, after the laxness and elongation of the anterior and posterior extremities have reached their limit, is further exhibited by a *degradation* of the body and especially of its extremities.

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[2] **See his Report on Crustacea, the Chapter on Classification, page 1395; also this Journal, vol. xxii, p. 14, 1856; where the principles explained in this paper are illustrated by many examples, and with direct reference to the general subject of classification.**

In the step down from the Decapods to the Tetradecapods, there is an illustration of this principle in the eyes of the latter being imbedded in the head instead of being pedicellate. In the Entomostracans, (1) the elongated abdomen is destitute of all but one or two of the normal pairs of members—not through a system of abbreviation, as exhibited in crabs, but a system of *degradation;* and in some species, all the normal members are wanting, and even the abdomen itself is nearly obsolete. Again (2) the two posterior pairs of thoracic legs are wanting in the species, and sometimes more than two pairs. Again, (3) at the anterior extremity, one pair of antennæ is often obsolete, and sometimes the second pair nearly or even quite so. The *Limulus*, though so large an animal, has the abdomen reduced to a straight spine, and the antennæ to a small pair of pincer-legs, while all the mouth organs are true legs—the whole structure indicating an extreme of degradation.

In the order of Decapods, having nine as the normal number of pairs of cephalic organs, the species of the highest group have these organs compacted within the least space consistent with the structure of the type; in those a grade lower, the posterior pair is a little more remote from the others and begins to be somewhat pediform; a grade lower, this pair is really pediform or nearly like the other feet; and still lower, two or three pairs are pediform. Still lower in the series of Decapods (the Schizopods), there are examples under the principle of *degradation* above explained; (1) in the absence of two or three pairs of the posterior thoracic appendages; (2) in the absence or obsolescence of the abdominal appendages; (3) in the Schizopod character of the feet. These Decapods, thus degraded, approximate to the Entomostracans, although true Decapods in type of structure. Thus the principle is exemplified within the limits of a single order, as well as in the range of orders.

This connection of cephalization with rise of rank is also illustrated abundantly in embryonic development. It is one of the fundamental principles in living nature.[3]

When then, in a group like that of Mammals, in which *two* is the prevailing number of pairs of locomotive organs, there is a transfer of the anterior of these two from the locomotive to the cephalic series, there is evidence, in this exalted cephalization

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[3] In his Manual of Geology, just published, the writer, speaking of the ancient Ganoids, has preferred to use the term *vertebrated* tails rather than *heterocercal*, because this characteristic of a prolonged vertebral column is a mark of inferiority of grade on the principle explained; and the disappearance of it, in the Mesozoic era, was an instance of that abbreviation of the posterior extremity connected with a rise in grade. It is well exemplified, also, as Agassiz has made known, in the development of the modern Ganoid, the young having a vertebrated upper lobe of the tail, which is lost before reaching the adult size. Another reason for using the term vertebrated, is, that in some of the ancient Ganoids with vertebrated tails the vertebral prolongation is central in the tail, and the form is therefore not at all heterocercal.

of the system, of a distinction of the very highest significance. Moreover, it is of the more eminent value that it occurs in a class in which the number of locomotive members is so nearly a constant number. It places Man apart from the whole series of Mammals; and does it, on the basis of a character which is fundamentally a criterion of grade. This extreme cephalization of the system is, in fact, that material or structural expression of the dominance of mind in the being, which meets the desire both of the natural and intellectual philosopher.

This cephalization of the human system has been recognized by Carus; but not in its connection with a deep-rooted structural law pervading the animal kingdom. It is the comprehensiveness of the law which gives the special fact its great weight. Aristotle, in his three groups of Mammals, the *Dipoda* or two-footed, the *Tetrapoda* or four-footed, and the *Apoda* or footless species, expresses distinctions according with this law. The term *Dipoda*, as applied to Man, is far better and more philosophical than *Bimana*.

The erect form of the structure in Man, although less authoritative in classification, is a concomitant expression of this cephalization. For the body is thus placed directly beneath the brain or the subordinating power, and no part of the structure is either anterior or posterior to it. Two feet for locomotion is the smallest possible number in an animal. Cephalic concentration and posterior abbreviation are at their maximum. The characters of the brain distinguishing the Archencephala (Man) in Prof. Owen's system, so far as based on its general form or the relative position of its parts, flow from the erect form.

Man's title to a position by himself, separate from the other Mammals in classification, appears hence to be fixed on structural as well as psychical grounds.

The other Mammals are either true *viviparous* species, or *semi-oviparous*.

The latter, including the *Marsupials* and *Monotremes*, constitute a natural group, as usually so regarded, the most fundamental characteristic of which—the immaturity of the young at birth, by which they are related to oviparous Vertebrates—suggests the name OÖTICOIDS.

The viviparous species are variously arranged by different zoologists.[4] Prof. Owen, basing his subdivisions largely, as has been stated, on the characters of the brain, makes the two groups *Gyrencephala* and *Lissencephala*,—the former so named from having, in general, the surface of the brain *convoluted*, and the latter from its being, with some exceptions, *smooth*.[5]

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[4] See Professor Owen's memoir already referred to for an account of different earlier systems of the Classification of Mammals.

[5] See this Journal, vol. xxv, pp. 178, 179, for the precise characters of these groups.

The GYRENCEPHALA include, in Prof. Owen's system, three groups—I, the *Unguiculata* (consisting, as presented by him, of the orders 1, Quadrumana, 2, Carnivora); II, the *Ungulata* (1, Artiodactyla, or Ruminantia, 2, Perissodactyla or Solidungulata and Multungulata, 3, Proboscidia, 4, Toxodontia); III, the *Mutilata* (1, Sirenia, 2, Cetacea). The LISSENCEPHALA comprise four orders, arranged by him as follows: (1) Bruta or Edentata (Sloth, etc.), (2) Cheiroptera or Bats, (3) Insectivora (Mole, Hedgehog, etc.), (4) Rodentia.

Although the characteristics of the brain do not set forth satisfactorily the distinctions between the Gyrencephala and Lissencephala, the groups themselves (first laid down with the limits here assigned, as Prof. Owen states, by Jourdan) appear to be founded in nature. In the arrangement of the groups under these two divisions, however, the system proposed below widely differs from the above.

The Crustaceans have here also afforded the writer the principles of classification on which he rests his conclusions.[6]

The orders among Crustaceans are based not only on a difference of structure and cephalization, but also on a difference in the normal magnitude of the life-system. The Decapods are built on a life-system of large size as to plan as compared with that of the Tetradecapods. Deducing the relative size from the mean dimensions of the active species under the two types, the ratio is lineally as 4 : 1. (See the papers of the author already referred to.) Moreover, while thus distinct, the subdivisions of the two orders form parallel series—the Brachyurans, Anomourans and Macrourans running a close parallel with the Isopods, Anisopods and Amphipods; for the Isopods are literally *Brachyural* Tetradecapods and the Amphipods, *Macroural.*[7]

The life-system in the Entomostracans is on a still smaller plan.

Among the viviparous Mammals (exclusive of Man) the *first* group differs from the *second* on this same principle—the fact of a larger and more powerful type of structure or life-system. This fact stands out boldly to view on comparing active species

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[6] Principles are none the less important because indicated among these lower Articulates. The turns of a closed spiral are easily mistaken for circles, as was long the case with those of flowers in plants; but if the spire be drawn out long, it then exhibits its true characters and may display details that are otherwise undiscoverable. The class of Crustaceans is an example of a type of structure thus *drawn out*—its species ranging from the microscopic memberless Rotifer to the highest crabs, and the genera are distributed, so to speak, at distant intervals along the course of the series, since they are comparatively few in number. Fundamental principles in zoological science are therefore exhibited in this class on a magnified scale, easily perceived and understood.

[7] The parallelism is complete: for the Amphipods differ from the Isopods just as the Macrourans from the Brachyurans, in having a larger and less compacted head, looser and larger mouth-organs, longer segments to the body, and an elongated foot-bearing abdomen; all, points of inferior concentration and cephalization.

of each—the orang-outang with the largest bat; the tiger with any Insectivore; the horse or elk with any Rodent; a Cetacean with any Edentate. The species of the second division, are relatively small and feeble animals; and if they are sometimes of great bulk, as with some ancient sloths, it is an example—though natural to the species—of vegetative overgrowth; for the bodies of the sloths; great and small, are, in fact, too bulky to be wielded well by the small life-system within.

Adopting this view as presenting the true basis for the subdivision of the viviparous Mammals, the two groups are significantly designated (1) MEGASTHENES (from *μεγας*, *great*, and *σθενος*, *strength*), and (2) MICROSTHENES (from *μικρος* *small* and *σθενος*). Judging of the mean size of the life-system in the two divisions from their more active as well as powerful species, the lineal ratio is not far from 4 : 1, as between the Decapods and Tetradecapods.

The orders in these two groups, the *Microsthenes* and *Megasthenes*, have throughout a precise parallelism. The *Bats* or *Chiropters* in the latter represent the *Monkeys* or *Quadrumanes* in the former, these orders having so close relations that they are made to follow one another in Cuvier's system; the *Insectivores* represent the *Carnivores;* the *Rodents* represent the *Herbivores*; and the *Brutes* or *Edentates*, the *Mutilates*.

The classification indicated is then as follows:

I. ARCHONTIA (vel DIPODA)—MAN (alone).

II. MEGASTHENA.	III. MICROSTHENA.
1. Quadrumana.	1. Cheiroptera.
2. Carnivora.	2. Insectivora.
3. Herbivora.	3. Rodentia.
4. Mutilata.	4. Bruta (Edentata.)

IV. OÖTICOIDEA.

1. Marsupialia.
2. Monotremata.

It is interesting to observe, also, that the four orders of Megasthenes rise in grade, from the 4th to the 1st, on the principles of cephalization stated; and this affords other evidence, *superadded* to that of higher importance based on difference in type of structure, as to the naturalness of these subdivisions. The species of the 4th—the Mutilates—are characterized by a degradation and partial obsolescence of the limbs; by the body being massively prolonged behind; by a large part of the elongated vertebral column being used for locomotion; by the form and the low grade of structure of the head; and by the teeth, always of extreme simplicity of form, in most species of one set only, in some excessively multiplied in number, in others all wanting;—peculiarities indicating a very low degree of cephalization, and even a *degradation* of the anterior as well as posterior extremity. Those of the 3d—the Herbivores—by a more abbreviated body; by the two pairs of limbs being complete, but serving only for locomotion; by an elongated head. Those of the 2d—the Carnivores—by the limbs being still more perfect and serving, the anterior especially, for grasping; by the head being shorter and more compacted, and, in general, more complete in the series of teeth. Those of the 1st—the Quadrumanes—by the anterior limbs serving still more perfectly as hands; by the cephalic extremity further shortened; also by the mammæ being pectoral as in man. There is, in the series of orders, an advance by stages towards that acme of cephalization, Man.

Among the Microsthenes, the rise in rank on this principle is no less apparent. It is well seen between the lowest—the Brutes—and the others. These have posteriorly a remarkably lax vertebral column, but two or three of the vertebræ being soldered together to form the sacrum. The cephalic extremity exhibits, not only a low grade of cephalic concentration, as shown in the larger number of cervical vertebræ in some species—the excessive number of teeth in some species—the characters of the skull; but also a marked example of cephalic *degradation*, in the jaws,—in the very few teeth in most species and their total absence in some—in the inferior character of the teeth, and the growth of but one set; in all of which characteristics, as well as their bulky bodies, there is a close parallelism with the Mutilates, the lowest of the Megasthenes.

ART. XI.—*Astronomical Observations with the Spectroscope;* by LEWIS M. RUTHERFURD, (in a letter to the Editors).

Gentlemen:—In the course of a conversation, last December, with Dr. Gibbs, upon the remarkable revelations of the spectroscope, he suggested the continuation of Fraunhofer's observations upon the spectra of the heavenly bodies. At that time I had not seen Fraunhoffer's paper on this subject, I immediately began a series of experiments with the view of determining the best form of instrument for the purpose; they resulted in adopting Bunsen and Kirchhoff's simple form of spectroscope, consisting of a condensing telescope with adjustable slit, a scale telescope with photographed scale of equal parts showing bright lines upon a dark ground, a flint-glass prism of 60° and an observing telescope with Hygenian eye-piece, magnifying about five times, the whole firmly but lightly mounted on seasoned wood and provided with an adapting tube in front of the slit by means of which the spectroscope is attached to the eye-tube of the equatorial by Fitz, 11¼ aperture and 14 feet focal distance. In order to obtain a sensible breadth of spectrum it was necessary to throw the star out of focus, and in this manner a large portion of the light was lost upon the jaws of the slit. Most of my observations however have been made under this disadvantage. I subsequently found Fraunhoffer's paper in the Transactions of the Bavarian Academy, and there saw that he used no slit, but upon the hypothesis that the image of a star is a point, he elongated this point to a line by means of a cylindrical lens whose action is null in the direction of the length of the spectrum but serves to give it the desired breadth. I at once adopted this idea and my instrument is now provided with such a lens made by Mr. Fitz, placed between the objective of the condensing telescope and the prism; the result is a very satisfactory increase of light, besides freeing the spectrum from the longitudinal lines of diffraction caused by the edges of the slit and the other annoyances consequent upon imperfections and dust upon the jaws. It is still however necessary to make use of the slit to confine the image to a given point in the field of view; but inasmuch as it is placed at the focus of the telescope where the image has no appreciable dimensions, no light is lost and the spectrum remains uniform and pure.[1]

It will be easily seen that the lens spoken of is serviceable only in observations upon stars, and is of no use in the spectral investigation of planets or other sources of light having appreciable dimensions. I would here incidentally remark that the spectroscope so mounted furnishes the best means of investigating the achromatic condition of the telescope; for it is evident that if the different colored rays have foci at different distances from the objective it will require a change of focus for each in order that it may comply with the condition of passing the slit (in case of a star) as a point. In my telescope, I find that the luminous rays from near the outer margin of the red to the indigo are brought to a focus at one point, the ultra red require a small but measurable adjustment, and the violet and indigo quite a large change of focus. I intend to make use of this method to find more accurately the photographic focus of the instrument which at present is determined only by experiment.

Before and after observation the spectroscope has always been examined as to the zero point, the standard being that the soda line D should coincide with division 30 on the scale, and the necessary corrections have been applied to all the observations.

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[1] Fraunhofer used no condensing telescope; he simply placed a prism and cylindrical lens before the objective of a small telescope and received the star's light directly upon the prism; being thus confined to the dimensions of the prism as the measure of the volume of light examined, he discontinued his observations, proposing to resume the subject at another time.

The observation of star spectra is of the most difficult and delicate description, requiring perfect action in the equatorial clock, great patience in the observer and skillful management of the scale illumination. Most of the lines and bands, particularly in the ends of the spectra, are faint and can only be seen in a good atmosphere.

The difficulty of the observations, the imperfection of the spectroscope and the want of a sufficient accumulation of observations, render it necessary that the places assigned to the fainter lines should be received with caution, but I believe that no line is represented on the accompanying sketch which does not exist. The smallness of the scale and the imperfection of the drawing render it necessary that I should increase the length of this communication by giving a short note upon each object.

Sun.—I have inserted the seven principal lettered lines in the solar spectrum at the points seen on the scale and carried them through the page as points of comparison. These places are the results of several observations, all of which agree absolutely, except as to the place of the lines H, for which I have taken the mean; at a future time and on a larger scale I propose to locate all the solar lines which may be visible with my instrument, and thus have further points of comparison with the stellar spectra. The reading for the sun's lines is as follows:

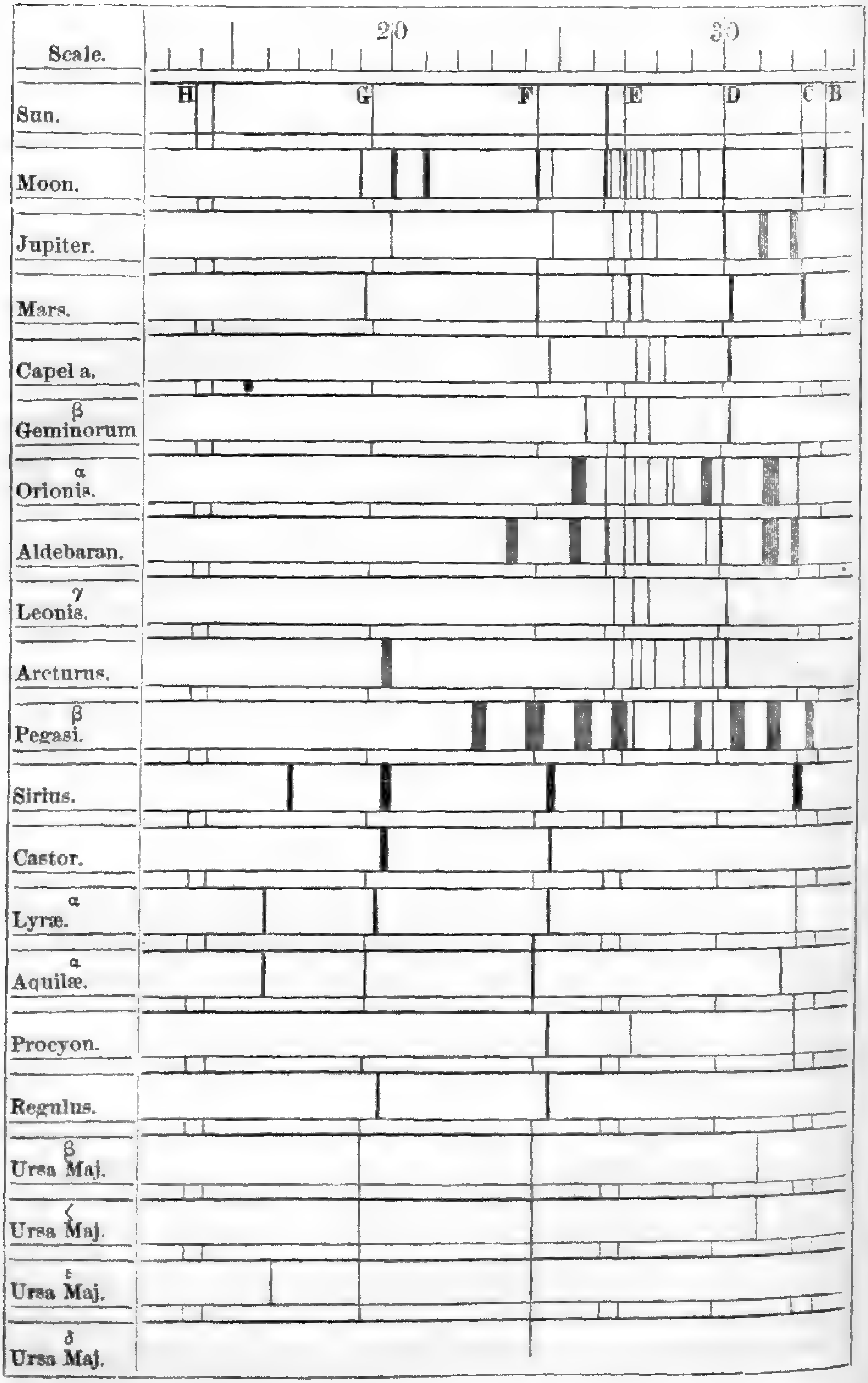
B 33·1 C 32·3 D 30· E 27· 26·5 F 24·4 G 19·3 H 14·5 13·9

Moon.—These readings are the means of two observations agreeing very closely in most particulars and coincident in all the stronger features. 33·05 broad line generally limiting the spectrum; 32·35 sharp dark line; 30·05 well defined; 29·3 faint line; 28·7 faint line; 27·8 faint line but stronger than the last; 27·65 very faint line; 27·4 darker line; 27·25 faint line; 27·05 strong line; 26·85 faint line; 26·65 line; 25·55 strong line; 24·75 line; 24·35 strong line; 21·05 faint band; 19·9 broad line; 18·09 broad dark line.

Jupiter.—Mean of three observations. 32·1 band; 31·12 band; 30 06 line; 28 faint line; 27·5 faint line; 27·26 line; 24·7 line, 19·9 line.

Mars.—Mean of three observations. 32·4 line; 30·25 well defined line; 27·5 well defined line but faint; 27·1 strongest line in the spectrum; 26 55 quite strong line; 24·4 band; 19·1 line. I would here remark that the line D is not present, as the observations made in different nights, one by myself and two by Mr. Wakeley, my assistant, agree in placing a line at 30·2 but none at 30.

ASTRONOMICAL OBSERVATIONS WITH SPECTROSCOPE.



Capella.—Mean of observations on five nights in which the greatest discrepancy is but one-tenth of a division of the scale. 30·22 line; 27·73 line; 27·38 line; 26·75 line; 24·78 line.

β Geminorum.—Mean of four observations agreeing remarkably well, greatest discrepancy one-tenth of a division.

30·23 line; 27·7 faint line seen but on one evening; 27·35 line; 26·8 line; 25·8 fine line seen but on one evening.

α Orionis.—Mean of six observations agreeing well in most of the strong features, but containing some discrepancies in the faintest lines and in the limits of the bands. This star has not yet been observed with cylindrical lens. 32·4 broad line; 31·6 to 31·2 shaded band best defined at 31·2; 30·1 line shaded towards the red; 29·5 faint band; 28·4 faint line; 28·3 fine line; 27·75 faint line; 27·3 faint line; 27 line; 26·4 strong line; 25·7 to 25·4 band.

Aldebaran.—Mean of four observations, three with lens and one without—agreeing remarkably well. 32·2 to 32 band generally limiting spectrum, still in places the red is seen beyond it. 31·6 to 31·3 band; 30 line; 29·6 faint line; 27·7 faint line; 27·4 faint line; 27 line; 26·6 rather strong line; 26·5 line not so strong as last; 25·6 faint band; 23·6 faint band seen but on one occasion.

γ Leonis.—Mean of two observations very concordant. 30·2 line; 27·7 line seen but on one occasion; 27·35 line; 26·8 line.

Arcturus.—This star has been observed but twice and without lens. I have affixed a mark of interrogation to those lines, the places of which depend upon single or somewhat discordant observations. It promises a fine spectrum with the cylindrical lens. 30·2 line; 29·85? faint; 29·5? very faint line; 28·9? faint line; 28? faint line; 27·6 line; 27·32 line; 26·82 line; 19·9 band.

β Pegasi.—This star, considering its faintness, scarcely a second magnitude, presents a remarkable spectrum which contains few lines and many bands, the limits of which are very difficult to locate. The adopted places are the means of four observations agreeing well in the main, all made with the cylindrical lens—32·8 band limiting generally the spectrum. 31·7 to 31·3 shaded band strongest at 31·3. 30·65 to 30·3 band strongest at 30·3. 29·8 faint line between which and preceding is included a yellow band or space. 29·3 faint band. 28·5 faint line. 27·3 strong line. 27·1 to 26·7 band. 26 to 25·6 band. 24·6 to 24·1 band. 22·9 to 22·5 band.

Sirius.—The spectrum of this star is one of a group which has little resemblance to those already mentioned; its lines are broad and black, they are well defined in margin, but unlike the band recorded in the foregoing notes, are totally without light, being in fact interruptions of the spectrum; no fine lines have been seen. The places are means of six nights' observations, which accord closely as might be expected from the decided nature of the lines.

32·4 broad black line. 24·8 do. 19·9 do. 16·8 do. The spectrum extends to 14·5.

Sirius has never been observed with the cylindrical lens.

Castor.—Mean of five nights' observations without lens. 24·78 strong black line; 19·87 strong black line.

α *Lyræ.*—Mean of four nights' observations. 32·2 broad but difficult; 24·7 broad dark line; 19·5 broad dark line; 16·3 seen only on one evening.

α *Aquilæ.*—Mean of three nights' observations. 31·8 line very faint, seen but on one evening; 24·4 strong line; 19·33 strong line; 16·4 faint line.

Procyon.—Mean of six nights' observations without lens. 32·3 faint line seen but once; 27·3 faint line seen but once; 24·75 strong dark line. Spectrum extends from 17·8 to 33·8.

Regulus.—Mean of five nights' observations, on one of which the lens was used, but without bringing out any more lines. 24·78 strong dark line; 19·9 strong dark line.

β *Ursa Majoris.*—Mean of two nights' observations with lens. 31·2 very faint line, seen only once; 24·35 strong line; 19·45 well defined line.

ζ *Ursa Majoris.*—Mean of three nights' observations with lens. 3·12 very faint line, seen but once; 24·53 strong line; 19·5 faint line. A line was seen in the violet, but too faint to bear the least illumination.

ε *Ursa Majoris.*—Mean of three nights' observations with lens. 24·53 strong line; 19·63 faint line; 16·5 faint line, seen but once.

δ *Ursa Majoris.*—Mean of two nights' observations with lens. 24·7 strong line. Two lines lower down on the scale were seen, but would bear no illumination.

α *Virginis*, β *Orionis*, ε *Orionis*, δ *Orionis*, ζ *Orionis* and α *Ursa Majoris* have been repeatedly examined, but although many of them, particularly the first two, present bright spectra, no lines or bands have been seen.

The sun's lines B, C, D, E, F find their counterparts in the lunar spectrum. G does not appear, but whether this absence is real or due to errors of observation remains to be proven. The moon was observed only twice—once by me and once by Mr. Wakeley; he placed the line nearest G at 19·85, and I at 19·95. When I reëxamine the lunar spectrum I intend introducing a condensing achromatic between the great objective and the slit, and in this manner increase the intensity of the light. No doubt many more lines will be brought out, and those already observed more accurately placed.

In the spectrum of Jupiter are found two bands in the red and orange, between C and D, which are not found in the solar spectrum. It may be that these bands, as well as those so remarkable in α Orionis, Aldebaran and β Pegasi, are absorption bands due to the action of the atmospheres of those bodies; still it is possible that the application of sufficient optical power would resolve them into lines.[2]

The star-spectra present such varieties that it is difficult to point out any mode of classification. For the present, I divide them into three groups: first, those having many lines and bands and most nearly resembling the sun, viz., Capella, β Geminorum, α Orionis, Aldebaran, γ Leonis, Arcturus, and β Pegasi. These are all reddish or golden stars. The second group, of which Sirius is the type, presents spectra wholly unlike that of the sun, and are white stars. The third group, comprising α Virginis, Rigel, &c., are also white stars, but show no lines: perhaps they contain no mineral substance or are incandescent without flame.

It is not my intention to hazard any conjectures based upon the foregoing observations: this is more properly the province of the chemist; and a great accumulation of accurate data should be obtained before making the daring attempt to proclaim any of the constituent elements of the stars.

One thought I cannot forbear suggesting: we have long known that "one star differeth from another star in glory;" we have now the strongest evidence that they also differ in constituent materials,—some of them perhaps having no elements to be found in some other. What then becomes of that homogeneity of original diffuse matter which is almost a logical necessity of the nebular hypothesis?

Taking advantage of past experience, I propose to remodel and improve my spectroscope and continue to observe the stars, noting particularly the relations which may exist between the spectral revelations and the color, magnitude, variability, and duplicity of the objects.

New York, Dec. 4, 1862.

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[2] Since writing the above I have seen with Dr. Gibbs the absorption-bands produced by the vapor of iodine, bromine and other kindred substances entirely composed of fine lines.

ART. XII.—*The Chemical Theory of Interpenetration;* by CHARLES S. PEIRCE, A.M.

PHYSICISTS are now rapidly doing away with all theories which demand peculiar shapes and kinds of matter in favor of those which demand peculiar vibrations. At this day, the arrow-shaped particles of the old theory of light seem grotesque. There is a good reason for this tendency. We require an explanation of forces. Now a force is only a mathematical function of a change, and a change in space can only be conceived of *a priori* as a motion. To explain a thing is to bring it into the realm of our *a priori* conceptions. Hence, whenever we endeavor to explain any force of nature by means of hypothetical shapes and properties of matter these only help us so far as they are conditions of certain motions. These motions are the real explanation; and if we can succeed in getting the motions without the peculiarities of matter, our hypothesis will be so much the smaller.

The object of the present article is to apply this principle to the Atomic Theory.

I. In the first place, it is necessary to show that the hypothesis of atoms, in itself, explains nothing.

That which the atomic theory undertakes to explain is the connection of integral numbers with chemical equivalents.

An explanatory hypothesis is one which, being admitted, necessitates all the phenomena. The laws to be explained are as follows:

1. The Law of Equivalents, or that if a units of one body combine with x of a second and y of a third; and if x of that second combines with b of a fourth, that y of the third will also combine with b of the fourth.

The explanation is that these are the weights of the atoms and that bodies combine atom by atom. But how should we know that they combine atom by atom? This is an addition to the hypothesis.

2. The Law of Multiple proportions.

How should we know that atoms will mix in any simpler ratios than black and white beans would if stirred up together?

3. The Law of Combining Volumes of Gases.

The explanation is that the atoms of all gases are equally distant. A new hypothesis.

4. The Law of Volumes of Isomorphous Crystals. Another hypothesis needed.

5. The Law of Thermal Equivalents of the Elements.

Explanation: All atoms have the same capacity for heat. Still another hypothesis, which moreover does not apply to compounds.

6. The Thermal Equivalents of Isomorphous Crystals.
7. Kopp's Law of Boiling points. How is this explained?
8. Prout's Law as modified by Dumas.

The only atomic weights which have been determined with sufficient accuracy to test the law, beside those of Stas, are the following:—

Carbon 6·01 Berzelius; 6·00 Dumas and Stas; 6·00 Erdmann and Marchand; 6·06 Liebig and Redtenbacher; 6·03 Strecker. C is not more than 6·004.

Lithium, Diehl 7·026 (prob. error ±·006); Troost 7·01, Mallet (S=16·03, Na=23·05, Mg=12·0125) 7·027. Mean 7·02.

Calcium 20·002 (C=6·004) Erdmann and Marchand.

With less accuracy we have

Iron, Svanberg and Norlin (after rejecting two discordant experiments according to Peirce's criterion) 28·048; Berzelius, 28·024; Erdmann and Marchand, 28·012; Maumené, 28·000. Mean 28·017.

Combining the first three atomic weights with those determined by Stas, we have:—

	Experiment.	Law.	Difference.	Dif.÷Exp.
K	39·154	39·25	−·096	$\frac{1}{400}$
Na	23·05	23	+·05	$\frac{1}{500}$
Ag	107·94	108	−·06	$\frac{1}{1600}$
Pb	103·45	103·5	−·05	$\frac{1}{2000}$
Cl	35·46	35·5	−·04	$\frac{1}{900}$
N	14·04	14.	+·04	$\frac{1}{350}$
S	16·03	16	+·03	$\frac{1}{500}$
H	1·005	1	+·005	$\frac{1}{200}$
Li	7·02	7	+·02	$\frac{1}{400}$
Ca	20·002	20	+·002	$\frac{1}{10.000}$
C	6·004	6	+·004	$\frac{1}{1500}$

K is an unexplained anomaly, but the probability of only one difference out of thirteen being greater than $\cdot\frac{25}{4}$ is ·0000087, while the effect of the residual influence which carries *K* out of this limit is only $\frac{1}{1200}$ of the atomic weight. Omitting *K*, the sum of the above differences is +·001; the probability of this being so small is ·035; hence, upon this consideration, the probability of the law is ·782.

The probability is, therefore, still in favor of the law. The last column in the table shows how small the residual phenomena are; and they may be made still smaller by making the unit by which the atomic weights are measured a little larger.

This law presents another example of the connection between chemical equivalents and integral numbers, and must probably be capable of a common explanation with the rest. Yet it is clear that the atomic hypothesis never can explain it.

9. It is impossible for the atomic theory to explain why the monoatomic radicles combine together without condensation in the gaseous form; while the diatomic radicles lose their own volume, the triatomic one more than their own volume, &c., in combining with the monoatomic. Why in acetic ether, for example, $\left.\begin{matrix}\text{Є}\Theta.\text{Є}H_2.H\\ 2\text{Є}H_2.H\end{matrix}\right\}\Theta$ the dibasic radicles occupy no space at all.

II. I shall now attempt to show that the facts of chemistry are explicable by the view of Kant, that matter is not absolutely impenetrable and that chemical union consists in the interpenetration of the constituents.

1. The law of definite proportions is capable of demonstration without any hypothesis. We can conceive of no event in space which does not consist of a motion. Nothing can be the cause of a motion except a motion; hence every force is a motion. And every quality of matter is either a motion or some element of the mental analysis of the conception of a body moving in some way or other. Hence, when the force of one body acts on the quality of another to produce an event, it is merely one motion modifying a second to produce a third. Motion is never stationary, but always communicates itself *from* the moving particle to all others which are in communication with that. Accordingly, when one body acts on another *through a difference of quality*, the latter will also act on the former and there will be a tendency to produce homogeneity of quality throughout the two. This homogeneity is actually established, or it is not. If it is not, the amount of force which holds back the two forces from their natural action must be just as strong as the forces themselves. It is clear, therefore, that when the force of the acting body equals that of the body acted upon, all the force will be exhausted in preventing the homogeneity. Probably, however, it might be proved that the homogeneity is always established; and if it is, it cannot be established through both motions existing at the same time without interference. For, if they had not interfered, they could not have acted upon one another. They must, therefore, destroy each other (producing a new motion) and when they are equal the peculiarities by which they acted will be neutralized and there will be no further action. Now the same kind of matter under the same dynamical conditions possesses always the same amount of force proportionally to its mass; hence when one kind of matter acts on another through being of a different kind, it can only act on a definite amount of that matter, the dynamical circumstances remaining the same.

2. Let us call the reciprocal of the Atomic Weight the Chemical Intensity. This represents the force which causes bodies to combine. It remains the same under all dynamical circumstan-

ces. Hence, it must be something inherent in matter and unaffected by all vibrations. In gases it is proportional to the elasticity, and in elementary bodies generally it is equal to the specific heat, which is the elasticity of the medium of heat-vibrations. We conclude, then, that the Chemical Intensity is the molecular or substantive elasticity. (B. Peirce.)

When heat expands the body, it is the elasticity which restores it. Any motions of vibration in a homogeneous elastic medium may be resolved into expansions and contractions. Hence, if we assume that heat produces the expansions, this elasticity is an active condensing force.

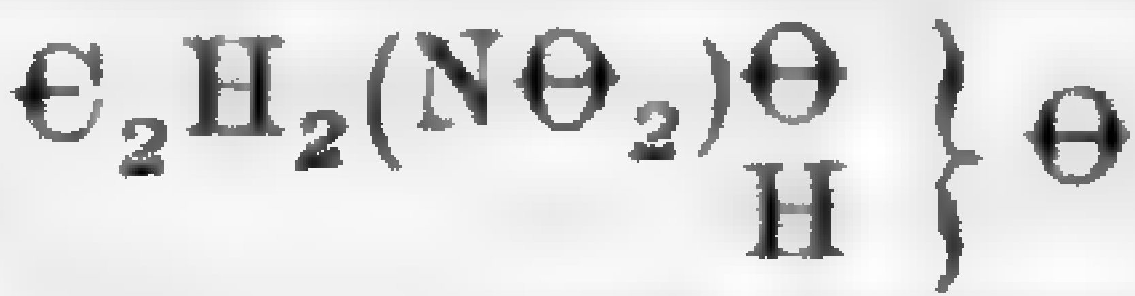
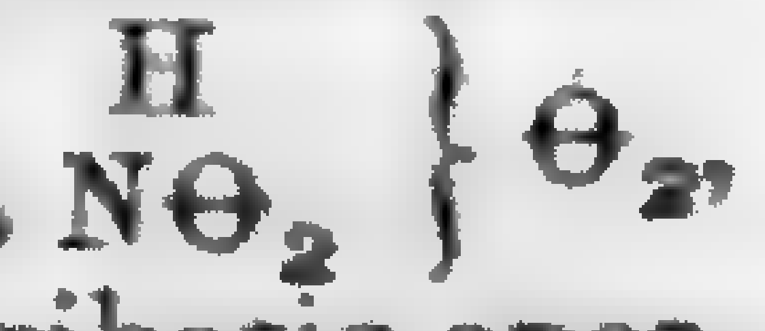
If two bodies interpenetrate it is clear that this force may hold them together. This explains the law of definite proportions, the law of vapor densities, and the law of thermal equivalents.

3. It is geometrically self-evident that interpenetration must take place between equal volumes and must result in a condensation to one half, unless some other action takes place. Accordingly we find that wherever there is no condensation there is only a double decomposition.

4. In one volume of a compound there is one equivalent of chemical intensity. Hence there is nothing to prevent its combining with one volume more, &c. This explains the law of multiple proportions, which it is to be observed has no place where the bodies unite without condensation.

5. The solid and liquid states result from the action of cohesion. Now cohesion is an attraction properly so called and acts at a distance, for if it did not it would not vary with the state of condensation. Hence it is a force affecting molecules and not matter in its continuity. This explains why the above reasonings from the state of gases are not invalidated by the facts relating to liquids and solids.

6. If we suppose, with the metaphysicians, that all the kinds of matter are derived from one, since this must have become condensed by the law of equal volumes, all the equivalents of the elements will be multiples of that of the original matter. This explains Prout's law. If, moreover, we admit that the different elements are distinguished by different elasticities, and accept the recent view that the lines of the spectroscope are only produced by elements in their free state, it will follow that every element except sodium is a mixture of several. We have no reason to suppose that these are present in equivalent proportions. So that this consideration gives room for large discrepancies from Prout's law.

7. It is observable that tribasic radicles frequently behave like monobasic ones, as N in  $\left.\begin{matrix}\text{Ͼ}_2H_2(N\Theta_2)\Theta\\ H\end{matrix}\right\}\Theta$ and in  $\left.\begin{matrix}H\\ N\Theta_2\end{matrix}\right\}\Theta_2$, and that monobasic radicles frequently behave like tribasic ones,

as Cl in ICl_3. There is the same confusion between dibasic and tetrabasic radicles, as in CO. Hence we infer that the distinction between even and odd-basic is altogether superior to that between monobasic and tribasic, dibasic and tetrabasic.

Now if a body can enter into double decomposition with hydrogen (that is, combine without condensation) it is obvious that it must be odd-basic; for in that case it will form a compound which being of two volumes cannot combine with another volume of H unless it combines with two volumes. If it does thus combine it will be tribasic, otherwise monobasic.

On the other hand, if a body cannot enter into double decomposition with the monobasic radicles, it must be even-basic; for in this case, since its volume after combination will be the same as before, there is no reason why it should not either combine with condensation with a new volume of the monobasic radicle (in which case it will be four or more basic) or else enter into double decomposition with it, in which case it will be dibasic. This explains why the dibasic radicles always lose their own volume in combining with the monobasic; why the tribasic lose twice their own volume, &c.

8. A radicle being a constituent in combination, it follows that its internal forces do not come to equilibrium of themselves, and this accounts for the fact that monobasic radicles cannot exist free. This fact is determined by reactions and not by vapor-density, for according to the present theory the volume fixes neither the atom nor the molecule but the *equivalent*, that is to say, the amount of matter containing a unit of chemical intensity. The dibasic radicles may exist in the free state because, since in combining they are condensed, it follows that there is some disturbance of their internal forces.

9. An odd-basic radicle being in itself out of equilibrium in this way, it follows that the addition of it to another radicle will change the basicity of that radicle from odd to even or from even to odd; while the addition of an even-basic radicle will have no such effect.

Cambridge, Mass., Dec. 1862.

ART. XIII.—*Exposition of the true nature of Pleurodyctium problematicum*; by CARL ROMINGER, M. D.

UNDER the above name I have long kept in my cabinet a specimen, collected at Kirchweiler in the Eifel mountains. After having identified it with the fossil described by Goldfuss, I laid it aside, and only recently, twenty years afterwards, when I happened to look over it again, the first glance convinced me that the *Pleurodyctium problematicum* is merely the cap of a *Favosites*, or more accurately speaking, of a *Michelinia*. I have subsequently found that Milne-Edwards had already recognized the family affinity between *Favosites* and *Pleurodyctium*, without however suggesting a generic identity of the two.

The fossil from Kirchweiler is represented by a lenticular cavity, a little over one inch in diameter and scarcely half an inch deep. To one side of this cavity are attached the bases of conical subangular columns, three or four millimetres thick at the lower ends; between these are interpolated a good many smaller and shorter columns. They all rapidly converge toward the centre of the opposite concavity. Their sides are longitudinally striated and covered with punctiform impressions. Numerous small cross-bars connect the columns, which are otherwise isolated from each other by a narrow intervening space.

The opposite side of the cavity, which forms the roof over the convergent smaller ends of the columns, is free, but closely approximated to them, and bears the impression of fine concentric rings of growth. This latter character is not very plain in my specimen, but Goldfuss has given a very good figure of it. He thought it to be the impression of the inner surface of a membranaceous envelope, instead of taking it for what it is,—the impression of the epitheca, surrounding the lower side of the corallum.

The vermicular body, frequently noticed adhering to or penetrating the root end of *Pleurodyctium*, is also seen in my specimen.

I was greatly surprised at observing the same vermicular perforation in some small specimens of *Michelinia*, which also in all other respects appear to be specifically identical with the coral of which the European *Pleurodyctium* is a cap.

The specimens were found in the shales of the Hamilton group, Cayuga county, New York, and are in the possession of Prof. Winchell of Ann Arbor. They form small cakes of not much over one inch in diameter. The lower side is almost flat, covered with a concentrically wrinkled epitheca; the upper side is semi-globular, and shows the mouth-ends of conical subangular tubes, the larger ones of which measure from 4 to 5 millimetres.

On the polished vertical sections of the coral, longitudinal striæ and rows of spinules, together with numerous side-pores, are visible along the walls of the tubes.

The upper part of the tubes is generally filled with calcareous matter, and shows no diaphragms, which are only preserved in the lower ends, and are in part simple, straight; in part vesicular.

The vermicular channel traverses the substance of the corallum, irrespective of the direction of the tubes, and seems to cut straight through them. After some flexures it ascends to the upper surface and opens there with a round mouth, while the other tubes are more or less angular. It is improbable that this perforating channel has anything to do with the organism of the coral, and is more likely the work of a parasitic animal; but after all it is still strange to see the majority of specimens of so distant localities attacked in the same way by a boring animal.

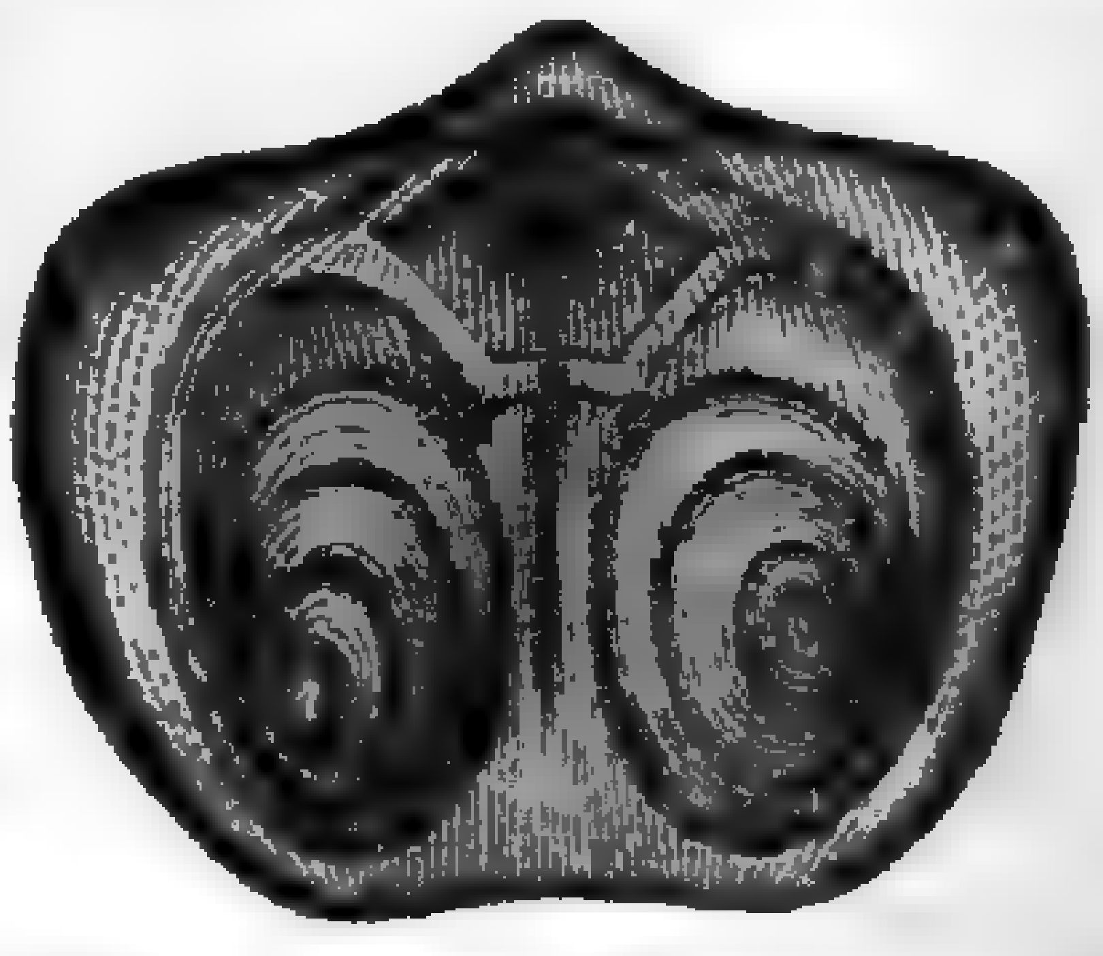
In the Corniferous limestone at Port Colborne, on Lake Erie, I lately found a cap exhibiting all the characters of *Pleurodyctium*. In its association numerous specimens of *Michelinia favositoidea* (Billings) are found, and there remains no doubt that this cast originates from a young specimen of this latter species.

In the 12th Annual Report of the Regents of the University of New York, Mr. Hall describes his genus *Leptocœlia*, but, misguided by an imperfect specimen, he gives us an incorrect idea about the form of the crura, which are in reality spirals, with three or four loose outward-turned volutions.

Some distance from their origin, the crura are divided into an exterior branch, which is spiral, and an interior, which, after running obliquely towards the front, soon bends inward and unites itself with the opposite branch. At the bend the angle projects as a little horn.

I observed this organization in translucent specimens of *Leptocœlia concava*, Hall. A perfectly similar structure is also found in *Terebratula lepida*, Goldfuss. Specimens of the latter are found in the Eifel. *Leptocœlia concava* is frequently found in our Devonian boulders.

The annexed figure is a specimen of *Lept. concava* from which the shell has been removed, the dorsal side being directed upwards.



Translucent specimen of *Leptocœlia concava*. Shell removed, upper side. The dark line in the middle is the impression left by the elevated crest in the upper valve.

Ann Arbor, Mich., Dec. 1862.

ART. XIV.—*Remarks on the family Actæonidæ, with descriptions of some new genera and sub-genera;* by F. B. MEEK.

THE family *Actæonidæ*, established by d'Orbigny, is a group of much interest to the Palæontologist and Conchologist, not merely in consequence of its comparative antiquity, and the number and diversity of forms assumed by the species of its various genera, but also because it is, as it were, a kind of prophetic group. That is to say, while the numerous species belonging to its several genera exhibit characters indicating their relations as members of the same family, they have presented, particularly during the Jurassic and Cretaceous periods, forms curiously simulating types often not then in existence, but subsequently introduced even within widely separated families. Thus in the genus *Cylindrites* which first appeared during the Jurassic period, we observe forms closely resembling the more modern genus *Oliva*, while others shade off towards *Actæon* and *Bulla*. In *Actæonella*, we have a type nearly resembling the recent genus *Volvula* of the family *Cylichnidæ;* and in the Jurassic genus *Euconactæon*, which is connected (in a family sense) through the sub-genus *Conactæon*, with *Actæonina*, there is presented a striking archetypal representation of the more recently introduced genus *Conus*. In *Globiconcha* and *Bullopsis*, the genus *Bulla* is again represented; while *Cinulia* mimics, as it were, certain groups of the *Auriculidæ*.[1] Again, if we admit into the family under consideration the genera *Pterodonta*, *Tubifer*, and *Soleniscus*, which seem to have some relations in this direction, we would have in the first a form foreshadowing some modern types of the *Strombidæ*, in the second a representative of the genus *Fusus*, and in the third, of *Fasciolaria*.

The resemblances in form and general appearance mentioned above, it should be remembered, are not as fanciful and imaginary either as might be supposed. On the contrary, they are often so close and striking as to deceive, not merely amateur collectors, but even as careful observers as Deslongchamps, Lyell and Sowerby, who at first supposed the types here called *Euconactæon* and *Conactæon* to belong to the genus *Conus*. It was not therefore until d'Orbigny and others had ascertained from the examination of better specimens, that these supposed Liassic Cones differ from the more modern genus *Conus* in never having the aperture effuse below and notched above, as well as in having the whorls all alike extremely thin,—that the true relations of these shells were understood.[2] Differences of nearly equal importance have been discovered also between the other forms and the several modern groups to which they were at first supposed to belong.

The descriptions of the family *Actæonidæ* generally given in the works on recent Conchology, although correct so far as the existing genera are concerned, do not convey a clear idea of the whole group, as developed through all the various epochs of the past, since its first introduction during the Carboniferous (or

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[1] Several of the species were at first referred. by the best palæontologists, to the genus *Auricula*.

[2] It is but just to mention here that Deslongchamps, at the same time that he referred these shells to the genus *Conus*, had observed that they differ from the modern Cones in their extreme thinness, and compared them, in that respect, to the genus *Bulla*, (*Mem. Soc. Linn. de Normandie*, vol. vii, p. 147). It was d'Orbigny, however, who first pointed out (so far as known to the writer) that they differ in thickness from the true Cones, mainly in having *all* the whorls very thin; while in *Conus* the outer whorl is thick, and the inner ones absorbed away to a mere film of shell.

Devonian?) period. D'Orbigny's description, published in 1842, when first proposing to establish a distinct family for these shells, is a more comprehensive and accurate definition of the group; but as he included in it a few genera at this time known to belong to other families, and a larger number of both fossil and recent species have since been discovered;—while some knowledge of the animal in the typical genus of the sub-family *Ringiculinæ* has been obtained, we have the means of forming more correct conclusions in regard to the limits of the family, and the relations of its various subordinate groups, than was possible at that time.

The diagnosis of this family first published by d'Orbigny (*Palæont. Française*, Terr. Cret. vol. 2, p. 106) is as follows:

"*Shell* generally oval, without epidermis, marked most usually with punctured revolving striæ or rows of pits. Spire short, sometimes entirely enveloped. Mouth entire or sinuate in front: lip simple, trenchant, or reflected and thickened without, sometimes dentate. Columella nearly always provided with large, more or less numerous, plications."

The genera then included by him were,—*Actæonella*, *Volvaria*,[3] *Actæon*, *Ringinella*, *Avellana*, *Ringicula* and *Globiconcha*. To these he subsequently (in 1850) added *Pedipes*,[4] *Varigera*, (= *Tylostoma*, Sharpe), and *Pterodonta*.

The following description of this family, and arrangement of sub-families, genera and sub-genera, are proposed, after a careful review and study of all the known genera, both fossil and recent, believed by the writer to be related to this interesting group:—

Family ACTÆONIDÆ, d'Orbigny.

Shell subovate, fusiform, turbinate, subcylindrical, obconic, or globose; varying in thickness according to the genera and species; spiral or involute; never pearly, but sometimes with a porcellanous lustre. Surface without an epidermis, smooth or with revolving often punctate striæ or furrows. Spire elevated, depressed, sunken or wanting. Columella imperforate, more or less twisted, and with or without plications. Aperture narrow, rounded or terminating in a notch or sinus in front. Lip entire, sharp or obtuse, sometimes reflected and thickened without, smooth or crenate within.

Animal (in the recent typical genus)[5] with lingual teeth in diverging transverse series, without a middle row (12–12);

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[3] Now referred by Conchologists to the *Marginellidæ*.

[4] Now known to belong to the *Auriculidæ*.

[5] The structure of the animal here given is of course only known to be applicable to the existing species. The extinct forms are therefore necessarily always classified from analogous characters of the shell only.

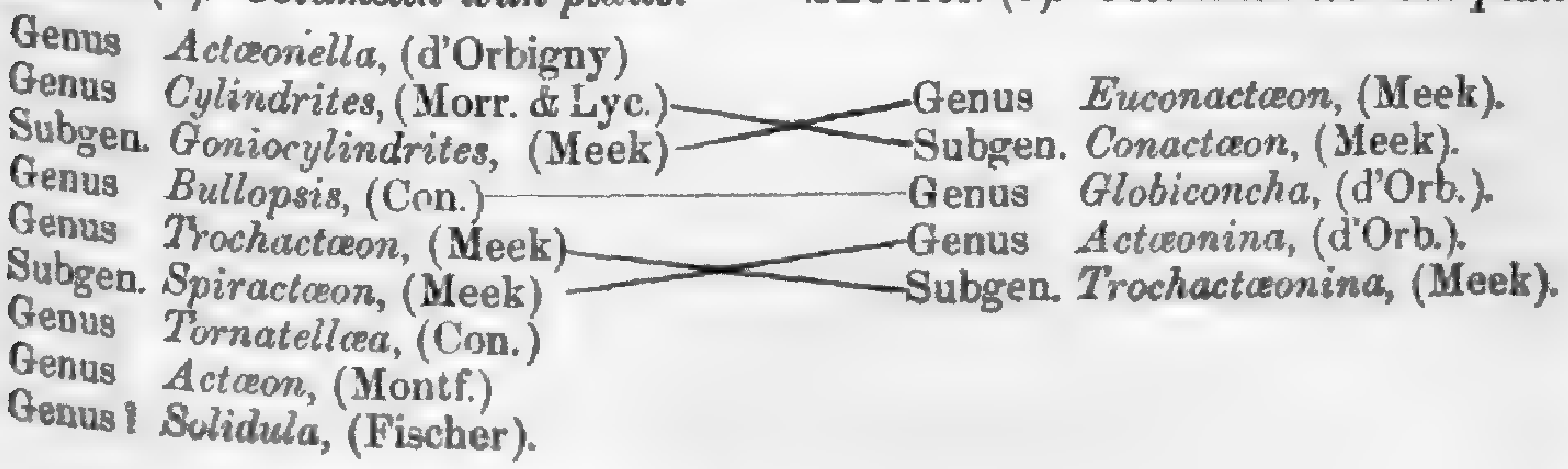
pointed and hooked or claw-shaped. Head depressed, subquadrate, truncate and more or less emarginate anteriorly; provided behind with two broad tentacular lobes, which are reflexed upon the fore part of the body-whorl when the animal walks. Eyes sessile near the middle of the head, at the anterior bases of the tentacular lobes. Mantle included within the shell. Branchial plume single. Foot oblong, truncated in front, and obtuse behind. Operculum corneous, narrow, subovate and transverse, or (in *Ringicula*) (?) wanting.

The genera embraced in this family, as above defined, are more or less readily divisible into two sub-families, distinguished, so far as has been determined from the examination of the recent typical genera of each, by differences in the animal as well as shell. These differences, looking at the living species only, would seem to be quite strongly enough marked to separate these groups into two distinct families; but when we compare the shells of all the various extinct species, they are found to be apparently so blended together by intermediate forms as to indicate that they should rather be arranged in different sections of the same family, than as distinct families.

It seems to be impossible to adopt any linear arrangement of the various fossil and recent genera and subgenera of this family, that will bring together those most nearly allied. The following mode of grouping them, however, will probably as nearly express their affinities as can readily be done.[6]

I. Subfamily ACTÆONINÆ.

Shell with lip not reflected, or thickened without, generally smooth within; surface smooth or spirally striate. Animal without proper tentacles; eyes sessile on the middle of the head at the base of the tentacular lobes. Provided with an operculum.



Section (a). *Columella with plaits.*		Section (b). *Columella without plaits.*	
Genus	*Actæonella*, (d'Orbigny)		
Genus	*Cylindrites*, (Morr. & Lyc.)	Genus	*Euconactæon*, (Meek).
Subgen.	*Goniocylindrites*, (Meek)	Subgen.	*Conactæon*, (Meek).
Genus	*Bullopsis*, (Con.)	Genus	*Globiconcha*, (d'Orb.).
Genus	*Trochactæon*, (Meek)	Genus	*Actæonina*, (d'Orb.).
Subgen.	*Spiractæon*, (Meek)	Subgen.	*Trochactæonina*, (Meek).
Genus	*Tornatellæa*, (Con.)		
Genus	*Actæon*, (Montf.)		
Genus ?	*Solidula*, (Fischer).		

II. Subfamily RINGICULINÆ.

Shell with lip reflected and thickened without, surface spirally striate, and usually presenting a porcellanous lustre. Animal (in *Ringicula*) as in *Actæon*, excepting that the lingual teeth are as in *Philine* and

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[6] The lines drawn across between the names placed in the two columns of each subfamily, are intended to indicate as near as can be done, the relations between the genera and subgenera falling within these two sections.

Scaphander, (Woodward), and the operculum probably wanting, (H. & A. Adams).

SECTION (*a*). *Columella plaited.*

[7] Genus *Ringicula*, (Desh.)
[7] Genus *Ringinella*, (d'Orb.)
[7] Genus *Cinulia*, (Gray)
Subgenus *Avellana*, (d'Orb.)
Subgenus *Euptycha*, (Meek)

SECTION (*b*). *Columella without plaits.*

Genus *Aptycha*, (Meek).

? Genus *Tylostoma*, (Sharpe).

In addition to the genera here ranged in the *Actæonidæ*, the genus *Macrocheilus* of Phillips, which has been generally referred to the *Pyramidellidæ*, probably also belongs to this family. If so, its position would appear to be intermediate, as it were, between sections (*a*) and (*b*), of the subfamily *Actæoninæ;* some of the species having rather distinct folds on the columella, others having them very obscurely developed, and still others being entirely destitute of such folds or plaits. D'Orbigny and several others also include the curious genus *Pterodonta*, which certainly seems to be related to this group in some of its characters; but if included at all, it should stand apart as the the type of a very distinct subfamily, on account of its dilated, Strombus-like lip, with a single internal tooth, as well as in consequence of the distinct anterior canal of some of the species. The Jurassic genus *Tubifer*[8] of Piette, and the Carboniferous genus *Soleniscus* of Meek & Worthen, although apparently excluded from this family by their distinct Fusus-like canal, nevertheless present, as already stated, other characters indicating affinities to this group.

The position of *Tylostoma* in the subfamily *Ringiculinæ* is also

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[7] These three are regarded by some authors as not being generically distinct, and even d'Orbigny, after proposing the genus *Ringinella*, united it with *Avellana*. However difficult it may sometimes be to separate them, they still appear to represent three generic types, and should doubtless be so regarded.

[8] The genus *Tubifer*, as established by Piette in 1856 (Bull. Geol. Soc. France, 2 ser., vol. xii, p. 1033, pl. 31, and vol. xiii, p. 592), includes two rather distinct subgeneric groups. The first of these is represented by *T. nudus*, the type of the genus, a very delicate, smooth, elongate fusiform shell, with a rather long canal and smooth columella. The other group consists of short bucciniform shells, with a short canal, and distinct vertical costæ, usually each terminating in a little tubercle above. For this latter group *Costellifer* would bè a good name, and *T. plicatus* may be regarded as the type. It would also include *T. bicinctus*, Piette, and a species described by Zittel and Goubert (Jour. Conch., Paris, 3d ser., vol. i, p. 206) under the name *Actæonina plicata*. As this latter species is however clearly congeneric with *Tubifer plicatus*, of Piette, although specifically distinct, it becomes necessary to give it a new specific name. I would therefore propose to call it *Tubifer* (*Costellifer*) *Zitteli*.

Another little Jurassic shell, figured by Piette in the 13th vol. Bull. Geol. Soc., cited above, (pl. xv) under the provisional name *Fasciolaria nuda*, (previously referred by him to *Mitra*), seems to be closely related to the genus *Soleniscus*, Meek & Worthen, from the Coal Measures of Illinois, (Proceed. Acad. Nat. Sci. Philad., Oct., 1860, p. 467). It should either be ranged as a subgenus under *Soleniscus*, (in consequence of having three folds on the columella instead of one), or regarded as the type of a new genus.

somewhat doubtful. Some of the species have the surface striate or punctostriate, as is usual in that group, and the outer lip thickened, but only at intervals, so as to leave varices on the volutions; while between these it was probably always thin during the growth of the shell. In its other characters this genus seems to be allied to *Globiconcha*, of the subfamily *Actæoninæ.*

Some elegant little elongated East-Indian shells, usually referred to Dr. Lea's genus *Monoptigma*, (but clearly not congeneric with the type of that genus), are also placed by some authors in the *Actæonidæ*, though they seem to be more nearly related to the *Pyramidellidæ.*

From the names mentioned on pages 87, 88 it will be seen that several new genera and subgenera are here proposed in this family. In giving descriptions of them it becomes necessary also to define some of the allied groups which it is proposed to restrict. The following descriptions are therefore offered:—

Subfamily ACTÆONINÆ.

SECTION *a.*

Genus ACTÆONELLA, d'Orbigny. (As restricted.)

Shell ovate-volvuliform, rather thick, involute, more or less attenuate above, widest below the middle,—entirely without any traces of a spire. Surface nearly smooth. Aperture very narrow, arcuate, and equalling the greatest length of the shell. Outer lip smooth, generally rather obtuse. Inner lip thickened near the base of the aperture, and twisted outwards so as to form on the columella three prominent revolving folds; also usually a little thickened at the summit of the aperture.

Type:—Volvaria levis, Sowerby.[9] (=*Actæonella*, d'Orb.). Also includes *Volvaria crassa*, Dujardin, (=*Actæonella*, d'Orb.); *Actæonella Caucasica*, Zekeli, *A. Syrica*, Con., and *A. Dolium*, Rœm. (All Cretaceous.)[10]

Genus TROCHACTÆON, Meek, (*Actæonella*, (part) d'Orb.).

Shell turbinate, rather thick; the widest part always above the middle of the body-whorl. Last turn large, rounding in above, and tapering from near the summit, with more or less convex or ventricose sides, to the base. Spire generally low, sometimes scarcely rising above the summit of the body-whorl, or even sunken so as to form an umbilicoid cavity; when prominent, with sides generally concave in outline. Suture sometimes channeled. Surface nearly smooth. Aperture very narrow and long, generally subangular or narrowly rounded below. Outer lip sharp or obtuse, smooth within. Inner lip thickened below, and twisted into three folds, which continue around the columella within the whorls.

Type:—Actæonella Reynauxiana, d'Orbigny.[11] Also includes *A. conica*, *A. glandiformis*, and *A. rotundatus*, Zekeli; *A. gigantea*, d'Orbigny, *Conus minimus*, d'Archiac, (*Actæonella*, d'Orb.); *Cylindrites pyriformis*

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[9] Trans. Geol. Soc. Lond., vol. iii, pl. 39, fig. 33.

[10] Excepting *A. Syriaca* which is supposed to be Jurassic.

[11] Palæont. Franc. Terr. Cret., vol. 2, p. 108, pl. 164, fig. 7.

and *C. bullatus*, Morris & Lycett; *Tornatella Lamarcki*, Sowerby, (*Actæonella*, Zekeli). (Jurassic and Cretaceous.)

Subgenus SPIRACTÆON, Meek.—Shell more or less oval, or subfusiform; spire rather prominent, sometimes as long as the body-whorl, convex in outline on its lateral slopes. Body volution not very ventricose.

Type:—Tornatella conica, Munster,[12] (*Actæonella*, Zekeli). Also includes *Actæonella elliptica* and *A. obtusa*, Zekeli; and *Tornatella Voluta*, Munster, (*Actæonella*, Zekeli). (All Cretaceous.)

I was at first under the impression that the shells upon which this genus is founded might be included in Mr. Conrad's genus *Bullopsis*, supposing that the type of the latter, *B. cretacea*, (Jour. Acad. Nat. Sci. Phila., vol. iv, new series, pl. 46), might be a species of this group with a sunken spire, similar to *Cylindrites pyriformis*, of Morris & Lycett. On comparison, however, it will be found to differ materially from that, and all the other species included in the group under consideration, in the form of its aperture, which is much broader, and so much more rounded below, as to give an entirely different expression to the base of the shell. Its columella is also not near so thick nor so straight below as in the group here described.

The differences between these shells and the typical *Actæonellas* are, it seems to me, as strongly marked and as constant as we can ever expect to see between any two genera of the same family of Gasteropoda. In the first place, in the true *Actæonellas* the whorls are so nearly rolled together upon the same plane that there are no traces of a spire, and the form is consequently nearly that of *Volva* or *Simnia*, the aperture being produced upwards even above the summit of the body of the shell, while the *widest part of the body-whorl is below the middle.* Now if we compare this form with the genus under consideration, we find the latter always differs in having the body-whorl turbinate, or widest *above the middle*, and the spire generally present and *exserted or often elevated.* Even in cases, however, where the spire is sunken, and its place occupied by an umbilicoid cavity, as is sometimes the case in this group, the body-whorl still retains its turbinate or obovate form, and the upper extremity of the aperture is never produced upwards, as a kind of canal, over the middle of the summit.

Genus CYLINDRITES, (Auct.) Morris & Lycett. (As restricted.)

Shell subcylindrical, or oliviform. Spire generally short, often much depressed, or even sunken below the summit of the body-whorl, in which latter case the immediate apex usually rises in the form of a nipple in the middle of a saucer-shaped cavity. Body-whorl long, with nearly straight parallel sides which round in to the suture above. Aperture very narrow, often nearly or quite equalling the greatest length of the shell. Inner lip somewhat thickened, and twisted outwards, so as to form a few obscure folds at the base of the columella.

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[12] Goldf. Petrefact., iii, p. 48, pl. 177, fig. 1–2.

Examples:—*Actæon cuspidatus* and *A. acutus*, Sowerby[13] (*Cylind.* Morr. & Lyc.); *Cylindrites angulatus* and *C. alatus*, M. & L.; *Bulla Thorntoni*, Brong., (*Cyl.* M. & L.), and *C. excavatus*, M. & L. Also *Actæon Oliva*, Piette. (Mainly Jurassic.)

Sub-genus GONIOCYLINDRITES, Meek. (*Cylindrites*, Division B. (part) M. & Lyc.) Shell abruptly truncated at the summit of the body-whorl; sides straight and not rounding in above; spire sunken or a little exserted.

Type:—*Cylindrites brevis*, M. & L.[14] Also includes, *C. cylindricus*, M. & L.; *Actæon cylindraceus*, Geinitz, and *Cylindrites* (undt.) Sharpe.[15] (Jurassic and Cretaceous).

SECTION *b*.

Genus ACTÆONINA, d'Orbigny. (As restricted.)

Shell subovate or subfusiform. Spire generally rather prominent, but usually shorter than the body-whorl, which is long, and sometimes a little truncated at the suture above. Surface nearly smooth, or sometimes with revolving striæ, very rarely with vertical costæ. Aperture narrow, rounded and not sinuous below; columella more or less thickened but always smooth.

Type:—*Chemnitzia carbonaria*, Koninck,[16] (*Actæonina*, d'Orb.). Also includes *Actæonina Lorieriana*, *A. sparsisulcata*, *A. Sarthacensis*, *A. Franquana*, *A. Dormoisiana*, *A. acuta*, *A. Mileola*, *A. Hordeum*, *A. subandiana*, *A. Deslongchampsii* and *A. cylindrica*, d'Orbigny. (Carboniferous to Jurassic.)

Subgenus TROCHACTÆONINA, Meek. (*Actæonina*, (sp.) d'Orbigny.)

Shell turbinate or subglobose, the widest part being above the middle of the body-whorl. Spire much depressed, sometimes a little attenuate near the apex. Body-whorl large ventricose, rounding in above.

Type:—*Actæonina ventricosa*, d'Orbigny.[17] Also includes *A. Davoustana*, d'Orbigny, and *Cassis Esparceyensis*, d'Arch. (*Actæonina*, d'Orb.). (All Jurassic.)

NOTE.—Zittel and Gobert describe and figure in the first vol. of the Conchological Journal of Paris, (3d ser. pl. 12, f. 11) under the name *Actæonina striato-sulcata*, an interesting little Jurassic shell which I was at first inclined to retain here, as the type of a strongly marked subgenus. Farther comparisons have satisfied me, however, that the angular, or subcanaliculate character of the base of its aperture, excludes it from the genus *Actæonina*, and, together with its other characters, place it even in the family *Aplustridæ*, near the genus *Bullina*.

Genus EUCONACTÆON, Meek. (*Actæonina* (part), d'Orb. and others.)

Shell very thin, distinctly obconic, involute. Spire wanting, its place being occupied by a cavity. Body-whorl composing the entire length of the shell, and enveloping all the others; broad and abruptly truncated above, and tapering from the summit to the base with nearly straight

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[13] Sowerby, Min. Conch., pl. 455, fig. 1–2.

[14] Morris & Lycett, Mon. Moll. Grt. Ool., pt. 1, p. 101, pl. 8, fig. 13, 13*a*.

[15] Trans. Geol. Soc. London, 2d. ser., vol. vii, pl. xxviii, fig. 24.

[16] Koninck, Animaux foss., pl. 22, f. 9, and pl. 41, f. 15.

[17] Pal. Franc., Terr. Jur., vol. 2, p. 178, pl. 288, f. 7, 8.

sides; sometimes faintly constricted near the middle. Surface smooth or with revolving punctate striæ. Aperture very narrow or sublinear, straight, equalling the greatest length of the shell, and not sinuous or effuse at either extremity. Inner lip smooth, sometimes slightly thickened below.

Type:—Conus Caumontii, Deslongch.[18] (*Actæonina*, d'Orb.). Also includes *Conus subabbreviatus*, and *C. concava*, Deslongch. (*Actæonina*, d'Orb.) (All Jurassic).

? Subgenus CONACTÆON, Meek.

Shell elongate-obconic; spire more or less depressed, conical, and turretted; whorls distinctly truncated and rectangular above, with numerous minute wrinkles near the angle. Body-whorl with slightly convex sides, converging from the summit to the narrowly rounded base.

Type:–Conus Cadomensis, Deslongch.,[19] (*Actæonina*, d'Orb.). (Jurassic.)

There may be room for some doubts in regard to this latter type (*Conus Cadomensis*) being congeneric with *Euconactæon*, but as it agrees in most of its essential characters, the only difference of any importance being its more or less prominent, instead of sunken spire, forms will probably be found connecting these two types. That they should, however, be both separated from the genus *Actæonina*, in a systematic classification of these shells, is I think, clearly evident.

Subfamily RINGICULINÆ.

SECTION *a*.

Genus CINULIA, Gray.

The genus *Cinulia* of Gray, was founded upon *Auricula globulosa*, of Deshayes, a subglobose shell, with a comparatively very large body-whorl, a short, abruptly attenuate spire, and a single obscure oblique fold on the thickened columella. Its outer lip is thickened and reflected without, and smooth within; its aperture is narrow, and its surface marked with revolving striæ. D'Orbigny, in subsequently proposing to found a genus for this and similar shells, under the name *Avellana*, describes first in that connection, the same species (*Auricula globulosa*), so that his genus becomes exactly synonymous with *Cinulia* of Gray. As d'Orbigny, however, included several other forms, differing subgenerically from the species *globulosa*, and agreeing more nearly with his diagnosis, his name *Avellana*, may be retained for one of these subordinate groups as follows:—

Subgenus AVELLANA, d'Orbigny.

Shell globose; body-whorl large; spire much depressed; aperture narrow, arcuate, sometimes a little sinuous below; outer lip strongly thickened without, crenate within; columella thickened, and provided with two or three prominent transverse folds; surface with revolving usually punctate striæ.

Examples:–Auricula incrassata, Mantell,[20] (*Avel.* d'Orb.); *Cassis Avellana*, Brong. (*A. Cassis*, d'Orb.); *A. Hugardiana*, d'Orb., &c. (Cretaceous.)

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[18] Mem. Soc. Linn. de Normand., vol. 8, p. 165, pl. 18, f. 7.

[19] Mem. Soc. Linn. de Normand., vol. 7, p. 147, pl. 10, f. 10, 15.

[20] Mantell, Geol. Sussex, pl. 19, fig. 33.

Subgenus Euptycha, Meek.

Shell like *Avellana* in form; aperture very narrow, arcuate; columella thickened and provided with two or three folds. Outer lip as in *Avellana*, excepting that it has in addition to the crenulations above, two or three large obtuse teeth or tubercles, at the base within. Surface with comparatively coarse revolving ridges and furrows.

Type:—Auricula decurtata, Sowerby,[21] (*Avellana*, Zekeli). Also includes *Avellana Royana*, d'Orbigny. (Cretaceous.)

Section *b*.

Genus APTYCHA, Meek.

Shell oval; spire moderate; body-whorl rather large. Aperture narrow subovate, rounded below, and acutely angular above; outer lip smooth within, inner lip callous, particularly above, but destitute of any traces of folds or plaits. Surface with revolving punctate striæ.

Type:—Tornatella labiosa, Forbes.[22] (India.—Cretaceous.)

The type of this genus has the thickened and reflected outer lip of *Ringicula*, *Avellana*, and other genera of the *Ringiculidæ*, but wants the folds on the columella, so characteristic of that section of the subfamily. It therefore bears exactly the same relation to those genera, that *Actæonina* bears to *Actæon*, *Tornatellæa*, *Solidula*, &c., in the subfamily *Actæoninæ*.

From the foregoing descriptions and remarks, it will be seen that in the family *Actæonidæ*, the elevation or depression of the spire, when unaccompanied by any more important differences, cannot be regarded as being of generic value. Indeed the transitions from an elevated to a depressed or sunken spire, are so gradual, that within a considerable range of limits, it cannot be relied upon even for the separation of species. Amongst the most important generic characters, visible in the shell alone, (particularly in the extinct genera) may be mentioned, first, the *general form and expression of the body-whorl*,—that is to say, whether it is cylindrical, oval, turbinate, obconic, or globose, &c.; second, the presence or absence of folds upon the columella; the thickness or thinness of the shell, &c., and the various combinations of these and other characters, sometimes individually of subfamily or sectional value.

Various opinions have been entertained by conchologists in regard to the position of this family in a systematic classification of the Mollusca, some placing it between the *Scalaridæ* and the *Cerithiopsidæ*, while others place it with the *Bullidæ*, the *Pyramidellidæ*, or in part with the *Doliidæ*, &c. In many of its characters, it must be admitted, the animal of the living typical genus *Actæon* shows affinities to the *Bullidæ*, and from what has already been stated, it will also be remembered that the shells of many of the fossil forms show a constant tendency to shade off

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[21] Trans. Geol. Soc. Lond., iii, pl. 38, fig. 10.

[22] Ibid., 2d ser. vol. viii, pl. xii, f. 24.

towards genera of that family. From all the facts, I am inclined to agree with those who think the group should be ranged near the *Bullidæ* and *Cylichnidæ*.

In regard to the geological range of this family, we have evidence of its existence as far back as the Carboniferous epoch, where it is represented by the genus *Actæonina*. If we include the genus *Macrocheilus*, however, it would carry the origin of the family back to the Devonian. It attained its greatest development during the Jurassic and Cretaceous periods,—since which it has declined; and, although still represented in our existing seas by a comparatively few forms, it may be regarded as a type probably destined to pass out of existence during the present geological period.

Washington, D. C., Dec. 20, 1862.

ART. XV.—*Contributions from the Sheffield Laboratory of Yale College.*—V. *On the Equivalent and Spectrum of Cæsium;* by S. W. JOHNSON and O. D. ALLEN.

IN the last vol. of this Journal a method is described of separating cæsium from rubidium by fractional crystallization of the bitartrates of these metals.[1] The analyses of the bitartrate of cæsium there given, while perfectly according with each other as regards carbon, disagree with the numbers deduced from Bunsen's equivalent to such an extent that we have undertaken to ascertain whether the salt was impure or Bunsen's equivalent incorrect.

From the great care used in preparing the bitartrate and especially from the fact that its spectrum remained unaltered though the salt was repeatedly recrystallized, we were inclined to suppose that Bunsen had not operated with a pure substance. This might easily happen on account of the small quantity of material at his disposal without at all detracting from the merit of this distinguished chemist.

A quantity of bitartrate of cæsium purified by concentrating its solution and recrystallization as described in the paper referred to, and containing no foreign matters recognizable by the spectroscope, except an inevitable trace of sodium and (to judge from a certain red line,) perhaps some lithium, was treated directly with bichlorid of platinum in quantity sufficient for complete precipitation. This platinchlorid of cæsium after thorough washing was reduced in hydrogen, the chlorid of cæsium dissolved from the platinum and evaporated to dryness with addition of a little hydrochloric acid.

We thus obtained an amorphous mass of a pure white color

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[1] Observations on Cæsium and Rubidium, by O. D. Allen, vol. xxxiv, pp. 367–373.

which, unlike Bunsen's chlorid was *not perceptibly deliquescent* even in a very moist atmosphere. The spectrum of the chlorid thus prepared was identical with that of the original bitartrate. Both salts gave a red line nearly coincident with the α line of lithium. In order to determine whether this line was due to a trace of lithium or belongs to the spectrum of cæsium, a portion of chlorid was again precipitated with a relatively small quantity of bichlorid of platinum, the precipitate was most thoroughly washed and from it a new sample of chlorid of cæsium was prepared. The red line was no less apparent in this than in the former preparations. The same process of partial precipitation was repeated to the third time without altering the spectrum.

Again, from a hot dilute solution of 15 grms. of chlorid of cæsium, about 1 grm. of cæsium was thrown down as platinchlorid; the product thus procured gave a spectrum identical with that from the original bitartrate.

We concluded from these experiments that our chlorid of cæsium was free from lithium and as pure as it is well possible to obtain any substance without the most extraordinary and for most purposes unreasonable precautions.

As to the properties of the chlorid of cæsium, we observed that not only is it not deliquescent, but it is hardly hygroscopic. The unfused and porous salt may be weighed in moist air with as much accuracy as chlorid of sodium. After it has been fused it does not alter in weight during 24 hours' exposure to the air in cold dry weather. It may be fused in a platinum capsule over the gas flame when the air is dry, without acquiring an alkaline reaction. In a damp atmosphere it is apt to lose chlorine during fusion. The residue after the reduction of platinchlorid of cæsium by hydrogen at a gentle heat, is alkaline. It is hardly possible to fuse chlorid of cæsium without loss, by volatilization. Hence our first estimations of cæsium in this form were too low by 4 to 7 tenths of one per cent.

For determining the equivalent of cæsium we have made four chlorine estimations. Two of these, I and II, were made in the chlorid obtained as already described. Their details and results are given below. The filtrates from these analyses containing nitrates of cæsium and silver, after the latter had been removed, were added to a solution of several grammes of the original chlorid and the whole was partially precipitated with bichlorid of platinum and a second portion of chlorid of cæsium procured, on which determination III. was made. Finally the nitrate of cæsium from this analysis was mingled with repeatedly purified chlorid obtained in the previous study of the spectrum, about half the cæsium was again thrown down as platinchlorid, and with this product another estimation of chlorine, IV, was made.

The determination of chlorine was conducted in the usual manner by precipitation with nitrate of silver and filtration. Washed Swedish filters were employed which gave each an ash weighing $\frac{4}{10}$ths of a milligramme. The weighings were taken on a balance by Becker and Sons of Brooklyn, N. Y., which with an ordinary load indicates $\frac{1}{20}$th of a milligramme with great decision and perfect constancy.

The data of our determinations are as follows:

I.	1·8371 grms. Cs Cl gave	1·5634	Ag. Cl	=·386598	Cl, and	1·4505 Cs.
II.	2·1295 " " "	1·8111	"	=·447848	"	1·68165 "
III.	2·7018 " " "	2·2992	"	=·56853	"	2·13327 "
IV.	1·56165 " " "	1·3302	"	=·32893	"	1·23272 "

The percentage composition of chlorid of cæsium and the equivalents deduced from the above figures are as follows; silver being considered =107·94 and chlorine =35·46, Stas:

	Per cent of		Equiv. of Cs.	
	Cl	Cs		
1.	21·044	78·956	133·050	Allen.
2.	21·031	78·969	133·150	Johnson.
3.	21·043	78·957	133·054	Johnson.
4.	21·063	78·937	132·892	Allen
Average,	21·045	78·955	133·036	

We may accordingly assume the round number, 133, as the equivalent of cæsium.

Calculated by this equivalent the formula of bitartrate of cæsium corresponds well with the results of experiment. As mentioned in the paper referred to, the analyses of this salt furnished the following data:

I. 0·4718 grm. gave { 0·0786 grm. water, and 0·294 " carbonic acid.

II. 0·5966 grm. gave { 0·101 grm. water, and 0·372 " carbonic acid.

III. 1·3086 grm. gave 0·7708 grm. chlorid of cæsium.

In two other estimations since made—

IV. 2·0347 grm. gave 1·206 grm. chlorid of cæsium.
V. 1·8271 " 1·0857 " "

Calculated.						Found.				
	Cs=123·35			Cs=133·		I.	II.	III.	IV.	V.
C_8	48·00	17·62	C_8	48·	17·02	16·99	17·02	....	....	....
H_5	5·00	1·83	H_5	5·	1·77	1·85	1·88	....	....	....
O_{11}	88·00	32·31	O_{11}	88·	31·21	....	....	....	....	....
CsO	131·35	48·24	CsO	141·	50·00	....	....	49·30	49·61	49·76
	272·35	100·00		282·	100·00					

The equivalent number 133, brings cæsium into a triad with rubidium and potassium. We have then two alkali triads, viz: lithium, (eq. 7), sodium (eq. 23) and potassium (eq. 39·1),

$$\frac{7+39}{2}=23$$

and potassium, rubidium (eq. 85·36) and cæsium.

$$\frac{39+133}{2}=86$$

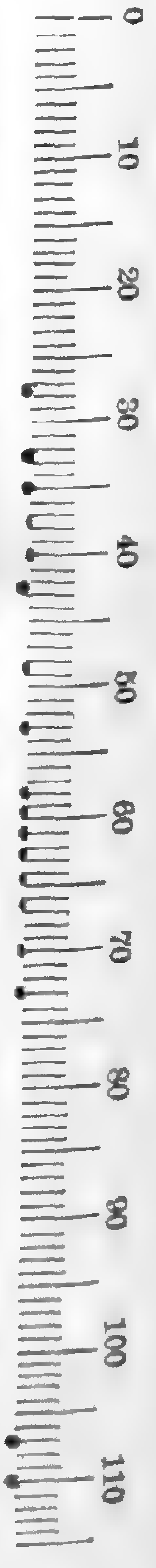
The correction of the equivalent of cæsium implies a revision of its spectrum, since the data given by Kirchhoff and Bunsen with reference to both, were obtained from the same impure material.

The cæsium spectrum, as we have procured it, is, perhaps, from the number, color and definition of its lines, the most beautiful to be observed among all the alkali and earthy metals. Kirchhoff and Bunsen, in the figure given by them (*Pogg. Ann.*, 1861, and *Fres. Zeitschrift für Analyt. Chemie, Heft*, 1, 1862), represent 11 lines. We find without difficulty 7 more lines, and observe further that some of those figured by K. & B., are not mapped in their correct positions. To enable other chemists to compare their cæsium preparations with ours, we will attempt to describe the cæsium spectrum as seen in our instrument, which has a single flint glass prism.

Beginning at the left or red extremity of the spectrum, we will indicate the lines in the order of their occurrence by Roman numerals; I. is a red line of medium brightness nearly equidistant between the Fraunhofer lines *a* and B; II. is a bright line partly coincident with, but slightly to the left of and narrower than the α line of lithium; III. is a faint line nearly approaching Fraunhofer's line C; IV. is the faintest of the red lines; V. is a faint line midway between the α and β lines of lithium; VI. is a bright red line midway between the sodium line and α lithium; VII. is an orange-red line of medium intensity directly to the right of the α strontium line; VIII. is a fine yellow line just to the right of and close upon the sodium line. The position of the green lines it is difficult to describe. First comes a group of three, IX, X. and XI, which are separated by very narrow spaces, and which are represented well in the spectrum plate of Kirchhoff and Bunsen, though placed a trifle too far to the right. Then, after an interval scarcely wider than the lines themselves, come XII. and XIII, which are very near each other. After another space as broad as these lines we encounter XIV. Midway between XIV. and XVI. is XV. The latter, XV, coincides with the dark line E. Finally, the two pale blue lines, XVII. and XVIII, complete the list.

For the convenience of those who may use spectroscopes of the same construction as ours, we will mention the degrees on the scale of our instrument, which correspond to the cæsium lines. In our observations we have brought the degree 100 (10 on the scale) into the sodium line. Then the blue of strontium is at 156°, the violet of potassium 257°, the red of potassium at 65–6°; the red of lithium at 80–1°. With this adjustment the cæsium lines are as follows, beginning with the red: I 75°, II 80°, III 82–3°, IV 85°, V 87–8°, VI 91°, VII 97–8°, VIII 101°, IX 106°, X 107–8°, XI 109°, XII 111°, XIII 112–13°, XIV 114–15°, XV 118°, XVI 121°, XVII 157–58°, XVIII 160°.

The position of the cæsium lines on the scale figured at the top of the spectrum plate in Fresenius' Zeitschrift, is approximatively given in the accompanying diagram, by help of which our results may be directly compared with those of Kirchhoff and Bunsen.



The order of brilliancy in the lines of what we suppose to be the spectrum of pure cæsium, with but the minutest trace of sodium, is for the red lines as follows: VI, II, VII, I, V, III, IV. The line IV is only made out under the most favorable conditions. II, nearly coincident with α lithium of Kirchhoff and Bunsen, and not figured by them, is as bright as their γ cæsium, our VI (?). Among the yellow and green lines to the right of the sodium line, the order of brilliancy is the following: VIII, IX, XI, XII, XIV, XIII, XV, X. The yellow line VIII, is hardly less characteristic of the spectrum of *pure* cæsium than the two blue lines. It also is nearly as distinct as any of the green lines when sodium is not present in too large quantity, and is much more readily made out than the extreme red line δ of rubidium.

To sum up, we find 4 red lines to the left of those given by Kirchhoff and Bunsen, one of which is as bright as any of the red lines in the cæsium spectrum. Further, the red lines of K. & B. are not figured in their true positions, being too near each other and too far to the right. Finally, we observe a fine yellow line and two unimportant green lines not mapped by K. & B. The lines which we have supplemented to those of K. & B. are not characteristic except in the absence of foreign matters. For this very reason however they become important to those who are engaged in the study of the new elements.

New Haven, Conn., Dec. 24th, 1862.

ART. XVI.—*On Tellurbismuth from Dahlonega, Georgia;* by DAVID M. BALCH. (Communicated for this Journal by Dr. C. T. JACKSON.)[1]

THE specimen of tellurbismuth submitted to the following examination, was obtained at Field's mine near Dahlonega, Ga., by Dr. C. T. Jackson, who presented it to me with the request that I would carefully ascertain its composition. It appeared to be part of a tabular crystal, and was easily separable into thin folia, very splendent, and quite free from impurities. Before the blowpipe a small portion entirely volatilized, and the peculiar odor of selenium was faintly recognizable. The specific gravity was found to be 7·642 at 18° C. Two portions weighing respectively ·827 and ·552 grm. were analyzed as follows, the folia being first dissected to ascertain if there was any mechanical admixture of gold in thin layers, which is often the case.

The mineral was digested in hot chlorhydric acid, to which a little nitric acid had been added; it dissolved quickly and left no residue. The solution was now evaporated till all traces of nitrous oxyds were expelled, somewhat diluted, and tested for sulphuric acid by chlorid of barium; the non-formation of a precipitate proved the absence of sulphur in the ore: (any selenium which may have been present would of course not be thrown down, since selenite of baryta is soluble in acids). After the excess of barium had been separated, the solution was evaporated to a small bulk, (a few c. c.) mixed while hot with an excess of bisulphite of ammonia, and set aside for some hours.

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[1] *To the Editors of the American Journal of Science:* Gentlemen—An analysis, made by me, some years since, of a tellurbismuth from Field's gold mine in Dahlonega, Georgia, gave results which led me to the belief that it was bornite, and it was published, as such, in your Journal and in the Mining Magazine, of New York.

Dr. F. A. Genth of Philadelphia made a new analysis, which differed from mine essentially, and placed the mineral near tetradymite. Some discussion took place between us, in the Mining Magazine, on the subject, and I thought best,—though I could have easily made a new analysis,—to refer the matter to a chemist, who had not read either of our papers, at that time. I therefore presented to Mr. David M. Balch some carefully selected crystals of the mineral, with the request that he should make an exact analysis of them, and prepare a paper on the subject for publication. * * * I have this day received Mr. Balch's results, which I enclose for publication, and would state that I fully concur with him in the opinion he expresses, namely, that the mineral, being a tertellurid of bismuth, is evidently a new species.

In explanation of the error in my original analysis, I would state that the bismuth, having been precipitated before the tellurium, carried down with it a portion of the latter and made the weight of the oxyd of bismuth too high, and that of the tellurium too low. I was not aware that I had made this mistake before I looked back to my laboratory notes of this analysis. I therefore withdraw the name bornite, as not applicable to this species, and adopt the chemical name given it by Mr. Balch.

Respectfully, &c., CHARLES T. JACKSON.

Boston, May 28th, 1862.

All the tellurium and selenium present are thus thrown down as a black powder easily washed by decantation. To avoid the precipitation of basic tellurium salts and small quantities of bismuth, it is necessary that the solution should contain much free chlorhydric acid; it should also be concentrated and warm. The precipitate, after the decantation of the supernatant liquid, was washed with dilute sulphurous acid to which some chlorhydric acid had been added, then on a tared filter with water containing a little sulphurous acid, dried at 125° C. and weighed.

The filtrate and washings from the tellurium were evaporated nearly to dryness, the residue dissolved in largely diluted chlorhydric acid, and from this solution the bismuth determined as teroxyd in the usual manner.

Analysis *a*. ·827 grm. gave,

·4256 Bi	=	51·46	pr. ct.
·3990 Te	=	48·26	"
·8246		99·72	

Analysis *b*. ·552 grm. gave,

·2847 Bi	=	51·57	pr. ct.
·2690 Te	=	48·73	"
·5537		100·30	

To ascertain whether this tellurium contained selenium in appreciable quantity, a portion (·186 grm.) was fused at a dull red heat with six times its weight of a mixture of nitre and carbonate of soda, to convert any selenium present into selenic acid. The fused cake was dissolved in water, and a little nitric acid and nitrate of baryta added; no precipitate formed, even after several days, which proves the absence of selenium, except in minute traces as evinced by the blowpipe test before noticed.

The ore was found to be free from gold, silver and iron.

The specimen that I have analyzed is therefore a pure tellurid of bismuth, $BiTe_3$; thus—

			Dahlonega.	
		Calculated.	*a*.	*b*.
Bi	208	52·00	51·46	51·57
Te_3	192	48·00	48·26	48·73
	400	100·00	99·72	100·30

The tellurbismuth from this locality has already been analyzed by Dr. Genth, with nearly the same results as above; he also finds the same formula for the Fluvanna county, Va., mineral.

Allow me to offer a few remarks on the compounds of bismuth and tellurium, suggested by an examination of the many published analyses of this ore from both American and foreign localities. It appears that selenium is present only in traces, and sulphur (where it exists at all) in quantities not exceeding 5 per cent. The mineral called tetradymite, taking Berzelius's analyses of that from Schoubkau as an example, has the following formula, $(Bi\,Te_3)^2 + Bi\,S_3$, and other analyses agree closely with this. Examples of a compound or complex mineral formed by the union of two simple ones are common; for instance, bromyrite (Ag Br) and kerargyrite (Ag Cl) unite to form embolite (Ag Cl+Ag Br); and others might be cited. It seems therefore probable that when sulphur is present in a tellurbismuth, it is due to an admixture of bismuth glance ($Bi\,S_3$), and that tetradymite, like embolite, is formed by the union of two simple minerals; in the case of tetradymite these minerals are tertellurid of bismuth, $Bi\,Te_3$, and tersulphid of bismuth, $Bi\,S_3$, (bismuth glance, a mineral much resembling the other in its physical properties).

The native tertellurid of bismuth in a pure state, has been observed only at Dahlonega, Ga., and the "Tellurium Mine," Fluvanna Co., Va., and is up to this time at least, a mineral peculiar to the United States.

Taking this view of the subject, the American tertellurid of bismuth should be considered a new species, to which the term tetradymite is hardly applicable.

In conclusion I would call attention to the fact, that, although by artificial means bismuth and tellurium can be fused together in all proportions, in their native combinations one equivalent of the former appears to be always united to three equivalents of the latter metal; the bornite of Brazil offers the only exception to this rule and according to Damour's analysis differs entirely from the other tellurbismuths.

Salem, Mass., May 20, 1862.

ART. XVII.—*Recent Researches relating to Nebulæ;* by Prof. A. GAUTIER. (Translated for this Journal from the *Bibliothèque Universelle*, for Sept., 1862.)

[We have translated Prof. Gautier's article, both because it furnishes a compact and clear account of the recent researches relating to nebulæ, and for the sake of showing our readers the esteem in which the labors of distinguished American astronomers are held abroad. We have taken the liberty to add foot notes on one or two points where some change seemed desirable.—EDS.]

THERE is no part of the vast field of practical astronomy which does not require laborious investigation. I propose to give a general idea of those researches which relate to a very large and curious class of celestial objects first specially studied by the two illustrious astronomers Herschel and Messier, and more recently by Lord Rosse, by Fathers di Vico and Secchi, and by Messrs. Lamont, Lassell and Bond, which present peculiar difficulties and in regard to which much remains yet to be explained. I design to speak of nebulæ, or those small white specks of feeble light which the telescope shows to exist in great numbers in the heavens, and which the most powerful instruments enable us to regard most generally as masses of stars situated at immense distances from the earth.

In this rapid review I shall follow, in general, the chronological order, commencing with a few remarks upon a catalogue of the positions of 53 nebulæ, as determined from observations made at the Observatory of Paris by M. Laugier, chiefly in the years 1848 and 1849, and presented to the *Académie des Sciences* of Paris at the session of Dec. 12, 1853. This catalogue, published in the *Compte Rendu* of that session, gives the right ascension and mean declination of the centers, or points of greatest brilliancy, of these nebulæ for Jan. 1, 1850, and also the differences between these positions and those obtained from the catalogues of Herschel and of Messier. This is the first attempt to determine the precise positions of a certain number of nebulæ, undertaken for the purpose of serving, hereafter, to decide the question whether these bodies are really situated beyond the fixed stars visible to the naked eye.

Researches upon the nebula of Orion.—M. Liapounoff, director of the Observatory of Kazan, at the beginning of 1856, presented to the Academy of Sciences of St. Petersburg, by the hand of M. W. Struve, a memoir upon the great nebula of Orion, deduced from four years' labor with an equatorial telescope, having a power equal to the telescope at Dorpat, and a meridian circle of Repsold.[1] He has undertaken to determine very exactly, by a process of triangulation, the positions of all the stars which his instruments permitted him to see in this nebula, and he has mapped with great care every part of this remarkable celestial object; several sheets are already prepared in which he has given particular names to its different regions. Comparing the results of M. Liapounoff with those previously obtained by Sir John Herschel and by Messrs. Lamont and Bond, M. Struve has expressed the opinion that this nebula must be subject to changes of form and of relative brightness in different parts.

Otto Struve has continued (at the Observatory of Pulkova) the labors of M. Liapounoff, and he has put forth the first results of his researches in a communication, dated May 1, 1857, presented to the Astronomical Society by Prof. Airy, on June 12th

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[1] I have only learned of this memoir by a brief notice of it at the end of the "Monthly Notices" of the Astronomical Society of London, for March 14, 1856, vol. xvi, p. 139.

of that year, and published in the "Monthly Notices," vol. xvii, pp. 225–230.[2]

Struve begins by pointing out the change in the brilliancy of different small stars situated in the nebula of Orion, a variation which he has shown either by comparison of his observations with those of other astronomers, or in the progress even of his own observations.

"The existence," says Struve, "of so many variable stars in so small a space of the central part of the most curious nebula in the heavens, would naturally lead us to suppose that these phenomena are intimately connected with the mysterious nature of this body. . . . Admitting that the rapid changes of light observed in these small stars, either in the region called *Huygens* or in that called *Subnebulosa*, may be connected with the nature of the nebula, one would expect in like manner to observe changes in the appearances of the nebula and in the distribution of the nebulous matter. But observations of this kind are subject to so many illusions, that one cannot be too careful in regard to the conclusions which he draws from them. I do not believe that the view ordinarily taken by astronomers in regard to researches of this kind, to wit, the comparison of graphic representations made at different epochs by different observers, can ever lead to results which can be regarded as certain. The optical power of the telescope, the transparency of the atmosphere, (varying at different stations), the peculiarities of the eye of the observer, the degree of skill and experience in graphic representations of this sort, all this added to the influence of the imagination of the observer, form obstacles which will always be difficult to overcome in processes of this kind. It may be possible perhaps by pursuing this method for centuries to discover the existence of progressive changes, but it will never be possible to demonstrate in this manner those changes which take place in short intervals of time. But the rapid variations of light in the stars require us to give attention to similar changes, perhaps periodic, in the appearances of the nebulous matter. It is thus to rapid changes of this kind that we ought especially to direct our attention, and we shall be better able to prove their existence by comparative observations upon the degree of light and the forms of some prominent portions of the nebula, than by representing it as a whole. It is in this way that I have endeavored to proceed the past winter, and at different points I have had a strong impression that considerable changes occurred during the short period of my observations. . . . I do not allow myself, in

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[2] I have had occasion to mention the labors of Struve in an article upon the stars of variable brightness, published in the *Bibliothèque Universelle*, for September and October, 1857, (*Archives*, tome xxxvi, p. 5 and 89). M. Otto Struve has recently succeeded his father as director of the great Russian Observatory of Pulkova.

the meanwhile, to regard these as positive facts until they have been corroborated, especially by observers located in more favorable climates and provided with optical apparatus sufficient for the purpose."[3]

Struve describes in detail four parts of the nebula of Orion where he has most distinctly observed, within the interval of a few months, changes of form or of the intensity of light. The first is a bay, which extends from the strait of *Le Gentil* in the direction of a trapezium of stars situated towards the middle of the nebula. This bay appeared to him sometimes wholly obscured, like the strait, sometimes full of nebulosity, and little inferior in brilliancy to the neighboring portions of the region of *Huygens.* Dr. Lamont first mapped this bay, which had never been seen by Sir J. Herschel. The second is a *nebulous bridge* which crosses the *Sinus Magnus*, with a point of light concentrated towards its middle. Struve has seen it in winter, sometimes as Herschel and sometimes as Liapounoff represented it, with more concentration of light, but always much more extended than these two astronomers have drawn it, and very much diminishing the southern limit of the great strait. Lamont has represented it only with very feeble traces, and Bond has never seen it at all.[4] The third is a nebulosity surrounding star 75 of Herschel's catalogue, and which appeared to Struve to be subject to great changes of brilliancy. The fourth part is a sort of *straight canal*, joining in a right line the dark space situated around the stars 76, 80 and 84 of Herschel's catalogue, with the northern border of the *Sinus Magnus* near the exterior limit of the bridge mentioned above. The canal, which had never been represented by any other observer, was distinctly seen by Struve, March 24th, 1857, although on other occasions he did not perceive the least trace of it.

This astronomer adds, in closing his communication, that the general impression produced by his observations is, that the principal parts of the central portion of the nebula of Orion are in a state of continual change of brilliancy. In those parts where the images were most distinct their appearances did not

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[3] The memoir of Struve upon this subject has been published, I think, in the second volume of a journal entitled, *Mélanges Mathématiques et Astronomiques.*

[4] We must, in the interest of truth, dissent from this assertion—that the bridge over the *Sinus Magnus* "has not been seen by Bond at all." The assertion rests on no evidence excepting its partial omission in the published engravings of Prof. W. C. Bond.

We are authorized to say that this feature may be distinctly recognized in no less than *five* original sketches made by him on as many different dates in 1847 and 1848, previous to the publication of the engraving, as well as on the very 'copy' from which the plate was engraved—it occurs also in several drawings made more recently.—Eds. *Am. Jour. Sci.*

seem to him to be entirely uniform on different nights. These changes in the degree of light could only be perceived, however, in a great number of cases, with instruments of considerable optical power, and he did not think they could be seen with achromatic telescopes of less than ten inches aperture, except in very favorable states of the atmosphere.

Vol. xxi of the "*Monthly Notices*" contains (pp. 203–207) an analysis of another memoir in relation to the same nebula. It was communicated to the Astronomical Society May 10, 1861, by Prof. George P. Bond, who has succeeded his father as director of the Observatory of Harvard College, at Cambridge, Mass., and it is entitled,—"*On the Spiral Structure of the Great Nebula of Orion.*"

Mr. Bond (the father) remarked, in a memoir published in 1848, that the light of this nebula had a tendency to radiate on the southerly side, separating near the trapezium from the star situated near its middle. In 1857, Mr. G. P. Bond undertook the formation of a catalogue of stars comprised within a square of 40 minutes of a degree on each side, having θ of Orion as its center. He has selected 121 brilliant stars as points by which to determine the positions of those stars which are smaller and generally have too feeble a light to be visible when the micrometer wires are strongly illuminated. He has first placed in one chart 262 stars and has divided the surface of the same into four sheets, so constructed as to be united into one. The form and arrangement of the elongated luminous clusters, alternating with spaces more or less obscure, emanating from the vicinity of the trapezium, have been determined by two independent processes, the nebula having been first sketched as a bright object upon a dark ground, and afterwards as a dark object upon a white ground.

I cannot here enter into the descriptive details given in the analysis of the memoir of Mr. Bond. I therefore confine myself to stating his conclusion that the general appearance of the greater part of the nebula of Orion is an assemblage of tufts or curvilinear pencils of luminous matter, emanating from brilliant masses adjoining the trapezium, and extending towards the south on each side of an axis passing by the summit of the region called *Huygens*, and having an angle of position of about 180°. He has distinctly traced a score of these circumvolutions, while others, producing the same impression, are too feeble or too complicated to be accurately described. It is thus possible, according to Mr. Bond, to classify the nebula of Orion among the spiral nebulæ which were first described by Lord Rosse by the aid of his great reflecting telescope. The nebula No. 51 of Messier's catalogue was the first in which this spiral arrangement, which had escaped the attention of the two Herschels, was discovered.

Mr. Bond has observed, in a great number of cases, that masses of nebulous matter are associated with stars, frequently in the form of small tufts extending from the south side. He cites two remarkable cases where there was a deficiency of luminous matter near very brilliant stars; the first was attached to the trapezium itself, the dark center of which had been noticed by many observers, and the other was attached to the star *Iota* of Orion. These peculiarities appear to Mr. Bond to favor the supposition of a physical union of the stars with the nebula. The existence of an arrangement of the parts which compose it in the form of a spiral accords with the idea of a stellar constitution: for among the objects which present this peculiarity of form are found not only nebulæ resolvable into stars but masses of stars properly so called, such for example as the great mass of stars of the constellation Hercules, where the exterior stars evidently have a curvilinear arrangement.[5]

Other facts in relation to nebulæ.—In 1860, Norman Pogson, while at the Observatory of Dr. Lee, at Hartwell, noticed a change in the nebula, or mass of stars, No. 80 of the catalogue of Messier, situated in the constellation of the Scorpion, and very near a pair of variable stars, *R* and *S* of the Scorpion, which had been studied by Chacornac since 1853. On the 9th of May this nebula had its ordinary aspect without any stellar appearance, and on the 28th of the same month Pogson saw a star of the 7th or 8th magnitude which was also observed, May 21st, at Königsberg, by Messrs. Luther and Auwers, who estimated it above the 7th magnitude. On the 10th of June following, with a magnifying power of 66, the stellar appearance had very nearly disappeared, but the nebula was much brighter than usual, with a well marked central condensation. Pogson did not think it possible to attribute this variation to a change in the nebula itself, but he regarded it as singular that a new variable star, the third comprised in the same field of view, should be found situated exactly between the earth and this nebula. This observation was published on page 32 of vol. xxi of the "*Monthly Notices.*"

Quite recently Chacornac has observed, with the great telescope of Foucault, furnished with a mirror of silvered glass, and adapted to high magnifying powers, the annular nebula of Lyra, and he has shown that it may be resolved into a mass of very small stars, exceedingly near to each other, the more brilliant occupying the extremities of the smaller diameter. This

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[5] Prof. G. P. Bond has now the means of publishing a complete account of the Observations made on the Nebula of Orion for fourteen years past with the great refractor at Cambridge, and hopes soon to set about it. The comparisons of the data can hardly fail to be interesting and to bring something new to light. Its spiral structure has been seen by Prof. Bond, in perfect distinctness, with the great Clark object-glass of 18½ inches aperture.—EDS. *Am. Jour. Sci.*

nebula, which was examined for many nights, presented to him the appearance of a hollow cylinder, seen in a direction very nearly parallel to its axis. Its centre, as Lord Rosse described it, is veiled by a curtain of nebulous matter, which is resolved into a thin stratum of small stars. Chacornac adds, in his communication upon this subject to Dr. Peters, under date of Paris, June 9th, 1862, published in No. 1368 of the "*Astronomische Nachrichten*," that when the eye is protected from all extraneous light the scintillation of this multitude of luminous points, occupying a great portion of the surface of the retina, produces a very curious vertigo.

I pass now to the labors of M. d'Arrest upon the nebulæ. This astronomer directed his attention to this subject while he was connected with the Observatory of Leipsic, and he published in 1857, in the collection of memoirs of the Royal Society of Saxony, the results of his observations upon 230 nebulæ, made with a biannular micrometer of Fraunhofer's construction applied to a telescope having an aperture of 52 lines and a focal length of 6 feet. Prof. d'Arrest is the acting director of the Observatory of Copenhagen, and has continued, since September, 1861, his observations of nebulæ, with an achromatic telescope of 11 inches aperture and a focal length of 16 feet, and with a power estimated to be intermediate between Herschel's 20 feet reflector and the telescope of the same kind with which Lassell also observed the nebulæ from 1852 to 1854. The telescope of Copenhagen has enabled d'Arrest not only to recognize all the nebulæ of Herschel, but to discover more than a hundred new ones among 776 observed in 8 months. He has also been able to see, with some difficulty, certain nebulæ described by Lassell.

D'Arrest, making his observations alone, soon perceived that he could make but little comparison of observations on celestial objects of feeble light, with the microscopic readings of the circles of his instrument. The result is that his new catalogue does not give with all possible accuracy the absolute position of each object upon the celestial sphere. The position is only given to a minute of a degree in right ascension and declination; but the nebulæ are very carefully compared with the small stars near them, by means of annular and wire-micrometers. It will thus be a good means of recognizing exactly their proper movements relative to those stars, which was the principal object of the researches of d'Arrest. This astronomer has published in No. 1366 of the "*Astronomische Nachrichten*" an interesting notice of his latest researches, dated May 20th, 1862, from which I shall extract some details tending to complete those given above.

Variation of the brilliancy of the nebulæ.—M. d'Arrest admits, upon the basis of the great work of Argelander who has made a new catalogue of stars, that among 50,000 stars already well known there is but a very small number whose light varies periodically, and he thinks it is now possible, though with less certainty, to affirm that the same is true of nebulæ.

Sir W. Herschel has divided the nebulæ into three classes according to the degree of light. D'Arrest has found a great number of cases where nebulæ, such as had been first classified by Herschel, ought now to be displaced one or even two units in the classification. The latter cause has changed, in the course of a number of years, many of his own estimates of the magnitude of nebulæ. But, in view of the great diversity of atmospheric influences in moist climates, for observations of this kind, d'Arrest agrees with Otto Struve that it is not possible to be so confident in regard to conclusions deduced from variations of this kind. Meanwhile he states a small number of cases where he has been able to show some positive variation.

The first case of this kind is one deduced from observations of Struve upon the nebula of Orion which I have mentioned above. The observations upon this nebula recently made by d'Arrest, and frequently repeated, with his great telescope, on favorable nights, have confirmed those of Struve, especially those relating to the *bridge* upon the "*Sinus Magnus,*" which has been frequently visible at Copenhagen the past winter, (1861–2,) and it has appeared just as it was described by Lassell.

The second case of well marked variation is the almost total disappearance of a small and feeble nebula discovered by Hind, Oct. 11th, 1852, in the constellation Taurus, recognized by other astronomers and easily discernable, at the commencement of 1856, with a telescope of 6 feet focal distance. Two years later it was seen with great difficulty in the heliometer of the observatory of Königsberg. It was invisible Oct. 3d, 1861, with the great telescope of Copenhagen. Chacornac with the new telescope of Foucault, and Lassell at Malta, with his reflecting telescope of 4 feet diameter, vainly sought it in 1862, although it has been seen with the great achromatic telescope of Pulkova.

One curious circumstance connected with the great diminution of the brightness of this nebula is that this diminution was coincident with that of a small star almost in contact with the nebula. Argelander in 1852 estimated the brightness of this star at 9·4. Its magnitude was no more than the 10th in 1858, the 11th in 1861 and only the 13th or 14th magnitude in February, 1862.

Sir John Herschel thought that he lately found another example of the disappearance of a nebula, not seeing inscribed in the first catalogue of d'Arrest a very feeble nebula described by Sir W. Herschel near two others in the Hair of Bernice. But Chacornac with the aid of the telescope of Foucault proved that this feeble nebula was still visible, and d'Arrest has also observed it with his great telescope. This astronomer mentions also a small number of cases where there may have been a variation of brightness and even a disappearance of nebulæ, but these cases are not as well authenticated as that of Hind.

Double Nebulæ.—Sir John Herschel has remarked, in his great memoir upon nebulæ published in the *Philosophical Transactions* for 1833, p. 302, that the number of nebulæ physically connected with others is much more considerable, in proportion to the total number of nebulæ, than is the number of double stars among the fixed stars.[6] Assuming a mutual distance of 5 minutes of a degree as the greatest distance of double nebulæ, d'Arrest has already computed about 50 comprised within this limit, and he has estimated that there may be two or three hundred in a total number of about 3000 nebulæ in that part of the heavens visible to us.[7] This considerable proportion of double nebulæ, it is proper to presume, have a real connection in these groups, and their appearance confirmed this idea, particularly in the case where we see rare forms presented at once in two equal examples. Sir William Herschel does not appear to have had any idea of this physical connection between nebulæ, but Sir John has spoken of it clearly and frequently. There can be little doubt that it will be possible, in the distant future, to calculate the orbits of double nebulæ.

M. d'Arrest mentions some particular cases of nebulæ of this sort, one of which is triple. He recognized it only when, on comparing the distances and positions of two nebulæ, of the same group, observed in 1785, 1827 and 1862, he found sensible changes, which seemed to indicate a movement of revolution of one around the other. This particularly interesting nebula is situated in 109° 12′ of right ascension and 29° 45′ of northern declination. Lassell has represented it in No. 9 of plate XI, which accompanied his memoir, inserted in vol. xxiii of the Transactions (4to) of the Astronomical Society of London. The two components are very distinct although their mutual distance is actually only 28 seconds of a degree; but it is difficult to see them when the wires of the micrometer are illuminated.

A very small star is found between them, exactly at the same place where Lassell found it ten years before. M. d'Arrest will cite hereafter some other analogous cases of change in the relative positions of double nebulæ, when his work upon this subject, now in progress, is completed. He does not infer from what he has yet seen that he has found any of these groups of nebulæ with periods of revolution so short as those which have been determined for some of the double stars.

Finally d'Arrest describes a very small number of cases where

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[6] A brief analysis of these valuable researches of Sir John Herschel, accompanied with a plate, was given in the *Bibliothèque Universelle* for June and July, 1834.

[7] M. d'Arrest has quite recently published in No. 1369 of the "*Astronomische Nachrichten*," a catalogue of the positions and appearances of 50 double nebulæ, for the beginning of 1861, which he has already recognized and of which a dozen are new.

he has been able, by comparing a nebula with some small star near it, and repeating this comparison after a certain time, to show slight differences of distance or of position which might indicate a proper motion of one or the other of these heavenly bodies.

I here terminate this brief review, in which I have been able to give only a hasty glance at the actual labors of observers upon one of the more difficult and less advanced portions of astronomical science.

P. S. M. d'Arrest announces, in No. 1378 of the "*Astronomische Nachrichten*," that he has recognized in the constellation Taurus the existence of a second nebula of variable brightness.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS.

1. *On a new form of Spectroscope*, (from a letter of Dr. Wolcott Gibbs to B. Silliman, Jr.)—"Messrs. J. and W. Grunow, the well known opticians of this city, have just completed, at my suggestion, a spectroscope involving a new principle or rather one for the first time applied to instruments of this kind. In this instrument the prism of flint glass has a refracting angle of only 37°: the rays which diverge from the slit are rendered parallel in the usual manner by an achromatic lens having the slit in its principal focus. The bundle of rays then falls upon the first surface of the prism at a perpendicular incidence, and of course makes an angle of 37° with the second surface. Under these circumstances the refraction takes place at an angle so near the limiting angle that the refracted rays emerge nearly parallel to the second surface of the prism. The amount of dispersion produced in this manner is very great, while the loss of light, occasioned by reflection at the first surface in prisms of 60° placed in the position of least deviation, is avoided. The spectrum thus produced possesses remarkable intensity and the dark lines are seen in countless numbers and with great distinctness. The instrument in this form is sufficient for all *chemical* purposes, but it is so constructed as to permit the use of a second prism by which the length of the spectrum is of course greatly increased. Though the telescopes are only 6 inches in length, with a magnifying power of about 6, the spectrum compares very advantageously with that of a large apparatus with telescopes of 18 inches focal length and 1½ inches aperture and a prism of 60°. I may mention that the centre of the second surface of the prism lies in the vertical axis of the instrument, and also that in a prism of this kind the refracted rays diverge as if from a single radiant point, which is not the case with prisms of the ordinary construction, the angular dispersion being at the same time much greater. So far as I have been able to find, this form of prism was first employed by Matthiessen. In a lithographed copy of Regnault's lectures on Optics at the *College de France* in 1848, prisms on this principle of various forms are figured and described, together with the spectra produced. These last exhibit an extraordinary extension of the

violet end of the spectrum. A Matthiessen prism of flint glass in which the first surface is concave, so as to admit the addition of a double convex lens of crown glass, appears to be preferable for the spectroscope, in consequence of the saving of light."

New York, Nov. 28, 1862.

II. CHEMISTRY.

1. General Chemistry.

2. *On the preparation of Ozone.*—Schönbein has given a method of obtaining ozone ($-O$) in comparatively large quantities and with great facility. Chemically pure, finely pulverized hypermanganate of potash is to be dissolved in pure sulphuric acid of density 1·85 [HO,SO_3], so that the liquid is opaque and has a deep olive-green color. The solution is to be introduced into a flask with two necks, arranged in such a manner that finely pulverized peroxyd of barium may be introduced at pleasure and the gas evolved collected over water. The gas obtained in this manner possesses all the properties of ozone as obtained by the slow oxydation of phosphorus or by electrolysis. Taken into the lungs it produces contraction of the chest and catarrh. It destroys organic coloring matters with the greatest energy; burns pyrogallic acid completely to carbonic acid and water; does not combine with water to form HO_2, but reduces peroxyd of hydrogen to water, losing its smell and power of oxydation; it oxydizes lead, silver and arsenic in the cold; liberates iodine from metallic iodids; oxydizes the protoxyds of lead and manganese to peroxyds; converts sulphids into sulphates, and changes ferrocyanid to ferridcyanid of potassium. The gas thus possesses all the properties of ozone: it is however only a mixture of a small quantity of ozone with a large quantity of neutral oxygen. The author remarks that it is only the green solution of the hypermanganate which yields ozone in the above process. When the sulphuric acid is so dilute as to give a red solution no ozone is evolved.

Böttger claims priority in the discovery of the above method of preparing ozone. He recommends a mixture of two parts of dry hypermanganate of potash with three of sulphuric acid, and finds that the addition of peroxyd of barium is wholly unnecessary, as the mixture slowly evolves ozone at ordinary temperatures. Böttger finds this mixture one of the most powerful oxydizing agents yet known. Ether, alcohol and the etherial oils burst into flame when brought into contact with a mere trace, and flowers of sulphur are instantly converted into sulphuric acid, the action being attended by an explosive noise.—*Journal für Prakt. Chem.*, B. 86, p. 70 and 377. W. G.

3. *On the allotropic form of Oxygen.*—Schönbein has further endeavored to strengthen his position in regard to the existence of a positive and a negative oxygen, $+O$ and $-O$, by the following facts. Strips of paper soaked in a solution of sulphate of manganese are rapidly rendered brown by $-O$ in consequence of the formation of peroxyd of manganese MnO_2, while antozone or $+O$ produces no such change, but on the contrary bleaches paper rendered brown by the peroxyd. This is easily proved by hanging strips of darkened paper over a vessel in which $+O$ is generated by the action of sulphuric acid upon peroxyd of barium. Hypermanganic acid is rapidly decolorized by $+O$ with formation of

protoxyd of manganese, which may then be converted by $-O$ into MnO_2. In place of sulphate of manganese, basic acetate of lead may be used which with $-O$ gives PbO_2 in its turn reduced by $+O$ to PbO and neutral oxygen. Chromic acid is also reduced by $+O$ to Cr_2O_3. The explanation of these facts, according to Schönbein, depends upon the existence of $-O$ in the peroxyd of lead, hypermanganate of potash, and chromic acid, while $+O$ is contained in the peroxyds of barium and hydrogen. The union of equal weights of $+O$ and $-O$ gives ordinary or neutral oxygen. This view, which is certainly attractive and plausible, appears to be contradicted by several facts. Thus peroxyd of hydrogen, HO_2, oxydizes acetate of lead and gives PbO_2, which with excess of HO_2 is again reduced, while neutral oxygen is set free. Concentrated iodhydric acid is also decomposed both by $+O$ and $-O$ and even by neutral oxygen, though slowly. Schönbein endeavors to explain these facts by assuming that the different forms of oxygen may pass into each other and that certain substances possess the power of producing such a change. According to this view acetate of lead, protoxyds of iron and manganese, iodhydric acid, &c., by contact convert $+O$ into $-O$, and Schönbein accordingly lays down the principle that for the oxydation of the same kind of matter the same kind of oxygen is always necessary.—*Journal für prakt. Chemie,* 86, p. 30. *Chemisches Centralblatt,* No. 44, 1862. W. G.

4. *The fundamental properties of Oxygen and Hydrogen.*—Heldt has published a pamphlet with the above title in which the views of Schönbein as to the allotropic modification of oxygen are controverted. The author's principal conclusions are as follows:

(1.) There are no such modifications of oxygen as ozone and antozone. Phosphorus with water and oxygen yields ordinary peroxyd of hydrogen HO_2, and a gaseous peroxyd of hydrogen of powerfully oxydizing properties which is mixed in variable proportions with air or oxygen. The presence of hydrogen in this compound may be proved by passing the gas through a perfectly dry tube lined on the inside with a delicate coating of anhydrous phosphoric acid and heating the tube in one place. The acid remains unchanged in the flame but deliquesces behind it. The same result is obtained with the gas produced by the decomposition of peroxyd of barium by sulphuric acid and which Schönbein terms antozone.

(2.) Pure uncombined oxygen never possesses the properties of these gases.

(3.) Powerfully oxydizing bodies are obtained by saturating various liquid or gaseous organic compounds with oxygen. They obtain in this manner the properties of the inorganic superoxyds. Oil of turpentine, oil of bitter almonds, &c., are of this class.

(4.) Other oils are perfectly indifferent to starch and iodid of potassium paper. The vapors of these oils cannot serve as carriers of oxygen.

(5.) Certain oils possess the property of bleaching the blue reagent paper, and by mixing the vapors of two kinds of oil, vapors may be obtained which neither bleach blue paper nor render white paper blue.

(6.) In cases of oxydation by means of oxygen gas, whether in the dark or in sunlight, the oxygen never passes first into another or active condition. The author proved that air which had been employed to oxydize a solution of sulphate of iron had undergone no change whatever.

(7.) The only method of communicating to perfectly dry oxygen a higher activity is electrization. Otherwise oxygen is never capable of setting iodine free from iodid of potassium.

(8.) Atmospheric air almost always gives a more or less distinct reaction with iodid of potassium paper. This arises from various causes as the atmosphere is a reservoir for all the gaseous substances which are formed at the surface of the earth. The reaction is always produced by two opposing forces, one which sets the iodine free and another which combines with iodine or bleaches the blue paper. Among the former we may mention nitrous acid; among the latter, various hydrogen compounds, as HS, PH_3, &c.

(9.) Peroxyd of hydrogen (of Thénard) is not oxydized water, or, as Schönbein assumes, $HO+(+O)$, but a carrier of oxygen of which *all* the oxygen may be transferred. When the peroxyd is brought in contact with another substance which has an attraction for oxygen or hydrogen, the whole quantity is resolved with oxygen or hydrogen, either of which may combine with the body in question, so that the peroxyd may act as a reducing or as an oxydizing agent. According to Heldt, when HO_2 and PbO_2 are brought in contact, the oxygen given off arises exclusively from the HO_2 and not as Schönbein maintains, partly from PbO_2 and partly from HO_2. When hydrate of baryta and peroxyd of hydrogen are brought in contact, the latter simply yields half its oxygen to the former. In this manner the author endeavors to show that the assumption of polarity of oxygen is unnecessary.—*Die fundamental Eigenschaften des Sauerstoffs und Wasserstoffs. Experimental-untersuchungen von Dr. Wilhelm Heldt.*—Quoted in *Chemisches Central Blatt*, No. 44, 1862.

W. G.

5. *On the formation of nitrite of ammonium from water and atmospheric air under the influence of heat.*—The readiness with which a solution of nitrite of ammonium is decomposed into water and nitrogen according to the equation $NH_4O, NO_3=2N+4HO$, is familiar to all chemists. Schönbein has succeeded in showing that water and nitrogen may be made to recombine with unexpected facility under the influence of heat. When pure water is dropped into a platinum crucible heated to so high a temperature that the water evaporates immediately without passing into the spheroidal state and each drop is allowed to evaporate before another is added, it will be found that the water, condensed in a cold flask held over the crucible, contains distinct traces of nitrite of ammonium. A few grammes, acidulated with some drops of dilute sulphuric acid, communicate a blue color to iodid of potassium and starch. The reaction is sometimes more and sometimes less distinct, and the substance of the crucible has no influence whatever on the result. In a successful experiment, the addition of caustic potash evolves ammonia enough to tinge curcuma-paper distinctly and give a distinct cloud with chlorhydric acid gas. When a large copper still is used for the experiment, the water collected contains so much nitrite as to give distinct reactions, not only with the iodid-starch but with hypermanganate of potash, which is decolorized.

On evaporation to dryness with caustic potash, a residue is obtained which possesses all the properties of a nitrite. De Saussure long since showed that the combustion of hydrogen in oxygen mixed with nitrogen produced ammonia and nitrous, acid which he mistook for nitric acid, and Schönbein in 1845 showed that the combustion of hydrocarbon jets, &c., produced some oxydizing agent, the nature of which was not clearly recognized for want of sufficiently delicate tests. Schönbein now shows that the combustion of charcoal, fats, illuminating gases, wood, coal and phosphorus produces the nitrite in determinable quantities. A piece of phosphorus burnt inside of a bell glass which stands upon a plate filled with water, will give, after a few repetitions of the operation, enough ammonia to be distinctly recognized by means of caustic potash. The slow combustion of arsenic, in air at a temperature of 200°, also produces ammonia. Schönbein attributes the formation of nitrite of ammonium in all these cases to the heat and not to the act of combustion. The importance of the facts pointed out by Schönbein in explaining the occurrence of nitrite and nitrate of ammonium in the atmosphere will be obvious, as well as their bearing on agricultural chemistry.—*Ann. der Chemie und Pharm.*, cxxiv, 1.

Prof. Böttger of Frankfort, claims to have been the first to show by experiment as well as to announce that in every act of combustion which takes place in air, nitrite of ammonium is formed. (*Pogg. Ann.*, cxvii, 175.) An experiment of Kolbe's may also be mentioned in this connection. This chemist found that when hydrogen is burned in an open flask of oxygen standing vertically, a reddish-yellow gas is soon formed, and the water which collects in the flask has a strong acid reaction from the presence of nitric acid.—(*Ann. der Chemie und Pharmacie*, cxix, 176.)

W. G.

6. *On a new mode of detecting the presence of small quantities of peroxyd of hydrogen.*—When a solution of basic acetate of lead is added to water containing peroxyd of hydrogen, a portion of the lead is converted into peroxyd, PbO_2. Schönbein has based upon this reaction a method of detecting the presence of the minutest traces of peroxyd of hydrogen, which consists simply in adding to the suspected water a few drops of basic acetate of lead, a solution of iodid of potassium starch and a few drops of dilute acetic acid, when a more or less intense blue color makes its appearance. In this manner it is easy to detect the presence of HO_2 in water containing only one three-millionth part of its weight.—*Journal für prakt. Chemie*, lxxxvi, 129.

W. G.

7. *On the oxyethylene bases.*—**Wurtz** has described in some detail the formation and properties of the remarkable series of compounds of oxyd of ethylene and ammonia discovered by him some time since. These bases are formed by the direct union of oxyd of ethylene, $C_4H_4O_2$, with ammonia. Their basic characters are perfectly distinct but diminish in intensity as the quantity of oxyd of ethylene increases. The formulas of the compounds in question are as follows:

$(C_4H_4O_2)_1, NH_3$
$(C_4H_4O_2)_2, NH_3$
$(C_4H_4O_2)_3, NH_3$
$(C_4H_4O_2)_4, NH_3$
$(C_4H_4O_2)_5, NH_3$
$(C_4H_4O_2)_6, NH_3$
$(C_4H_4O_2)_7, NH_3$

and it is possible that bases of a still higher order exist. Wurtz remarks that these bases cannot be reduced to or derived from the ammonia type, whence it follows that there may be, among the neutral bases containing oxygen, bodies which are not compound ammonias, that is, which cannot be considered as derived from ammonia by substitution.—*Comptes Rendus*, liii, p. 338. W. G.

8. *On Acetylene.*—Berthelot has found that when graphite is intensely heated by means of the galvanic current in an atmosphere of hydrogen, acetylene is formed in considerable quantity. The same result is obtained with gas-carbon and with purified wood-charcoal, though in this last case with much greater difficulty, perhaps in consequence of the difficulty of heating the very porous mass to the requisite high temperature. Carbon does not combine with chlorine, bromine, or iodine under the circumstances in which acetylene is formed, nor can pure carbon be made to combine with pure nitrogen. The spark of Ruhmkorff's apparatus gives no acetylene with pure carbon and hydrogen.—*Comptes Rendus*, liv, 1042, 1070. W. G.

9. *On a new series of compounds containing Boron.*—Frankland has given a further account of the compounds of boron with ethyl, &c., already noticed in this Journal. Boric ethid, $B(C_4H_5)_3$, combines with ammonia with great energy to form an aromatic, oily, alkaline liquid, which has the formula $B(C_4H_5)_3+NH_3$. Boric methid, $B(C_2H_3)_3$ is formed like boric ethid by acting upon boric ether with zinc-methyl. It is a colorless gas of an intolerably irritating and pungent odor: its density is 1·93137. Under a pressure of three atmospheres at a temperature of 10° C., it condenses to a transparent colorless liquid. It is sparingly soluble in water but very soluble in alcohol and ether. In air it takes fire spontaneously, burning with a bright green flame. When suddenly mixed with air it explodes with great violence. When boric ethid or methid is allowed to escape very slowly from a glass tube into the air, it burns with a lambent blue flame invisible in daylight, the temperature of which is so low that the finger may be held in it for some time without inconvenience. Boric methid combines with ammonia to form a colorless crystalline body having the formula $B(C_4H_5)_3+NH_3$. Caustic potash, soda, lime and baryta absorb boric methid, forming alkaline substances soluble in water. They may be compared to borates in which three equivalents of oxygen are replaced by three of methyl.—*Proc. Royal Society*, vol. xii, 123. W. G.

2. ANALYTICAL CHEMISTRY.

10. *Behavior of Magnesia Salts towards Carbonate of Ammonia.*—Divers finds that the statement, common in treatises on analytical chemistry, is incorrect, that carbonate of ammonia precipitates magnesia salts imperfectly or not at all, and that any precipitate formed, may be redissolved by chlorid of ammonium. If dilute solutions of sulphate of magnesia, chlorid of ammonium and carbonate of ammonia be mingled, a granular precipitate is formed in ten minutes or so; the less time being required as the carbonate is in greater excess. The precipitate thus produced is the double carbonate of ammonia and magnesia $NH_4O\,CO_2, MgO\,CO_2, 4HO$. This salt is decomposed by a little water, carbonate of ammonia being dissolved, and carbonate of magnesia remaining. It dissolves completely

in a large amount of water, but, if the solution be nearly saturated, it shortly lets fall carbonate of magnesia. In solutions of chlorid of ammonium and sulphate of ammonia, it is very slightly soluble, and is almost totally insoluble in solutions of carbonate of ammonia. It is therefore inadmissible to employ carbonate of ammonia in precipitating phosphate of magnesia-ammonia, as Rose has pointed out in his *Traité.—Jour. Chem. Soc.*, May, 1862, p. 196. S. W. J.

11. *On Arsenic in Sulphuric Acid.*—BLOXAM finds that all commercial sulphuric acid contains a trace of arsenic which cannot be separated by boiling with hydrochloric acid, or chlorid of potassium, nor by repeated fractional distillation, either alone or with bichromate or permanganate of potash.

Bloxam prepared pure sulphuric acid from sulphurous acid, steam, and nitric oxyd, but only when the sulphurous acid was evolved from crystallized sulphite of soda and sulphuric acid at a low temperature, and nitric oxyd from nitre, sulphate of iron, and dilute sulphuric acid at a very moderate heat.

Bloxam traced the arsenic of oil of vitriol to the sulphur, being able to detect it in the Sicilian sulphur employed in the manufacture of the purest specimen of commercial sulphuric acid.—*Jour. Chem. Soc.*, Feb. 1862, p. 52. S. W. J.

12. *Estimation of Lime.*—WICKE converts oxalate of lime into sulphate in the following manner: the dry oxalate is transferred to a platinum crucible, and the filter, after it is burned by itself, is added. The contents of the crucible are treated with such a quantity of pure concentrated sulphuric acid that the mass is entirely saturated with it; great excess being avoided. The crucible is now placed on the sand bath until the first action, which consists in a moderate swelling of the mass and effervescence, is over. Next, the excess of sulphuric acid is expelled by cautiously heating over a small flame in a ventilating hood; finally, the residue is ignited, and the sulphate of lime is weighed. Wicke found this method both accurate and speedy of execution.—*Henneberg's Journal für Landwirthschaft*, 1861, p. 115. S. W. J.

13. *Quantitative determination of Starch.*—Starch has been estimated hitherto by mechanical separation, by fermentation and weighing the carbonic acid, by conversion into sugar and finding the amount of the latter by means of Fehling's standard copper solution, or finally by difference. Of these methods none are worthy of entire confidence in the majority of circumstances. Fehling's method, the best in most cases, has little value as usually conducted, since the more delicate forms of cellulose pass into sugar by digestion with acids, while the insoluble albuminoids yield both by treatment with acids and diastase, substances which reduce alkaline copper solutions.

Dr. Dragendorff of the Rostock Laboratory proceeds with starch determinations as follows: the pulverized substance after drying out all hygroscopic moisture at 212° is digested for 18–30 hours at a temperature of 212° in 10–12 times its weight of a solution of 5–6 parts of hydrate of potash in 94–95 parts of anhydrous alcohol. The digestion must take place in sealed glass tubes, or in a silver vessel which admits of closing perfectly. By this treatment the albuminoid substances, the fats, the sugar and dextrin are brought into such a condition that simple washing with alcohol or water suffices to remove them completely. The chief part of the phosphoric and silicic acids is likewise rendered soluble. The starch grains are not affected, neither does the cellulose undergo alteration, either qualitatively or quantitatively. In fact this treatment serves excellently to isolate starch grains for microscopic investigations. Besides starch and cellulose nothing resists the action of alcoholic potash save portions of cuticle, gum, and some earthy salts.

When the digestion is finished, it is advisable, especially in case the substance is rich in fat, to bring the contents of the tube upon a filter while still hot, as otherwise potash salts of the fat acids may crystallize out. It is also well to wash immediately, first, with hot absolute alcohol, then, with cold alcohol of ordinary strength, and finally, with cold water until these several solvents remove nothing more. In the analysis of matters which contain much mucilage, as flax seed, the washing must be completed with alcohol of 8–10 per cent, to prevent the swelling up of the residue.

The filter should be of good ordinary (not Swedish) paper, should be washed with hydrochloric acid and water, dried at 212°, and weighed. When the substance is completely washed, the filter and its contents are dried, first at 120° and finally at 212°. The loss consists of albuminoids, fat, sugar and a part of the salts of the substance, and when the last three are separately estimated, it may serve to control the estimation, by elementary analysis, of the albuminoids.

The filter with its contents is now reduced to powder or shreds, and the whole is heated with water containing 5 per cent of hydrochloric acid until a drop of the liquid no longer reacts blue with iodine. The treatment with potash leaves the starch grains in such a state of purity from incrusting matters, that their conversion into dextrin proceeds with great promptness and is accomplished before the cellulose begins to be perceptibly acted upon. By weighing the residue that remains from the action of hydrochloric acid, after washing and drying, the amount of cellulose, cork, lignin, gum and insoluble mineral matter is found. By subtracting these from the weight of the substance after exhaustion with potash, the quantity of starch is learned with great accuracy. The only error introduced by this method lies in the solution of some saline matters by the acid. The quantity is however so small as rarely to be appreciable. If needful, it can be taken into account by evaporating the acid solution to dryness, incinerating and weighing the residue. By warming with concentrated malt extract at 132°, the starch alone is taken into solution, and no correction is needed for saline matters. If it is wished to determine the sugar produced by the transformation of the starch, a weaker acid must of course be employed. In case of mucilaginous substances, the starch must be extracted by digestion with a strong solution of chlorid of sodium, to which the requisite quantity of chlorhydric acid has been added, and the residue should be washed with water to which some alcohol has been added.—*Henneberg's Journal für Landwirthschaft*, 1862, p. 206.

S. W. J.

III. METALLURGY.

1. *Metallurgy. The art of extracting metals from their ores, and adapting them to various purposes of manufacture;* by JOHN PERCY, M.D., F.R.S., *Lecturer on Metallurgy at the Government School of Mines.* 8vo, pp. 635. Murray, London, 1861.—This volume—after a brief introduction on certain physical properties of the metals, and some general considerations on metallurgical processes—treats in a most thorough and masterly manner of the subjects, *Fuel*, *Fire-Clay*, *Copper*, *Zinc* and *Brass.* Dr. Percy's work is not merely a critical compilation from the best authorities, but it contains a very large amount of exceedingly valuable original matter, the result of his own investigations, and of experiments made under his direction by Messrs. R. Smith, Dick, Spiller, Tookey and others, in the Metallurgical Laboratory of the Royal School of Mines. In fact, so far as our own knowledge extends, this work contains more valuable original matter than any other treatise on General Metallurgy which has been published since the classic work of Karsten. The book will prove of great service to both chemists and practical metallurgists. It is characterized by great clearness and accuracy in its statements, giving careful reference to authorities when quoted, exercising a discriminating criticism when needful, and withal a frankness in dealing with unsettled and questionable points, which commands the respect and confidence of the reader. The work is illustrated by more than one hundred and fifty wood engravings, which are remarkable for their great accuracy. We look with interest for the second and final volume, and trust that it will soon appear, inasmuch as the author promises to have it ready for publication before the end of 1862. It will treat of the subjects Iron, Lead, Silver, Gold, Platinum, Nickel, Cobalt, Arsenic, Bismuth, Antimony, Tin, Mercury, etc. G. J. B.

2. *Occurrence of crystallized Silicon in Pig-Iron.*—Prof. ROBERT RICHTER has discovered crystallized silicon in a specimen of crystallized pig-iron from a furnace at Gradaz in Carniola (Austria). Fragments of the iron were treated with dilute chlorhydric acid until all evolution of gas ceased; the residue was thrown on a filter, washed, dried and then heated in a platinum crucible in a stream of oxygen gas until all the carbon and iron were completely oxydized. The oxydized residue was boiled with concentrated chlorhydric acid, and after solution of the oxyd of iron there remained a quantity of graphite-like scales, which, examined under the microscope had a perfect metallic lustre, and a silver-white color. These scales remained unchanged when heated in oxygen, and were unacted upon when treated with chlorhydric and nitric acids: heated with nitre and carbonate of soda the scales were rapidly oxydized, and on further treatment the product of this oxydation proved to be silicic acid. The knowledge of the occurrence of silicon in pig-iron is a matter of importance for the ironmaster, as this may sometimes be the cause of the difficult welding, and other undesirable properties of some kinds of iron. For this crystallized silicon cannot be removed by the ordinary process of puddling; as has already been shown, it is not oxydized even when heated in oxygen gas. To remove crystallized silicon from iron in the puddling process it would be necessary to add soda, or perhaps litharge

in order to separate it.—*Berg. u. Huttenmäannisches Jahrbuch der k. k. Montan-Lehranstalten zu Leoban und Przibram*, xi, 289. G. J. B.

3. *Concentration of silver in lead by Pattinson's process.*—The Pattinson process for desilverizing lead depends upon the fact that an alloy of silver and lead in certain amounts, and up to a certain proportion, is more fusible than pure lead, or lead with only a little silver. Prof. Reich of Freiberg has made a series of experiments to ascertain the limit to which the concentration process is practicable. He finds that when lead contains about 2¼ pr. ct. of silver, the alloy has reached its lowest fusibility, and consequently the crystals which separate on cooling have the same richness as the remaining fluid metal or "mother liquor." Reich gives the following table, showing the progress of the concentration of the silver in the lead in his experiments.

Amount of silver in the original lead.	Silver in the separated crystals.	Silver in the fluid mother liquor.
·704 pr. ct.	·390 – ·466 pr. ct.	1·025 pr. ct.
·732	·318 – ·374	1·076
·966	·410 – ·680	1·450
·988	·390 – ·624	1·530
1·442	·682	1·922
2·090	2·011	2·260
2·116	1·728 – 2·216	2·248
2·206	2·212	2·268

On attempting to obtain crystals from lead containing 2·266 pr. ct. of silver, the crystals separated with difficulty giving a mean amount of 2·264 pr. ct. of silver, while the remaining mother liquor contained 2·292 pr. ct. Two experiments made to determine the point of fusion of argentiferous lead, gave with a mercury thermometer the following results: lead with 0·0065 pr. ct. silver fused at 321° C. with 0·476 fused at 309° C. —*Jahrbuch für den Berg- und Hütten-Mann.* Freiberg, 1862, p. 185.

G. J. B.

4. *On the desulphuration of iron in puddling.*—The inferior quality of bar-iron obtained from the puddling of pig-iron reduced from iron ores rich in sulphur, or even from good ores when reduced with coal containing much pyrites, is well known to ironmasters, and many methods have been devised for the desulphuration of this iron in the puddling process. Among the best of these is the addition of binoxyd of manganese; still this is liable to objection as it is infusible, and thus prevents its becoming thoroughly incorporated with the iron; moreover, commercial oxyd of manganese often contains impurities which possibly may be taken up by the iron in the puddling-process, and influence unfavorably the quality of bar-iron produced. This subject has recently been studied by Prof. Robert Richter of Leoben (Austria). Richter calls to mind the powerfully oxydizing effect of litharge (oxyd of lead), and its use to promote oxydation in many metallurgical processes. On experiment he finds that litharge will not only remove sulphur in the puddling process, but, what is equally important, it also oxydizes the phosphorus contained in the iron, thus affording a most simple means of correcting two sources of greatest annoyance to the ironmaster.

The experiments were made at the forges of Count Donnersmark at Frantschach near Wolfsberg in Carinthia, with pig-iron which contained so much sulphur that it was impossible to make it into puddled-bar. The process of puddling was undertaken in two double puddling-furnaces arranged for burning wood. Each furnace was charged with 7 cwt. of this iron. To one of the furnaces there was added 3 lbs. of sulphid of iron and ½ lb. of phosphid of iron, in order to still further deteriorate the quality of the product. After complete fusion, 3 lbs. of litharge was added to the furnace in which the sulphid and phosphid of iron had been placed, and on thoroughly mixing this with the charge, the iron commenced to boil finely—the litharge being deoxydixed by the carbon. The reduced lead was immediately reoxydized by the atmosphere, and by subsequent reduction and reoxydation it again and again exercised its oxydizing influence on the harmful impurities contained in the iron. There was soon formed an easily fusible slag containing oxyd of lead, which also exercised an oxydizing influence upon the impurities contained in the iron, while at the same time the oxyds thus formed united with the slag. After an hour and a half from the time of charging, the iron was made into balls, these were shingled, and without difficulty rolled into puddled bar. In the other furnace, in which the iron was puddled in the usual manner, it was two and a half hours before the puddled balls could be taken out of the furnace, and, notwithstanding the greatest care was exercised, these crumbled to pieces when struck with the hammer, and rolling into bar was not to be thought of. Besides this, the loss in weight when the litharge was employed was but 11 per cent, while in puddling this iron by the ordinary process the loss was 18 per cent. The puddled-bar obtained from puddling with litharge proved neither hot or cold short, and was of sufficiently good quality to be forged into iron for scythes. A repetition of the experiments gave a confirmation of these results. Richter adds, that in some instances the use of metallic lead may perhaps be preferable to litharge.—*B. u. H. Jahrbuch*, x, 505. G. J. B.

5. *On the amount of manganese in some varieties of iron.*—It is well known that iron reduced from spathic ore, and other ores containing manganese, not unfrequently contains a considerable percentage of manganese. In the variety of pig-iron called by the Germans *Spiegeleisen* (*mirror-iron*), the manganese has been estimated by different chemists to be from 4 to 7 pr. ct. In 1860, Dr. K. List published an analysis of a white-iron from Rüblinghausen, made from a mixture of ores containing from 20 to 25 pr. ct. of oxyd of manganese, in which he found but 3·80 pr. ct. of manganese. As the ore was so rich in manganese, List concluded that the iron obtained from its reduction must contain the maximum amount of manganese—that iron could not take up more than 3·80 pr. ct. manganese, and that the earlier analyses giving more than this must be incorrect. (*Polytechnisches Journal*, clv. 119.) Prof. Richter of Leoben has, however, reviewed List's results, and shows that the differences in the manganese content of iron smelted at different furnaces, or at different times does not necessarily depend upon the quantity of this substance in the ore, but upon the temperature of the furnace, and the relative amount of coal used in the reduction. The higher the temperature, and the larger the proportion of coal in the charge, the greater will be the relative

amount of manganese reduced. The basic or acid nature of the slag has also an important influence on the amount of the reduced manganese—it is easily reduced from a basic slag, but with considerable difficulty from an acid slag. Richter gives analyses of *Spiegeleisen* from Jauerburg in Carniola and Theresienthal in Bohemia:

	Jauerburg.	Theresienthal.
Sulphur,	0·073	....
Silicon,	1·902	2·732
Manganese,	7·578	22·183
Carbon,	....	2·311

The extraordinary amount of manganese found in the specimen from Theresienthal so influenced the properties of the iron, that it was not magnetic, and had not the power to throw down copper from a solution of chlorid of copper, it simply reduced it to sub-chlorid.

Richter further remarks that the same mass of iron may contain more manganese in one part than another, this is due to the tendency manganese has to separate from the fused mass, and the upper portion of a "pig" may thus contain more manganese than the lower portion.—*B. u. H. Jahrbuch*, xi. 295.

G. J. B.

IV. AGRICULTURAL CHEMISTRY AND VEGETABLE PHYSIOLOGY.

1. *On the Nature of the Gas produced from the Decomposition of Carbonic Acid by Leaves exposed to the Light*; by M. Boussingault.—An interesting paper in *Ann. Sci. Nat.*, (*Bot.*), 4th series, xvi, p. 1–27, 1862. Referring to the history of discovery in respect to the relations of plants to the atmosphere, Boussingault remarks, that Bonnet first took notice of the emission of air from the surface of leaves; Priestly recognized this air to be oxygen; Ingenhous showed the presence of light to be necessary; and Senebier proved that the oxygen gas eliminated by leaves under the light of the sun came from the decomposition of carbonic acid gas. Théodore de Saussure, nearly at the beginning of the present century, ascertained the fact, (which has since been often overlooked,) that the volume of oxygen gas produced was not quite equal to that of carbonic acid decomposed; and also that nitrogen gas was always evolved, to an amount about equal to that of the oxygen gas which had somehow disappeared. He supposed that this nitrogen came from the substance of the plant,—not considering, what is now obvious, that the substance of the plant did not contain, and therefore could not have furnished, any thing like this quantity of nitrogen.

In modern times, Daubeny was unable to obtain from leaves oxygen gas free from azote; and Draper states that he found the astonishing amount of from 22 to 49 per cent of the gas emitted from the leaves of *Pinus tæda* and *Poa annua* to be nitrogen. The first step towards the elucidation of the matter was made by Cloëz and Gratiolet, who, exposing the leaves of a common Pond-weed (*Potamogeton perfoliatus*) in water slightly impregnated with carbonic acid, found the first day 15·70 per cent of the gas eliminated was nitrogen; the second, 13·79; the third, 12·00; the fourth, 10·26; the fifth, 9·53; the sixth, 8·15; the seventh, 4·34; the eighth, 2·90. That is, the oxygen gas grew purer and purer, exactly as if the azote retained in the tissues of the plant, or in the water, was gradually expelled by the oxygen. Similar experiments were made by Boussingault in 1844, confirming these results; and also, later, a set of comparative experiments, with and without leaves, which confirmed the truth of the conjecture as to the source of most of the nitrogen. But, after all, he could not obtain any oxygen gas free from azote.

Boussingault now devised a new method of proceeding, by which he avoided the difficulty about extraneous nitrogen, &c. The mean results of 25 experiments (which are detailed particularly in the memoir), made with a variety of plants, are, that 100 measures of carbonic acid gas, decomposed by foliage under the light, gave 97·2 of oxygen gas; and that 1·11 of azote had appeared which, from the plan of the experiments, could not have come from the water, nor have been contained in the plant.

At this point Boussingault raised the question whether this gas, which remained after the absorption of the oxygen by the pyrogallate and the carbonic acid by potassa, was necessarily and really nitrogen. A suite of experiments, devised and executed in this view, brought out the interesting result that the supposed azote, which, moreover, corresponded very nearly with the amount of oxygen gas that had disappeared, was oxyd of carbon, i e. carbonic oxyd! There is also a little protocarburet of hydrogen. So "foliage during the decomposition of carbonic acid does not really emit nitrogen gas, but with the oxygen gas emits some oxyd of carbon and some protocarburet of hydrogen, and these combustible gases, like the oxygen, are produced only under the light of the sun. . . . . In other terms, to keep strictly within the conditions of the experiments, these gases constantly accompany the oxygen of which the sun determines the production, when it acts upon a vegetable submerged in water impregnated with carbonic acid." Is this also the case when carbonic acid is decomposed by foliage in the air?

Boussingault concludes his paper with the remark, that the earlier observers looked at their discoveries rather from the hygienic than the physiological point of view; that, while Priestly announced his brilliant discovery by the statement that plants purify the air vitiated by combustion or by the respiration of animals, it is curious enough that a century afterwards it should come to be demonstrated, before the Academy of Sciences, that probably the leaves of all plants, and certainly those of aquatic plants, while emitting oxygen gas which ameliorates the atmosphere, also emit one of the most deleterious of known gases, carbonic oxyd! He closes with the pregnant and natural query, whether the unhealthiness of marshy districts is not attributable, at least in part, to the disengagement of this pernicious gas by plants?

We add, that what strikes us with most surprise, is to learn that if these results are true, the vegetable machinery would seem to work at a loss, and with a real, though it be a small, waste of material! When any carbonic acid taken into the leaves passes off unchanged, so much work is not done; but there is no waste or loss in the process of manufacture. But, looking at the food of plants and their products,—comparing the raw material with the manfactured article,—it seems apparent that any carbonic acid which is reduced to carbonic oxyd, and given off as such, is so much loss or waste! We may avoid this unwelcome conclusion by the supposition that the carbonic oxyd and carburet of hydrogen are products of the decomposition of some of the vegetable matter coëtaneous with vegetable assimilation, but no part of that process itself. This is the more probable, since it cannot reasonably be supposed that carbonic acid supplied to the foliage is resolved into oxygen and carbonic oxyd and both set free,—which seems to be the alternative. A. G.

2. *Content of Starch in various Seeds.*—DRAGENDORFF, applying the method already noticed, (p. 116) for estimating starch, found the following percentages, which are interesting, either as serving to compare the results of his method with those obtained by others, or on account of including some seeds of which hitherto no analyses have been attempted. Dragendorff finds that in the seeds of colza and mustard the starch does not exist in the form of grains; but in an unorganized condition (*formlose Stärke* of Schleiden). In the seeds of the Leguminosæ, Dragendorff supposes a new and undescribed carbohydrate to exist, which has been confounded with starch hitherto, but which, unlike starch, is soluble in potash solution.

	Loss by drying.	Loss by treatment with alcoholic solution of potash.	Starch.	Cellulose, cork, cuticle, lignin, mucilage and insoluble mineral matters.
Wheat,	13·2	18·7	59·5	8·6
Wheat flour,	15 8	12·6	68·7	2·9
Rye,	11·0	23·2	59·7	6·1
Oats,	11·9	22·1	46·6	20·4
Barley,	11·5	23·5	57·5	7·5
Timothy seed,	12·6	29·9	45·0	12·5
Rice (hulled),	13·3	17·1	61·7	7·9
Peas,	5·0	34·2	37·3	23·5
Beans (white),	16·7	45·1	33·0	5·2
Clover seed,	10·8	60·0	10·8	18·4
Flax seed,	7·6	46·1	23·4	22·9
Mustard seed,	8·5	51·5	9·9	30·5
Colza seed,	5·8	63·5	8·6	21·1
Teltow turnips,[1]	dry substance	79·8	9·8	10·4
Potatoes,	dry substance	31·6	62·5	5·9

S. W. J.

3. *Peat-sandstone.*—According to Dr. Meyn there occurs in the heaths of Hannover a kind of moor-bed pan, which consists of sand cemented by peat; though on account of its color it is generally thought to be either bog-iron or iron-sandstone. It is formed by the evaporation of bog-water from a nearly pure quartz sand. The grains of sand first acquire a yellow, then a brown, and finally a dark brown or black color. When the peat solution evaporates, the peat is left in a form no longer soluble in water. It gradually fills up the interstices of the sand and makes an impenetrable mass, possessing a good degree of hardness and tenacity. When this peat sandstone is placed in ammonia a dark solution of humic acid is obtained, and nothing but white sand remains.—*Henneberg's Journal*, 1862, p. 344. S. W. J.

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[1] A sweet and mealy turnip grown on light soils for table use.

4. *On the occurrence of Silica in the higher Plants.*—The existence of considerable quantities of silica in the bamboo, in the equisetums, in the grasses and sedges has long been known.

The numerous analyses of the ashes of plants which we now possess, indicate that this substance is an invariable ingredient of the higher plants when they grow in natural soils. We find it in fact in nearly all parts of agricultural and forest plants. The seeds of the bean, quince, lemon, madder and flax are among the few parts of plants in which it has not been detected.

In the ash of the *wood* of most common forest trees, it ranges from 1 to 3 per cent; in the *Carpinus betul* it is as high as 4·97 per cent, (Fr. Schulze): in the *Pinus sylvestris*, 8·39 per cent, (Levi): in the *Pinus picea* 20·01 per cent, (Hertwig).

In the ash of *leaves* silica is more abundant than in that of wood. The ash of turnip leaves contains 3 to 10 per cent, (Anderson); of *Pinus picea*, 10·79 per cent, (Fr. Schulze); of the hop, 12·14 per cent, (Nesbit); of tobacco, in one case, 17·65 per cent, (Fresenius and Will); of the beech, *Fagus sylvatica*, 26·7, and the Oak 30·94 per cent, (Henrici). The ash of oat leaves contains 11–42 per cent, (Arendt), 16–58 per cent, (Norton).

In the *bark*, *rind* or *cuticle* of plants, silica appears to be most abundant. In the ash of the bark of the beech there is 17·97 per cent, (Wilhelmi), in *Prunus avium* 21·3 per cent, (Hoffmann). The most remarkable dicotyledonous plant in this respect is the *Hirtella silicea* or Cauto tree of South America. Henrici found in the bark of this tree 34·4 per cent of ash of which 96·17 per cent was silica. The bark is very firm, harsh and difficult to cut like a soft sandstone. Crüger states its ashes are used by the natives of Trinidad to mix with clay for making earthen vessels.

In the ash of the rind of the bamboo there is 70 per cent; in that of the *Chamerops excelsa* 90 per cent; in the ash of the *Equisetum hyemale* 97·52 per cent of silica, (Struve). In the bamboo we have, so to speak, silicious calculi—the Tabashir.

As to the *condition* of the silica in the plant, Arendt has shown that in the oat plant it is to a great degree insoluble (see table below), and his investigations of the oat in different stages of growth, further show that silica when once deposited in the tissues, suffers no subsequent change of place, as happens with other ingredients.

The *position* of silica in the plant is seen, from the percentages above quoted, to be, in general, at the surface. Although it is found in all parts of the plant, yet the *cuticle* is usually richest, and this is especially true in cases where the content of silica is large. Davy in 1799 drew attention to the deposition of silica in the cuticle, and announced the idea that it serves the plant an office of support similar to that enacted in animals by the bones.

That silica assumes the form of the cells in the cuticle of the Equisetums and Deutzias, is well known. Kindt finds that the hairs of nettles, Wicke that the hairs of hemp, hops and other rough leaved plants are incrusted with silica. According to Wicke the leaves of many forest and fruit trees when cautiously incinerated, leave a silicious skeleton that preserves the form of the epidermis. Mohl has minutely studied the position assumed by silica in many plants. He finds that in some leaves, only the upper, in others, both sides contain silica in the epidermal cells. In some the hairs alone, in others the hairs and epidermal cells also, are incrusted with this body. In *Deutzia* and *Ficus elastica* the vascular tissue is incrusted with silica. Wicke found that the bark of the beech and maple, *Acer pseudoplantanus*, are coated with silica. This is especially true of the beech which is literally enveloped in a silicious shirt of mail, whence the smooth and undecayed surface which its trunk presents. From the inner bark—bast-fibre—of flax, Wicke obtained after destruction of the organic matter, well characterized elongated cell-skeletons of silica. In the ashes of old linen he found 28 per cent of this substance. In the fibers of Manilla hemp, *Musa textilis*, Aloe hemp, *Agave Americana*, New Zealand flax, *Phormium tenax*, all tenacious textile materials, Wicke found as in flax, the entire cells incrusted with silica. In cotton fibre it is wanting. In jute, *Corchorus textilis*, some cells are partially incrusted. Wicke concludes that the durability of textile fibres is to a degree dependent on their content of silica.

The *function* of silica appears to be, in case of the grasses, sedges and equisetums, to give rigidity to the slender stems of these plants, and enable them to sustain the often heavy weight of the fruit. Two circumstances, however, embarrass the unqualified acceptance of this notion. The first is, that the proportion of silica is not greatest in those parts of the plant which would most appear to require its presence. Thus Norton (this Journal, [2,] vol. iii, pp. 235–6) found that in the sandy oat the upper half of the dry leaf yielded 16·22 per cent ash, while the lower half gave but 13·66 per cent. The ash of the upper part contained 52·13 per cent of silica, while that from the bottom part had but 47·79 per cent of this ingredient. According to Arendt (*Das Wachsthum der Haferpflanze*, p. 180) the different parts of the oat contain the following quantities of silica respectively:

Amount of silica in 1000 parts of dry substance.	Removed by water.	Insoluble in water.	Total.
Lower part of the stem,	0·33	1·41	1·74
Middle part of the stem,	0·30	4·82	5·12
Upper part of the stem,	0·36	13·02	13·38
Lower leaves,	0·86	34·37	35·23
Upper leaves,	0·52	43·35	43·87

We see then plainly that the upper part of the stem and leaves contain more silica than the lower parts, while the lower parts certainly need to possess the greatest degree of strength.

In the second place the great variableness observed in the same plant, and in the same part of the plant, as to the content of silica, would seem to indicate that this substance is to some degree accidental.

In the ashes of ten kinds of tobacco leaves, Fresenius and Will found silica to range from 5·14 to 18·39 per cent.

The analysis of the ash of 13 samples of pea-straw, grown on different soils from the same seed during the same year, under direction of the "Landes Economie Collegium" of Prussia, gave the following percentages of silica, viz: 0·56; 0·75; 2·30; 2·32; 2·80; 3·29; 3·57; 5·15; 5·82; 8·03; 8·32; 9·77; 21·35. Analyses of the ash of 9 samples of colza-straw, all produced from the same seed on different soils, gave the following percentages: 1·00; 1·14; 3·02; 3·57; 4·65; 5·08; 7·81; 11·88; 17·12.—*Journal für prakt. Chem.*, xlviii, 474–7.

Such instances might be greatly multiplied, and they have conducted to the opinion that a part of the silica is accidental, a notion further sustained by the fact observed by Saussure, the earliest investigator of the composition of the ash of plants (*Recherches sur la Vegetation*, p. 282), that plants raised on a silicious soil are in general richer in silica than those grown on a calcareous soil. Norton found in the chaff of the Hopeton oat from a light loam 56·7 per cent, from a poor peat soil 50·0 of silica, while the chaff of the potato-oat from a sandy soil gave 70·9 per cent.

Knop has recently published an account of the production of a maize plant that yielded 140 ripe seeds and had a dry weight of 50 grms. in a medium so free from silica that a mere trace of this substance could be found in the root, but half a milligramme in the stem, and 22 milligrammes in the 15 leaves and sheaths. It was altogether absent from the seeds.

The ash of the leaves of this plant thus contained but 0·54 per cent of silica and the stem but 0·07 per cent. Way and Ogston found in the ash of maize, leaf and stem together, 27·98 per cent of silica.

Knop is inclined to believe that the little silica he found in his maize plant was due to dust and did not belong to the tissues of the plant. He remarks, "I believe that silica is not to be classed among the nutritive elements of the gramineæ, since I have made similar observations in the analysis of the ashes of barley."

Knop does not inform us as to the firmness of the stem of this plant. It would seem however that while silica is not essential to the nutritive process in vegetation—is not required for the perfect elaboration of all the cells and organs of the plant—it is useful or even needful to consolidate the tissues, and thus to insure the vegetable structure against mechanical injury. The fact of its presence in variable amount and its most abundant occurrence in the upper and outer parts of the vegetable structure would indicate that the plants which contain it in large quantity oppose in their root surface no obstacle to its entrance, and that within the plant it obeys to a great extent the ordinary laws of diffusion until it is made insoluble by losing the colloid and assuming the crystalloid condition; or until it is arrested by the plant-tissues in a manner similar to that by which fabrics of dead cellulose attach to their surfaces the ingredients of mordants and dyes; or finally until it is left in the cuticular cells as a simple residue of the evaporation of the water that is perpetually streaming from the soil through the plant into the atmosphere. S. W. J.

V. MINERALOGY AND GEOLOGY.

1. *On a variety of Galena from Lebanon county, Pennsylvania.*—The following important notice of the remarkable octahedral galena, from Lebanon county, Pa., has been received from DR. TORREY.

"Prof. GEORGE J. BRUSH.—*My dear sir:* It is now more than two years since I gave you specimens of galena from Lebanon county, Pennsylvania, which exhibited a remarkably distinct octahedral cleavage. It was brought to me to be assayed for silver, and proved to be highly argentiferous, containing 179⅕ ounces of silver to the ton. From the same locality there were other specimens of galena, even richer in silver, but having the ordinary cubical cleavage. The octahedral variety was freely distributed among my mineralogical friends, but I was deterred from fulfilling my promise to give you a notice of it for publication, from having been told that a similar mineral had already been described. Not having been able to find any account of an octahedral galena and being assured by you, that none such has been recorded in the numerous works that you have consulted, I send you a short notice of the mineral.

It is said to occur in small masses disseminated through limestone, and is obtained while quarrying the stone for the purpose of converting it into quicklime. The mineral is brittle, like common galena, and the fresh surfaces have a strong and rather peculiar lustre. The fragments are all portions of octahedra, very sharply defined. In a few instances I have succeeded in obtaining cubes and cubo-octahedra by cleavage. When small pieces of the mineral are crushed, but not ground fine, the microscope detects some cubic particles. After being moderately heated in a test tube over a spirit lamp, a distinct cubic structure is developed. It is remarkable that no decrepitation attends the strong and sudden heating of the mineral.

Notwithstanding the eminent octahedral cleavage of this galena, I think it is pseudomorphous, possibly after fluor, although I cannot learn that fluor has ever been found associated with the ore. The natural joints of a crystal may remain after its composition is wholly changed; as is the case in Harrisite and other minerals; and it may still cleave readily, and only in the direction of these joints. Should my opinion that this galena is pseudomorphous not prove correct, we must conclude that sulphid of lead is dimorphous, or even trimorphous, if the crystals from Bernkastel, recently examined by Breithaupt, and noticed by you in the Tenth Supplement of Dana's Mineralogy, were true hexagonal prisms.

Yours truly, JOHN TORREY.

New York, Dec. 15th, 1862."

In connection with Dr. Torrey's important observations, it is appropriate to quote here the result of some interesting experiments made on this and other varieties of galena communicated to me by Prof. J. P. Cooke, under date of March 26th, 1862. Prof. Cooke says: "I have at last examined the galena, and hasten to send you my preliminary report. The octahedral cleavage is very perfect. I have measured the cleavage angles, on a large number of specimens, and they are all either 109° 28′, the angle between two octahedral faces over an edge, or 70° 32′, the angle between two octahedral faces over a solid angle. But although the octahedral cleavage is made the easiest, this variety of galena has also the natural cubic cleavage perfectly distinct, and quite as readily obtained as in ordinary galena. The reason that this is not generally noticed, is undoubtedly owing to the extreme facility of the octahedral cleavage which gives at once its direction to the fracture, unless special care is taken. I succeeded however in developing the cubic planes on every piece I tried, and in some cases merely by the pressure of the finger nail on the acute edges of the fragments. I enclose a small piece, which is an irregular octahedron, having two cube planes at opposite ends. On this I measured the angle between the octahedral and cubic planes, equal to 125° 16′, although in all these measurements there is an uncertainty of a few minutes, owing to the imperfect reflection of the planes. It then occurred to me that perhaps ordinary galena might have an octahedral as well as cubic cleavage, and that the first might be so marked by the great facility of the last, as to have escaped notice. I have tried several specimens of galena, and in almost every instance I have succeeded in detecting traces at least of octahedral cleavage. In some cases it was perfectly distinct. I enclose two small fragments. On one you will notice a very large octahedral cleavage plane. On the other there is a small octahedral plane on one of the cube angles. I did not succeed in obtaining this cleavage with a chisel and hammer, for when I struck in the direction of the octahedral plane, I immediately knocked off a number of small cubes. But by crushing in a steel mortar small cubic masses of the mineral, I could pick out among the fragments occasionally one with octahedral planes like the two I enclose. As the matter stands now, it would appear that galena has both octahedral and cubic cleavage; that in ordinary galena, the cubic cleavage is the easier; while in this I have examined, the octahedral is the easier. The octahedral cleavage is therefore nothing abnormal, but merely an unusual development of a constant condition. It will not, therefore, I think, be necessary to resort to any pseudomorphism to explain this peculiarity, which entirely disappears in this new view of the case. May not the cause of this unusual facility of the octahedral cleavage in this new variety be simply the pressure to which the vein has been subjected? My experiments with the crushing mortar look that way; and I mean to make further experiments before long with a hydrostatic press." . . . . In a subsequent letter, dated April 11, 1862, Prof. Cooke gives the results of his experiments with a hydraulic press. The galena from Rossie when crushed in a steel mortar with this press was found to give numerous examples of octahedral cleavage planes, while that from Freiberg gave very few, so "that it was necessary to hunt for some time to find one." Some specimens also gave indications of what appeared to be a dodecahedral cleavage.

Although Prof. Cooke's results apparently indicate that galena has an octahedral as well as a cubic cleavage, still the reason of the eminent octahedral cleavage of the Lebanon galena remains unexplained. It may be that cleavage in one direction could be produced by pressure, but it is difficult for us to conceive that a cleavage in four directions, corresponding to the octahedral planes, should be thus produced. We trust that Prof. Cooke will give us the results of his further experiments in this direction, and will demonstrate by measurements that the cleavage planes produced on the cubic galena are true octahedral planes.

Fluor presents an analogous case of double, and even triple cleavage; while the octahedral cleavage is perfect, and easily obtained in most varieties. Haidinger[1] has observed that the green fluor from Alstonmoor sometimes shows a distinct dodecahedral, and also a cubic cleavage; the blue fluor from St. Gallen in Styria shows dodecahedral cleavage, and the yellow fluor from Saxony a cubic cleavage. Other monometric species may also show this double and triple cleavage, but we are not aware that any example has before been observed where the cleavage ordinarily secondary becomes the primary cleavage. In the Lebanon Co. mineral the unusual octahedral cleavage predominates over the or-

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[1] **English translation of the Treatise on Mineralogy by F. Mohs, vol. ii, p. 69, Edinburgh, 1825.**

dinary cubic cleavage; while in the fluors just mentioned the perfect octahedral or normal cleavage remains preëminent.

The fact observed by Dr. Torrey, that the mineral developes a cubic structure by heat, has an important bearing in the consideration of this subject, and would seem to favor its being a case of dimorphism. But if it were a case of dimorphism, a difference between the specific gravity of this variety and that of ordinary galena would probably be observed: I find, however, that the Lebanon county mineral has a density of 7·63, which, although somewhat above that of ordinary cubic galena (7·568), does not offer any very great confirmation of its dimorphic character, especially as most works on mineralogy give the density of galena as from 7·2 to 7·6. If a mass of this octahedral galena could be heated in a closed vessel at a red-heat, without decomposition, until the cubic cleavage was developed, it is possible that fragments from the centre of the mass would show a different density from the original mineral. This would certainly denote dimorphism, but to make the proof conclusive a thorough analysis of both the original mineral, and the fragments showing the different density should be made, in order to make it certain that the composition of the centre of the mass was unchanged by heat. G. J. B.

2. *Discovery of Remains of vertebrated animals provided with feathers, in a deposit of Jurassic age;* (L'Institut, Nov. 5th, 1862).—We take from the Bibliothèque Universelle the following résumé of the publications made by A. Wagner and H. von Meyer on the feathered fossils recently discovered at Solenhofen.

The principal specimen, the object of these communications, is to be found in the beautiful collection of fossils belonging to Mr. Häberlein of Pappenheim—a specimen which has been described at Munich by A. Wagner, not as the result of a personal examination, but after the report of an enlightened naturalist in whom the learned Bavarian anatomist seems to put full confidence. H. von Meyer has since then figured in the *Palæontographica* a single feather, very well preserved, having both the shaft and the vane. They describe the specimens under two different names, the former under that of *Griphosaurus*, the latter under that of *Archæopteryx lithographica*.

The nature of the animal made known by these curious fragments is doubtful. Two hypotheses are possible. Either these feathers are those of a veritable bird, and it is necessary then to carry back the date of the appearance of this class, as has already been necessary for that of Mammals; or they covered the body of a Reptile, and, contrary to all precedent, it is necessary to admit the existence of feathered Reptiles. The details which follow seem to render this last alternative rather the more probable one.

The specimen of Mr. Häberlein is the one which furnishes the principal data for this discussion. It is an incomplete skeleton, lacking the head, the neck and the terminations of the anterior members. The feathers are preserved toward the base of the wings and about the region of the tail. According to the before-mentioned report, it is this latter part which is the most characteristic. The sacrum recalls the form of that of a Pterodactyl; the tail which is six inches long is composed of numerous vertebræ (20) diminishing uniformly, the last being the smallest, a structure, in our view, more analogous to the organization of Reptiles than to that of Birds. The feathers are situated upon the bone in a manner entirely unique; they are not set as in a fan, but grow on the two sides of the tail through its whole length, making an angle with it. They thus form, as it were, a flat leaf-like expansion, the extremity of which is much rounded, and extends beyond the last of the vertebræ.

The feathers of the wings are larger and form a fan upon each side, supported by a short and stout bone, badly preserved, which corresponds in position to the carpus. It is preceded by a fore-arm composed of a single bone (radius), and this by a humerus of equal length; both are robust.

This spinal column, by its free lumbar and sacral vertebræ, recalls rather the Reptiles. The left posterior member is complete, the right is reduced to the femur and the tibia. The femur is a stout bone, the tibia is longer and more slender; no fibula can be distinguished. The foot has no Reptilian characteristics, but on the contrary approaches some forms of Birds' feet. The tarsus is thick, composed of a single bone, a little shorter than the tibia, and parted at its extremity into three pullies to which are articulated three toes of moderate length terminated by strong hooked claws.

Upon the whole then, the animal has partly the characters of Birds, viz., the form of the foot and also the existence of feathers; partly those of Reptiles, viz., the form of the spinal column, of the sacrum, and especially of the tail. It has some new and anomalous characters in the implantation of the feathers, both those of the tail and those of the fore-arm.

Mr. Wagner appears disposed to consider the reptilian characteristics as predominating. He relies moreover upon a consideration which appears to us very just, in observing that the type of birds is singularly constant, without any marked aberrations; while we are habituated to the fact that Reptiles are excessively variable.

Note by James D. Dana.—Without questioning the above conclusion as to the reptilian peculiarities of the feathered fossils, the writer would here present some other considerations which bear on the subject, and which he believes may aid in determining the nature of the species. Where evidence is so evenly balanced, collateral facts or principles have special interest.

1. The abnormal characteristics ascertained are not incompatible with those of the bird type. They are mainly (1) the peculiarities of the sacrum and the elongation posteriorly of the vertebral column; and (2) the insertion of the quill-feathers in a line along either side of the tail thus formed. The last is, in fact a natural consequence of the form of the posterior extremity. Other minor reptilian features will probably be observed on a further study of the skeleton.

2. The occurrence of abnormal forms as the *earliest* representatives of a type is in strict accordance with the general tenor of geological history. All the synthetic types of Agassiz (or *comprehensive* types, as the writer has called them) are of this nature: the *Ganoids*, or fishes with reptilian characteristics; the stranger *Labyrinthodonts*, which have peculiarities of Batrachians united with some features of true Reptiles, etc.

3. A posterior elongation of the body is connected so profoundly with inferiority of grade in the different types of animal life, and is so often presented among the species of early time, that it is the very one of all abnormal features which is especially to be looked for in the early birds. It is a case of *vertebrated* tails, as in the ancient Ganoids. See, further, the article by the writer on page 65 of this volume.

4. The larger part of comprehensive types have become extinct, or nearly so. *Cystideans*, *Cyathophylloid corals*, *Trilobites*, *Labyrinthodonts*, *Enaliosaurs*, *Lepidodendrids*, *Sigillarids*, the *Dinothere*, *Sivathere*, and others, are extinct; and *Brachiopods*, *Crinoids*, *Ganoids*, *Cycads*, etc., are far less numerous than in a former age. The extinction of an early type of birds having some admixture of reptilian characters, would therefore agree with the general system in the progress of life.

The fact that birds have *now* small limits of variation, and reptiles wide limits, has therefore no great weight in this connection.

5. The age of these feathered species was the *Reptilian;* and in that age, nearly all the Vertebrates in existence had some reptilian features. The fishes, excepting the Selachians, were Ganoids; the Mammals were mostly, at least, Marsupials, and were allied to Reptiles in being semi-oviparous and in some other points. The coexistence of birds of a type having some reptilian characteristics, along with the Marsupials and Ganoids and the various Reptilians, would have made, for the age, a strikingly harmonious assemblage of species, consonant with known facts in other ages of the world's history.

6. As Mammals, or the superior class of Vertebrates, were represented in the world from the early Mesozoic, the probabilities are strongly in favor of the existence at the same time of *Birds*, species of an inferior class. The failure to discover fossils is not longer to be urged, provided the new specimens are of this class. At the same time it is to be considered, that, for various reasons, which need not here be stated, the remains of birds are necessarily very rare fossils; they having seldom been met with in the Tertiary and Post-tertiary, although birds then existed, while Tertiary mammalian fossils are of common occurrence.

7. Flying reptiles are exemplified in the *Pterodactyl*, the wings of which were formed, nearly as in bats, by an expansion of the integuments of the side of the body and limb, this being proved by the extension, for their support, of one of the fingers of each fore-limb. If, then, there were also flying reptiles in which the breadth of surface for the wing was produced by means of *feathers*, as in birds, there would have been two totally distinct methods of providing for the same variety of function in one single class of animals—which is altogether contra-natural. The Pterodactyl seems to teach which is the true reptilian method.

[From an article by Mr. Henry Woodward in the "Intellectual Observer" for December, 1862, (an excellent scientific Journal of a popular character, being as it states a "Review of Natural History, Microscopic research and Recreative Science")[1] we cite the following additional particulars. The paper came into our hands after the above was in type. It is accompanied by a beautiful plate of the fossil. The relation to the

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[1] Published by Messrs. Goombridge & Sons, London.

ancient Ganoid in the vertebrated tail is recognized by Mr. Woodward. —Eds.]

"Fortunately for English palæontologists, through the exertions of Professor Owen and Mr. G. R. Waterhouse (the latter of whom made it the object of a special journey to Pappenheim), this unique fossil has been acquired for the geological collection in the British Museum. Here it will be open to the observation of all the world. Before the issue of this present number, it will have been described by Professor Owen before the Royal Society, under the name of *Griphornis longicaudatus*, who thus indicates his conviction that it is a *bird*." [In a note here appended, it is stated that Prof. Owen, at the last moment, decided to retain von Meyer's name *Archæopteryx*, still regarding it, however, as a bird.]

"The head, neck, and dorsal vertebræ are wholly wanting. The right scapula and humerus and both the fore-arms are well preserved: the former bones are present on the left side, but imperfect; the fore-arm consists of radius and ulna; a metacarpal bone is present on the left side, lying beside the radius and ulna; there are also some small detached bones, which no doubt are finger bones. Above the wing-feathers on the left hand may be noticed two small slender bones, to which sharp claws, similar to those of the foot, are articulated. These may have been used for clinging, like those of the Pterodactyls and bats, or as offensive weapons, like the fighting spur with which the wings of the spur-winged goose of the Cape and Central Africa, the Chaja Screamer (related to the Rails) from Cayenne, and some others, are armed.

"The 'merrythought,' or *furculum* is seen lying between the wings. The ribs, small and unbird-like, are detached, and scattered on the surface, as if the head, neck, breast and body had been torn off or eaten out by some other bird of prey or small carnivorous animal, wandering at low water upon the estuarine flats bordering that ancient Oolitic sea.

"The lower right limb is well preserved, and consists of femur, tibia, and tarso-metatarsal bones; to the latter bone four toes are articulated, one hind-toe and three fore-toes, having severally 1, 2, 3, and (4?)[1] joints, *as in all birds*, and armed with strong hooked claws. The thigh and shank *only* of the right limb remain. The pelvis is well preserved on the left side, showing the cup-shaped cavity in which the head of the femur moved.[2]

The *sacrum* (so conspicuous in all known birds) cannot be traced in this skeleton, unless the stained surface of the stone indicates its remains. That one existed by which *a few* at least of the sacral vertebræ were firmly fixed together may be fairly concluded, for the hind limbs seem well adapted for hopping, running or perching; and the wings (which evidently were adapted for flight) must also have received support, in proportion to their size, from the body of the animal.

The whole of the vertebræ of the tail are completely and beautifully preserved. They are twenty in number, of a narrow, elongated form, the dimensions of which slowly but constantly diminish, so that the last

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[1] The fourth toe bones underlie the second and third, and cannot be certainly counted.

[2] The fossil is lying on its *back*, so that we view *the underside* of its feathers and bones.

is the smallest. The feathers of the tail are attached in pairs to each vertebra throughout its entire length. It is in the form and number of the caudal vertebræ, and the arrangements of the tail feathers, that the great and striking peculiarity of this remarkable creature lies."

3. *On some additional species that are common to Carboniferous and Permian strata, with remarks on the recurrency of Carboniferous species;* by JAMES W. KIRKBY.—We copy from Mr. Kirkby's paper the following list which will not fail to be of interest to American geologists, whose labors have already shown a similar blending of species in the two formations as they exist in North America.

List of Species occurring in Carboniferous and Permian Strata in Britain.

Carboniferous Name.	Permian Name.
1. *Gyracanthus formosus*, Agassiz.	*G. formosus*, Ag., King, in Mon. Perm. Foss. England, p. 221; Howse, Ann. Nat. Hist. ser. 2, vol. xix, p. 33.
2. *Terebratula sacculus*, Martin, 1809. Figured in Davidson's Monograph of Carboniferous Brachiopoda, pl. 54.	*T. elongata*, var. *sufflata*, Schloth. 1816. Figured in Davidson's Monograph of Carboniferous Brachiopoda, pl. 54.
3. *Spirifera Urii*, Fleming, 1828. Figured in Dav. Mon. Carb. Brach. pl. 54.	*S. Clannyana*, King, 1848. Figured in Mon. Carb. Brach. pl. 54.
4. *Spiriferina octoplicata*, J. de C. Sow. 1827. Figured in Mon. Carb. Brach. pl. 54.	*S. cristata*, Schloth, 1816. Figured in Mon. Carb. Brach. pl. 54.
5. *Camarophoria Crumena*, Martin, 1809. Figured in Mon. Carb. Brach. pl. 54.	*C. Schlotheimi*, Von Buch, 1834. Figured in Mon. Carb. Brach. pl. 54.
6. *Camarophoria rhomboidea*, Phillips, 1836. Figured in Mon. Carb. Brach. pl. 54.	*C. globulina*, Phillips, 1834. Figured in Mon. Carb. Brach. pl. 54.
7. *Athyris Royssii*, L'Eveillé, 1835. Figured in Mon. Carb. Brach. pl. 54.	*A. pectinifera*, J. de C. Sowerby. 1840. Figured in Mon. Carb. Brach. pl. 54.
8. *Discina nitida*, Phillips, 1836. Figured in Mon. Carb. Brach. pl. 54.	*D. Konincki*, Geinitz, 1848. Figured in Mon. Carb. Brach. pl. 54.
9. *Lingula mytiloides*, Sow. 1812. Figured in Mon. Carb. Brach. pl. 54.	*L. Credneri*, Geinitz, 1848. Figured in Mon. Carb. Brach. pl. 54.
10. *Fenestella plebeia*, M'Coy, 1844. Figured in plate accompanying present paper.	*F. retiformis*, Schloth. 1816–17. Figured in the plate accompanying present paper.
11. *Cythere elongata*, Münster, 1830. Jahrbuch f. Min. p. 65.	*C. elongata*, Münster (Jones). Figured in Mon. Perm. Foss. pl. 18; and Trans. Tyne. Field Club, vol. iv, pl. 11.
12. *Cythere inornata*, M'Coy, 1844. Figured in Syn. Char. Carb. Foss. pl. 23.	*C. inornata*, M'Coy (Jones). Figured in Mon. Perm. Foss. pl. 18; Trans. Tyne. Field Club, vol. iv, pl. 11.
13. *Cythere (Bairdia) gracilis*, M'Coy, 1844. Figured in Syn. Char. Carb. Foss. pl. 23.	*C. (Bairdia) gracilis*, M'Coy (Jones). Figured in Mon. Perm. Foss. pl. 18; and Trans. Tyne. Field Club, vol. iv, pl. 11.
14. *Cythere (Bairdia) plebeia*, Reuss (Kirkby). Figured in the plate accompanying present paper.	*C. (Bairdia) plebeia*, Reuss. Figured in the plate accompanying present paper.

15. *Cythere (Bairdia) Schaurothiana,* Kirkby. Figured in the plate accompanying present paper.
16. *Pinites Brandlingi,* Lindley.
17. *Trignocarpum Nœggerathi,* Brong.
18. *Sigillaria reniformis,* Brong.
19. *Calamites inæqualis* (?), Lindl.
20. —— *approximatus,* Brong.

C. (Bairdia) Schaurothiana, Kirkby. Figured in the plate accompanying present paper.

For the occurrence of these species in the Rothliegende, see Howse on the Permian Fossils of Northumberland and Durham, in Annals Nat. Hist. ser. 2, vol. xix, p. 38.

4. *Geological Survey of Canada.—Report on the Geology of Canada.* 8vo, pp. 692 (incomplete).—We have at the last moment received this valuable document as far as printed. Many of the more important of its general conclusions we have already been enabled to place before our readers, thanks to the kindness of Sir William Logan, Mr. Billings and Prof. Hunt. The general description of the rock formations of the Province, occupies about 450 pages. The mineralogical and chemical history of these rocks follows, including the mineral species, the composition of the stratified and unstratified rocks, and the mineral waters, filling about 220 pages. Then follow particular descriptions of the economic rocks and minerals of the Province, and in an Appendix a complete list of the organic remains, with a large number of figures in addition to those given in earlier parts of the Report. The two latter sections are still incomplete. We shall not fail to transfer to our pages from this able Report, such new matters as will prove of general scientific interest.

5. *Descriptive Catalogue of a collection of Economic Minerals of Canada, and of its Crystalline Rocks,* (sent to the London International Exhibition for 1862). Montreal, 8vo, pp. 83.—This catalogue, carefully prepared by Messrs. Logan and Hunt, possesses much more than an ephemeral interest, from the large amount of valuable scientific and practical information it contains, and the excellent system with which it is arranged.

VI. BOTANY AND ZOOLOGY.

1. Genera Plantarum *ad Exemplaria imprimis in Herbariis Kewensibus servata definita ; auctoribus* G. Bentham et J. D. Hooker. Vol. I, pars I, *sistens Dicotyledonum Polypetalarum Ordines* LVI (Ranunculeas—Connaraceas). London : Pamplin, Reeve, Williams & Norgate, etc., 1862, pp. 454, imp. 8vo.—The first words of the preface, "Linnæus *Generis* inventor fuit," state a proposition which, it would seem, may be questioned, upon the authority of the person who ought to know best. Linnæus himself, in the first edition of his Genera Plantarum, after due notice of Cæsalpinus and others, gives to Tournefort the credit of establishing genera in botany upon pure systematic rules ; and later, in the *Philosophia Botanica,* he declares that "Tournefortius primus characteres genericos ex lege artis condidit." And further, in Gen. Pl., "Characteres hos (genericos) dum authores evolvo, reperio nullos certos et fixos ante *Tournefortium,* ut ipsi non immerito inventionis gloriam circa genera concedere debeam." Accordingly, the Tournefortian genera which he adopts, as well as those of Plumier, &c., are uniformly acknowledged as such. So are they by Jussieu, as would naturally be expected, and to a good extent by Endlicher. The practice now introduced, of citing all the

earlier genera as if they originated with Linnæus, is therefore an innovation,—a bit of radical reform,—which may be deferred to, not as of right, but as practically convenient, at a time when systematic botany has full load enough to carry without dragging on more of the past than is strictly needful. Indeed, if the alternative be between this, and the practice of a few pedants, such as Sprengel, who, taking their cue from the *name* rather than from the *thing*, would trace our genera back to the mediæval herbalists, or even to Theophrastus, Pliny, &c., there could be but one opinion as to the proper course to pursue. That we are not shut up to either alternative is shown by the clear and consistent course adopted by Linnæus, and followed by Jussieu and their principal successors. A practice thus sanctioned might well enough be continued.

Our fault-finding (if such it be) may end where it began, with the first line of the book. The first edition of the Genera Plantarum of Linnæus was published in 1737, the sixth, in 1764; that of Jussieu, '*Secundum Ordines Naturales disposita*,' appeared in 1789; that of Endlicher, between 1836 and 1840. The present much-needed work, if less erudite than that of Endlicher, is more scientific. Endlicher, the best of compilers, appeared to know all that had been written about plants; Bentham and Hooker know the plants themselves. The former digested generic characters admirably from the authorities, rarely supplemented by original observations. The latter rely upon their own investigations, or verify those of others, and compile only in the rare case of the total want of materials,—which with their advantages rarely happens. Endlicher's characters are models of style; but the formula, like that of Linnæus, involves constant iteration of phrases which are ordinal rather than generic. Bentham and Hooker's are more synoptical and differential, more in the manner of Jussieu, and are not less remarkable for the intimate knowledge and sound judgment which they everywhere reveal. The latter is especially shown, also, in the limitation of genera; and we may hope that this work will take a leading and most influential part in the reaction against the view that genera are the lowest definable groups of species, and the practice of subdividing them accordingly upon single and purely technical characters. Where to draw the line and fix the grade of genus, which is so important because it carries the leading name of the plant, can seldom be determined by general rules propounded beforehand. It is a matter of judgment, not to say insight; and in this the genius of Linnæus was preëminent. The late Nees von Esenbeck may be taken as a good—indeed the worthiest—exponent of the tendency to generic subdivision which characterizes the botany of the last twenty or thirty years. The present work will mark the extent of the reaction in this respect.

Another excellent feature of the present work is found in the conspectus of the genera prefixed to each order. In this the characters of the tribes and other divisions are given, and these are not repeated in the body of the order, which saves room. We observe, also, that the authors mostly have but one grade of groups bearing names under the order, and that is *tribe*, except under *Sapindaceæ*, where five suborders take their place, the *Dodoneæ* being disposed as of equivalent value with the *Acerineæ* and the *Staphyleæ*. And the *Lardizabaleæ*, reduced to *Berberideæ* by a happy foresight (a new Chilian genus having since turned up in confirmation), stand only as a tribe of that order. We perceive however that in *Ranunculaceæ*, *subtribes* appear (probably left by an oversight,) and that in *Papaveraceæ* both *suborders* and *tribes* are admitted, the former in what we take to be the proper sense of the term, viz.; where the type is so far peculiar, or the characters of such moment, that a reasonable question may be raised whether the groups are not entitled to ordinal rank; e.g. *Fumarieæ*, and the like. Of course there can be no question of suborders in such an order as *Cruciferæ*.

Following the conspectus of the true genera of each order, excluded genera are mentioned, and the place where they are severally to be sought is indicated. Reduced genera are mentioned, and often criticised, at the close of the account of the genus to which they are referred. Abnormal forms, or exceptions to the general character of an order, are particularly specified in paragraphs which follow the ordinal character,—a great help to the student.

Finally, the general sequence of the orders is based upon that of De Candolle, which has become so familiar, beginning with the Polypetalous Dicotyledons, with *Ranunculaceæ*, &c.; the scheme however being revised and improved in its details, and the orders grouped naturally into *cohorts*, which in rank answer nearly to what Endlicher (following Brown's proposal) calls classes, and these, into a few *series*, which are somewhat equivalent to Endlicher's cohorts. The general scheme of arrangement appears in a Conspectus, separately paged, which is printed *pari passu* with the body of the work. As this volume will be at once in the hands of all working botanists, there is no occasion to point out, nor need we comment upon, the various changes or new combinations which appear even in this first instalment of the new *Genera Plantarum*. The publication of its immediate predecessor occupied four years, and this was a wonderful performance for a single person. Considering the greater amount of botanical research which the present plan requires, and the vast accession of materials to be elaborated, we cannot look for an earlier completion of this formidable undertaking from the conjoint labors of two of the best furnished and most industrious of botanists. A. G.

2. *Darlingtonia Californica*, Torr.—This most rare and curious pitcher-plant has last autumn been met with, by Professor Wm. H. Brewer, of the California Geological Survey, at what is supposed to be the original station. The locality, Dr. Brewer informs us, is "on the Sacramento trail, in the valley of the Upper Sacramento (not the Pitt River,) near 'Tim Southern's,' about thirty miles south of Shasta Mountain. This is the only locality that I have yet seen; but I hear of two other localities, one in the Sierras near San Juan, the other said to be on Scott's Mountain, over 200 miles northwest. The plant is very abundant in one small locality, on a hillside, with southern exposure, where a small stream of running water makes a narrow swamp; the soil gravelly; and with but little vegetable matter. All the older leaves contained many dead insects, but none contained water. . . . . The station is at the altitude of between 2300 and 2500 feet, where snow falls during winter, but is exposed to a clear unclouded sun for some months in the summer. I shall forward seeds to several botanists in the hope that this interesting plant may become less rare."

A small supply of sound ripe seeds, received by the writer, have been disposed of to the best advantage for ensuring their germination, after sacrificing two or three of the precious stock in ascertaining their internal structure. The embryo is similar to that of *Sarracenia*, but the albumen is more farinaceous. Externally there is little similarity, as their shape is clavate, no rhaphe is apparent, and the seed-coat is thin, loosely cellular, and beset all over, less thickly at the attenuate base, with spreading and stout, almost scale-like, bristly processes. The characters drawn from the seed, which complete the diagnosis of the genus, as presented in technical language, are as follows:

DARLINGTONIA. Semina basi attenuata obovato clavata, setis crassis (haud septatis e cellulis laxis testæ membranaceæ exortis) undique squarrosa; rhaphe inconspicua: tegmen tenue, ad micropylen attenuato-apiculatum. Embryo parvulus in basi albuminis granuloso-farinacei; radicula cylindrica; cotyledonibus perbrevibus. A. G.

3. *Botanical Collections in the Rocky Mountains.*—The botanical readers of this Journal are familiar with the results of Dr. Parry's reconnoissance of the mountains of Colorado Territory, at and beyond the mining district, last year, that is, in the summer of 1861. The limited collections he then made being much in demand, and his desire for exploration still unsated, Dr. Parry revisited this interesting region early last summer (1862,) accompanied by Messrs. E. Hall and J. P. Harbour, the party ascending Pike's Peak, and also crossing the principal range into Middle Park, &c. Dr. Parry remained in the mountain region until autumn, for the purpose of collecting the seeds of Coniferæ. Having devoted much of his time to geographical and barometrical observations, the larger part of the botanical collections, except towards the close of the season, are due to the sedulous labors of his associates, Messrs. Hall and Harbour. Most of the species collected in 1861,—often too scantily for general distribution—have now been gathered anew, and many additional ones have been secured, some of them of great rarity or novelty. Messrs. Hall and Harbour likewise collected the more interesting plants of the plains of Nebraska. A systematic enumeration of the plants collected, with characters of new species, &c., now in preparation by the present writer, will immediately be published.

The principal collections of the joint expedition, distributed into sets under Messrs. Hall and Harbour's tickets, extend to 695 numbers. These sets will be extended by the addition of from 50 to 100 or more alpine plants from the special collection of Dr. Parry, distributed under and in continuation of his former numbers; so that, in the whole, the flora of the Rocky Mountains will be adequately represented. The specimens are very good and well made; and the collection as a whole is particularly interesting. Thirty sets are offered to botanists. About fifteen of them are nearly complete and full, and are offered at eight dollars the hundred numbers. The remainder fall off to 600 or 500 numbers, and the specimens often less copious; these are held at six dollars the hundred, at which rate they are most desirable acquisitions, and they will doubtless be appropriated as soon as they are known. Applications may be addressed to Mr. Elihu Hall, Athens, Illinois, or especially to Prof. A. Gray, Cambridge. A. G.

4. *Species Filicum;* by Sir W. J. Hooker, parts XIII and XIV.—The progress of this important work has from time to time been noticed in this Journal, and it has now reached the middle of the fourth volume. Part XIII begins with the *Scolopendrieæ*, consisting of the genus *Scolopendrium*, which is here extended so as to include *Antigramme, Schaffneria*, and *Camptosorus*. Eight species are described, of which the first, *S. vulgare*, grows commonly in Europe, and has been found in Japan, but in the United States seems limited to the station at Chittenango. *S. Hemionitis* from the south of Europe, *S. pinnatum* from the Philippine Islands, the two species of *Antigramme* from Brazil, *Schaffneria* from Mexico, our "Walking Leaf" and its Siberian relative, make up the genus, which, thus constituted, is distinguished from the *Asplenieæ* by having the involucres arranged in pairs opposite to each other on contiguous veinlets.

The remainder of part XIII and part XIV are taken up with the *Aspidiaceæ*, the numerous species of which are arranged in seven genera, *Didymochlæna, Aspidium, Nephrodium, Nephrolepis, Oleandra, Fadyenia* and *Onoclea*. Of the first genus there is but one species, *D. lunulata*, Desv., having many synonyms, and growing in nearly all tropical lands. *Aspidium* includes all the Ferns with orbicular and peltate involucres, and is divided into sections *Polystichum*, with free veins, *Cyclodium*, with meniscoid venation, *Cyrtomium*, with veinlets slightly united, and *Euaspidium*, with veins variously and compoundly anastomosing. For convenience of classification, in the last section is included the group of species having compoundly reticulated venation and reniform involucres, constituting the genus *Sagenia* of Presl. All other Ferns with reniform involucres are put in the genus *Nephrodium*, here including as sections *Pleocnemia*, the veinlets forming elongated costal areoles, *Eunephrodium* with connivent veinlets, and *Lastrea*, with free veins. This arrangement of the old Swartzian genus *Aspidium* is very convenient to the student, more comprehensible than the arrangement of Mettenius, and much more reasonable than the multitudinous genera of Fée and others; but the placing in *Aspidium* of species having the technical characters of *Nephrodium* (*Sagenia*) is a confession that this division into two genera is not perfectly natural. Among the *Aspidieæ* with anastomosing venation it will always be difficult to separate the species with reniform involucres from those with orbicular and peltate involucres, so closely are they otherwise related, and thus it seems more natural to make but one genus of *Aspidium*, as Dr. Mettenius has done.

Of *Aspidium*, seventy-five species are described, and of *Nephrodium*, one hundred and fifty-two. The species of *Aspidium* found in the United States are five; *A. Lonchitis, acrostichoides, munitum, aculeatum*, (which includes a host of synonyms and varieties from all parts of the world,) and *A. juglandifolium*, the *Phanerophlebia nobilis*, Liebm., which occurs in New Mexico. Of these, *A. acrostichoides* and *A. munitum* are exclusively American; the latter, from the North West coast, being one of the handsomest of the whole genus. A frond of *A. munitum*, well covered with fruit, is one of the finest ferns ever seen in herbaria. Our species of *Nephrodium* are ten; *N. Thelypteris, Noveboracense, patens, Filix-mas*, (*Asp. Ludovicianum*, Kze. and *N. Floridanum*, Hook.,) *rigidum*, (*Asp. argutum*, Kaulf.,) *cristatum*, *Goldieanum*, *marginale*, *fragrans*, and *spinulosum* (including *dilatatum*). *N. Noveboracense*, *Goldieanum* and *marginale* are exclusively American. *N. Noveboracense* is strangely a subject of doubt, as to whether it is really distinct from *N. Thelypteris*. *Asp. Ludovicianum* the author has not seen, but his *N. Floridanum*, figured in *Filices Exoticæ*, is referred to *N. Filix-mas*, though somewhat doubtfully. The writer of this notice, who has seen the living Fern in Florida, is disposed rather to consider it a form of *Asp. cristatum*. (*See Chapman's Flora of the Southern States.*) Good and abundant specimens of *A. argutum* from California, and of the Florida and Louisiana species, are greatly needed to settle their not very obvious affinities. *Asp. Bootii*, Tuckerm. is not noticed in this work, though *Lastrea cristata*, var. *uliginosa*, Moore, which is the same thing, is referred to *N. spinulosum*. It is not impossible that *A. cristatum*, may have to be united with *A. spinulosum* and *dilatatum*. The two former constantly grow together, and there seem to be all degrees of intermediate forms.

Of *Nephrolepis* only six species are described, and it will not be easy to find places among them for all the forms which appear in herbaria. *N. exaltata* occurs in Florida. *Oleandra*, a most natural genus, is represented by five species, all of them tropical. *Fadyenia prolifera* is still retained as a genus, though hardly distinct enough from *Nephrodium*. *Struthiopteris* is now known to have involucrate sori, and is therefore very properly united with *Onoclea*, the oldest name. The species of *Onoclea* will be given in part XV.

There occur here and there some typographical and other errors. On page 60 the name *draconopterum*, which was given to a Fern from the Isthmus of Darien, is converted into *dicranopterum*, a good enough name, but not the original one, and not applicable to the plant referred to. So, on page 54, for *Euasplenium*, *Euaspidium* was intended.

One who compares this *Species Filicum* with other systematic works on this extensive and difficult order will find that it is remarkable for the ease with which it enables the student to identify an unknown Fern. Many doubtful and little known species are omitted; but if a Fern is described in the book, its name can almost invariably be found with ease and certainty.

Polypodium and *Acrostichum* are the largest genera now remaining to be elaborated, so that the work will hardly need to be extended beyond a fifth volume, though a supplementary volume, of species discovered after the genera were arranged, will probably be added.

It is to be hoped that the powers of this illustrious and venerable botanist may hold out, and his life be prolonged, to see the full completion of this work, and to enjoy his pleasant studies long thereafter.

D. C. E.

ZOOLOGY—

5. *On the classification of the Brachyura, and on the homologies of the antennary joints in Decapod Crustacea;* by WM. STIMPSON, M.D.—Dr. STRAHL has recently been making some carcinological investigations, (see *Monatsbericht der Königl. Akademie der Wissenschaften zu Berlin*, 1861, and *Annals and Magazine of Nat. Hist., London*, 1862,) which have led him to propose a new classification of the higher Crustacea.

He considers the characters of the external antennæ, particularly of their second joint (basicerite), of paramount importance, and would divide the suborder Brachyura, in accordance with these characters, into four groups, namely,

Orbata, with the first two joints of the antenna only present, the rest wanting, as in *Acanthocyclus*.

Liberata, with the basicerite free, as in *Oncinopus*.

Incuneata, with the basicerite wedged in between the pterygostomium and the epistome, as in *Cancer*.

Perfusa, with the basicerite completely united with the neighboring parts, as in *Stenorhynchus*.

These differences are certainly of great importance, and have not generally received sufficient attention from carcinologists. But they can scarcely be used for the primary subdivisions, as they are not coincident with characters of still higher value. By their use we should be required to dismember well-marked groups;—to separate for instance, *Macrocheira* from the Maioids and *Gecarcinus* from the Ocypodoids;—while strange approximations would occur, as of *Oncinopus* with *Myctiris*. Experience has long since shown us that it is impossible to group animals upon the variations of a single organ.

Some of Dr. Strahl's conclusions are so surprising, that they may well require the closest scrutiny before acceptation. For example, he says: "The *Leucosiæ* I consider to include only Dana's *Leucosidea*, with *Dorippe* and *Ethusa*. I separate the *Calappidæ* and *Matutidæ* from them, and unite them with the *Parthenopinæ* rejected from the *Oxyrhyncha*." This combination is justified "by the agreement in the situation of the afferent canal of the branchial cavity and of the male sexual organs," etc. But the *Calappidæ* are entirely removed from the *Parthenopinæ* in the structure of the mouth-parts; the buccal cavity is narrowed anteriorly so that the efferent branchial channels terminate at the middle instead of the sides of the endostome, and are covered by the indurated summits of the laciniæ of the first pair of maxillipeds (tritocheirognathites). Like the *Leucosidea* they are oxystomatous, as Milne-Edwards has shown. They indeed differ from these latter in the situation of the efferent canals, and should therefore be separated as a distinct group; but they should no more be united to the *Parthenopinæ* than should the *Dorippidæ*, which Dr. Strahl would unite with the *Leucosidea*, although these are far more nearly allied to the *Calappidæ*, not having the afferent canal covered by the exognath of the outer maxillipeds, which is the case in all *Leucosidea*.

Again, Dr. S. remarks, "The genus *Grapsus*, limited by the rejection of *Leptograpsus*, *Metopograpsus*, etc., and represented by the species *Pharaonis*, *strigosus*, *Webbi*, etc., must be removed not only out of the *Grapsoidea*, but even entirely out of the Brachyura, because the structure of the external antennæ differs completely from that which prevails amongst the Brachyura. *Grapsus*, for instance, has no operculum at the base of the external antenæ, but a perforated tubercle, as in the Macroura, and must therefore at least be placed among the Anomoura." Here we would have *Leptograpsus variegatus* and *Grapsus strigosus*, for instance,—forms so closely allied that they are placed in one and the same genus by so skillful a naturalist as Dana,—separated so widely from each other that the latter species is placed among the Anomoura! Let us examine fresh or wet specimens to ascertain whether *Grapsus* in reality has, at the base of the antennæ, a structure so essentially differing from that found in ordinary Brachyura. Dried specimens are too commonly used in these investigations, and are very apt to lead to error. The "operculum," spoken of above, is the coxal joint (coxocerite) of the external antennæ, which is moveable in all crabs, even where the next (basicerite) is not. In a *Maia* for example, this coxal joint may be raised a little, so that the membranous areola,[1] which occupies its postero-interior surface, may be partially seen. In *Leptograpsus* this areola is more exposed, encroaching somewhat upon the margin or outer surface of the coxal joint, or, in other words, this joint is kept permanently a little raised. In *Grapsus* the coxal joint (here the "perforated tubercle" of Strahl) is still more evolved, and its sides are folded in, giving it a globular form, and contracting the areola, which is thus placed in a slit and becomes almost wholly external. The different form of the coxocerite in *Grapsus* is, therefore, the result of a simple modification, not of structural importance. In *Dromia* the coxal joint is also slit, at one side, but the areola is on the inner surface. This joint in *Dromia* is not "so shrunken that only the tubercle remains." It is far larger in proportion than is usual in the higher Crustacea. Dr. Strahl says that "if we imagine the slit in the tubercle of *Dromia* carried out to one side, so that here the peripheral margin is completely separated, we have the operculum of the Brachyura in its perfect form." But this prolongation of the slit would cut the coxal joint in two, which is not the case in the "operculum." For this "operculum" is truly the homologue of the coxocerite of *Dromia* and *Homarus* in its entirety; as may be seen by comparing with this part in *Pilumnus*, for instance, where the basicerite is not soldered to the contiguous parts as is usual in Cancroids, but is free and articulated directly with the "operculum" in the same manner as it is with the coxal joint in the other two genera named. *Pilumnus*, we may remark incidentally, would be classed with *Parthenope* by the character of its antennæ.

Dr. Strahl proposes new names for the first two joints of the external antennæ; the first (coxocerite) he would call *intercalare;* the second (basicerite) *armiger;* while the third (ischiocerite), he calls the first joint of the antennæ, which is certainly liable to mislead. Professor Milne-Edwards, who has done so much towards elucidating the homologies of these joints, has given to them the names in brackets, which are more appropriate; for there is undoubtedly a perfect correspondence between them and the joints of the maxillæ or feet. I believe it possible to carry the homology even further than the celebrated French zoologist has done, and that the antenna in question, like a foot or maxilliped, consists normally of seven joints. In the embryo of *Hippolyte* as figured by Kroyer (*Monog. Fremst. af Hippolyte's Nordiske Arter*, etc., tab. vi, f.

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[1] The so-called *tympanum.* It is very doubtful whether the auditory organ is ever here situated. Kroyer has demonstrated (*Kongl. Danske Vidensk. Selskabs Skrifter*, 1856, iv, 288) that a far more complicated auditory apparatus exists at the base of the internal antennæ.

121), there are five distinct joints beyond the basicerite, which would make seven in all. Moreover they can be demonstrated in the adult *Squilla*, *Axius*, and *Pagurus*, and particularly well in *Homarus*, where the parts are more distinct from their large size. The "peduncle" of the antenna in the lobster is considered by Milne-Edwards to consist of five joints; but a sixth is indicated at the base of the penult, on the lower side of the member. Here there is a small triangular piece, articulating with the second and third joints as well as the penult, perfectly mobile, and dependent upon no one of these joints more than another. An additional evidence that this piece is the representative of a distinct joint is furnished by the fact that the articulations of the two proximate joints are in the same plane, and not, as should be the case were they normally contiguous, in planes perpendicular to each other. To complete the number (seven) of joints we have the flagellum, which corresponds to the dactylus or terminal joint of the thoracic members. This homology is rendered probable by the occurrence, in the remarkable Hippidean genus *Mastigopus*,[2] discovered by me in the Chinese Seas, of a multiarticulate dactylus to the chelipeds perfectly similar to the flagelliform terminal appendage of an antenna.

The squamiform appendix of the antenna is attached to the second joint, and is homologous to the exopod of the feet, or the exognath of the maxillipeds, which has the same position. It is called *scaphocerite* by Milne-Edwards, but would be more appropriately named *exocerite*, a term indicating its relations with greater exactness, and corresponding in construction with that of its homologues. This appendage is normally two-jointed, as is seen in the embryo *Homarus* and in the adult *Squilla*; its basal joint is obsolete or coalesced with the terminal squamiform joint in adult Macroura and Anomoura, while in Brachyura the entire appendage disappears with perfect development. The little basal joint of the exocerite in embryo *Homarus* is mistaken for the "armiger" (basicerite) by Dr. Strahl, who considers the large joint which supports both branches of the antenna as the "intercalare" (coxocerite), on the ground that in the adult the third joint is articulated with both the coxocerite and the basicerite. But this is so only in appearance;—if the antenna in a fresh lobster or cray-fish be bent outward, it will be seen that the posterior condyle of the third joint articulates with the basicerite alone. The basicerite, in the embryo Decapod, is far from being the trifling joint seen at the base of the scale-like appendage; but is, in fact, that large supporting joint which is the first to make its appearance, and which often reaches, with its exocerite, a large size before any trace of other joints, either coxal or terminal, can be perceived. In the figures accompanying the valuable observations of Dr. C. Spence Bate (*Phil. Trans.*, 1858, pl. xl, f. B. 3, etc.), this character of the basicerite is well shown in representations of the Zoea of *Carcinus mænas*. Here we have the joint in question very large, armed with a long spine on one side and the exocerite on the other, while the rest of the antenna is in a rudimentary condition, and there is no coxocerite visible. This latter joint, with its areola, makes its appearance at a later date, at the base of the basicerite.

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[2] Proc. Acad. Nat. Sci. Philad., Dec., 1858. Not the *Mastigopus* of Leuckart, which is a *Sergestes*.

The large comparative size of the exocerite in the embryo, is in accordance with what we observe in the gradations of adult Crustacea. Those lowest in the series have generally the external branch of their members most developed; as we rise in the scale, we observe the inner branch becoming more and more developed, while the outer branch is reduced and may disappear entirely. Compare, for example, the thoracic feet of some Schizopods with those of the Caridea and Brachyura.

6. *Observations on the genus Unio, together with descriptions of new species, their soft parts, and embryonic forms, in the family Unionidæ.* Read before the Academy of Natural Sciences of Philadelphia, and published in their Journal; by Isaac Lea, LL.D., President of the Academy of Natural Sciences of Philadelphia, &c.—Memoirs so elaborate and valuable to science as those of Mr. Lea demand a more extended notice than our pages will permit. We can do little more than call the attention of those interested to the great results of his untiring labors in the department of recent Conchology. It is well known to the scientific world that Mr. Lea has been, for many years, devoting a large portion of his time to the elaboration of the Unionidæ, a family of freshwater Mollusks. Up to this time the results of his labors are embodied in 8 vols. 4to, with a considerable number of finely executed plates. We have now vols. vii. and viii, of 2 parts each, before us.

Vol. vii, part 1 consists of 51 pages of text and 12 plates, with elaborate descriptions of 38 new species, with diagnoses of the soft parts of old species not before examined anatomically. "The descriptions and figures of the soft parts, in this paper, will be found to be important. That of *Unio multiplicatus* (nobis) represents the anomalous character of the female of this large and multiplied species, so common in the valley of the Ohio, with her distended branchial uterus occupying the four leaves of the branchiæ, charged with probably three or four millions of embryonic shells ready to be hatched. The singularly formed plicate branchial uterus of *U. Woodwardianus* (nobis) and *U. Phaseolus* Hild., will also attract the attention of the zoologist."

Vol. vii, part 2 consists of 39 pages text and 18 plates, with description of 40 new species. In the two parts of vol. vii, 39 exotic and the same number of indigenous species are described. Mr. Lea regards Georgia as the zoological center of Unionidæ. Up to the publication of this volume, he has described 151 species from that state alone!

Vol. viii, part 1, consists of 56 pages of text, containing descriptions of 46 new species, and is illustrated with 16 plates.

Vol. viii, part 2, contains 58 pages of text and 18 plates, with descriptions of 58 new species, all of which are indigenous to this country. From the author's introduction to the 8th volume, the following interesting facts are taken. "Since the issuing of my last volume (7th) many new species of the *Unionidæ* have come into my possession, and I now give full descriptions and remarks upon most of them. The Southern States, and particularly Alabama, Mississippi, Georgia and North Carolina have multiplied them greatly. The very remarkable diffusion of species of this kind of zoological life in so many varied forms, some of them so nearly allied, will strike the attention of the student; for no other portion of the globe exhibits anything at all kindred to this remarkable developement. Nature has been so lavish in these states, that although the greater and smaller streams penetrate in every direction, still nearly all seem to have some peculiar form pertaining to each. Unfortunately the existing troubles in the South have cut off these investigations, and until peace shall return to open again scientific correspondence, the prosecution of these researches will naturally remain interrupted."

"In the introduction to my last volume, I enumerated the species of the family *Unionidæ* described to that time as inhabiting the United States. The number was then in the United States 550; in other parts of North America, 38. Up to this time we have in the United States, 607; which are thus divided; *Unio*, 520; *Margaritana*, 28; *Anodonta*, 59. To these may be added for the remaining part of North America, 39 species; making together 646 species of the family now known."

"Texas has yet been but very slightly examined, and its branching streams, watering the soil in every direction, must be productive of riches in these mollusks, which will fully reward the labor of the naturalist. A large portion of Louisiana, Mississippi and Alabama has not been examined, and Florida is almost a virgin field for investigation."

Other memoirs by the same author are now in process of publication, abstracts of which have appeared in the Proceedings of the Academy. The papers are as follows; 1. Description of a new genus *Trypanostoma* of the family *Melanidæ*, and of forty-five new species. 2. Description of ten new species of *Unionidæ* of the United States. 3. Description of two new species of exotic *Uniones* and one *Monocondylæa*. 4. Description of a new genus, *Goniobasis* of the family *Melanidæ*, and eighty-two species. 5. Description of eleven new species of *Melanidæ* of the United States. We have been permitted to examine five plates of Mr. Lea's forthcoming Memoirs on the *Melanidæ*, upon which are figured 229 species. This will be noticed more fully hereafter.

VII. ASTRONOMY AND METEOROLOGY.

1. *Re-discovery of Daphne, Asteroid* (41).—It has been stated in this Journal, vol. xxxii, p. 438, that Daphne was discovered at Paris, May 22, 1856; but the reliable observations only embraced an interval of four days, and the arc described in this interval was but little more than one degree. Any orbit computed from these observations must of course be liable to considerable uncertainty.

On the 9th of September, 1857, M. Goldschmidt of Paris discovered a small planet near the position which had been computed for Daphne, and for several months no doubt was entertained that this planet was really Daphne; but on making a careful computation, M. Schubert discovered that the same orbit could not be made to represent both series of observations. He therefore concluded that the planet discovered Sept. 9, 1857, was a new planet; and it received provisionally the name of *Pseudo-Daphne*.

At the next opposition which should have occurred in December, 1858, neither Daphne nor Pseudo-Daphne could be found; and at the succeeding opposition in March, 1860, astronomers were equally unsuccessful. In the following year however they were more fortunate, as Pseudo-Daphne was rediscovered by M. Goldschmidt at Paris, Aug. 27, 1861. To this planet the name of *Melete* has since been given.

Daphne however had escaped the search of astronomers for more than six years, and seemed hopelessly lost. But on the 31st of August 1862, M. Luther of Bilk discovered a small planet of the 11th magnitude, and in three hours he perceived that the plane of its path bore some resemblance to that of Daphne. In a few days it became evident that this new planet was really Daphne. The following are the elements of this planet computed from observations of Aug. 31, Sept. 5, and Sept. 11, and side by side are placed the elements as they had been previously computed from the observations of 1856.

	Epoch 1862, Sept. 5·5. Berlin m. t.	1856, May 22·5. Berlin m. t.
$\pi =$	$233° \; 44' \; 39''{\cdot}8$	$236° \; 52' \; 17''{\cdot}1$
☊ =	179 7 7 ·7	179 55 11 ·8
$i =$	14 38 49 ·4	15 12 47 ·8
$\varphi =$	16 47 27 ·7	16 24 9 ·8
$\mu =$	$728''{\cdot}320$	$844''{\cdot}952$
log. $a =$	0·458452	0·415450

There is very little room for doubt that both series of observations belong to the same body. The remaining uncertainty can only be removed by a rigorous computation of an orbit which shall embrace all the observations of 1856 and 1862.

2. *Discovery of a new Asteroid by M. Tempel.*—On the 29th of August, 1862, M. Tempel, at Marseilles, discovered a planet of the 11th magnitude, whose position he indicated upon Argelander's chart. The following are the approximate positions of this planet for the 29th and 30th.

Aug. 29, 10^h R. A. $= 0^h \; 2^m \; 32^s$, $\delta = +3° \; 55'$
30, 10 30^m R. A. $= 0 \;\; 2 \;\; 12$, $\delta = +3 \;\; 50 \;\; 30''$

This asteroid has been named *Galatea.*

The following are the elements computed by Dr. Frischauf from observations of Sept. 16, 22 and 28.

	Epoch 1862, Sept. 16·0, Berlin m. t.	
$M =$	$353° \; 48' \; 52''{\cdot}9$	Mean equinox 1863·0
$\pi =$	6 42 36 ·5	
☊ =	200 29 20 ·2	
$i =$	3 15 43 ·8	
$\varphi =$	14 12 26 ·3	
$\mu =$	$858''{\cdot}592$	
log. $a =$	0·410813	

It was announced in the last No. of this Journal, p. 430, that Mr. Parkhurst, of New York, discovered an asteroid on the 25th of September. The positions given by Mr. Parkhurst correspond very nearly with those computed from the preceding elements, from which we infer that the planet observed was Galatea.

3. *Discovery of Asteroid* (75).—On the 22d of September, 1862, a new asteroid was discovered by Mr. C. H. F. Peters, director of the Ob-

servatory of Hamilton College, State of New York. It appeared as a star of the 11th magnitude. From observations of Sept. 22, 25 and 28, Mr. Peters has computed the following orbit:

Epoch 1862, Sept. 25·5, Washington m. t.

Mean anomaly,	22° 7′ 6″·7	
Longitude of Perihelion,	336 31 33 ·6	Mean equinox of epoch.
Longitude of ascending node,	0 22 23 ·0	
Inclination,	5 8 46 ·0	
Eccentricity,	0·2842059	
Mean daily motion,	825″·590	
Semi-major axis,	2·643389	

4. *Astronomical and Meteorological Observations made at the United States Naval Observatory during the year* 1861; published by authority from the Hon. Secretary of the Navy; Commander J. M. Gilliss, U.S.N., Superintendent. Washington: Government Printing Office, 1862. 4to. pp. 520.—This volume inaugurates a new order of things at the Naval Observatory, (formerly, but without authority, called the "*National* Observatory") in Washington. From a prefatory Notice by the Superintendent, we learn that the ten years' accumulation of observations, made prior to Jan. 1, 1861, are now in course of preparation for publication. These comprise observations with the transit instrument, mural circle, meridian circle and equatorial, from 1851 to 1860, both inclusive; zone observations from 1846 to 1851; magnetic observations, declinometer, vertical force instrument and dip circle, from July, 1842 to Oct. 1844; and meteorological observations from July, 1842 to Dec. 1860. Congress having made the requisite appropriations, a corps of copyists is now engaged in transcribing from the record books all the observations, in order to prepare for their computation by Dr. B. A. Gould, to whom this duty has been assigned and who has contracted to return them ready for the printer within two and a half years. The progress already made in the computations secures the publication of a volume very soon, and should no unforeseen event occur to cause delay, the whole of these long sequestered observations will be published within three years.

The Introduction gives an account of the instruments and *personelle* of the Observatory, and the plan of work, followed by the detail of observations made with each instrument.

The physical aspects of the comet of 1861 (II) is accompanied by a beautiful plate of its appearance, July 2d, 3d, 4th and 7th, and concludes with Prof. Hubbard's Elements, already published in this Journal, (xxxii, 310). The whole volume is beautifully printed at the Government Office.

5. *Discovery of Asteroid* (76).—On the 21st of October, 1862, M. d'Arrest, at Copenhagen, discovered another planet, which appeared as a star of the 12th magnitude. It has received the name of *Freya*, Goddess of love and beauty in the Scandinavian mythology.

METEOROLOGY.

6. *Shooting Stars of November*, 1862.—The following is an abstract of observations communicated to the Committee on *Periodical Meteors*, of the Connecticut Academy of Arts and Sciences, and reported to the Academy at their meeting in November.

Observations at Germantown, Pa., N. lat. 40°, W. long. 75$\frac{1}{5}$°—*The observer, Mr. Benj. V. Marsh.*

	Conform.	Uncertain.	Unconf.	
Nov. 14th. From 3^h 5^m to 4^h A. M.	11	4	1	16 in 55^m
" 4 " 5 5^m "	14	1		15 " 65
Being in all,	25	5	1	31 in 2^h

The conformable radiated from Leo, and were nearly all bright—leaving trains. The observations were mostly in the N. and N. E.

Observations at Haverford College, N. lat. 40°, W. long. 75$\frac{1}{3}$°.—The observers were Prof. Saml. J. Gummere and Mr. Jos. G. Pinkham.

	Conform.	Uncer.	Unconf.	Total.
Nov. 14. 0^h to 1^h A. M.	14	3	1	18 in 1^h
1 " 2 "	21	3	2	26 " 1
2 " 3 "	12	2	1	15 " 1
Being in all,	47	8	4	59 in 3^h

The brightest of these was observed at 1^h 5^m. It left a train visible 5^s.

One observer at the same station, Mr. Thos. H. Battey, saw, Nov. 14, 3^h to 6^h A. M., 26 conform., 8 unconf.; total 34 in 3^h.

The radiant was in Leo. At 5^h 16^m one train near θ Orionis continued visible about 5^s. One meteor seen by Mr. Battey is recognized as identical with one seen by Mr. Marsh.[1]

Observations at Weld, Maine, N. lat. 44$\frac{3}{4}$°, W. long. 70$\frac{1}{3}$°.—One observer, Mr. Stillman Masterman, saw, Nov. 12th, 9^h to 9^h 25^m, P. M., 4 bright stars radiating from the triangle made by α and ζ Persei and α Aurigæ. Cloudy through the night following.

Nov. 16, 1^h 50^m to 2^h 10^m, not a meteor seen, in a clear sky in which stars of the fifth magnitude were distinctly visible.

Besides the foregoing, Mr. Masterman has recorded as follows:

Sept. 22d, 2^h 40^m to 3^h, he saw eight shooting stars, of which five conformed to a circle of 5° around 50 Cassiopeiæ, and two within 15° of the same.

Observations at New Haven, N. lat. 41$\frac{1}{3}$°, W. long. 73°. One observer —Prof. A. C. Twining.—Nov. 11, 3^h 54^m to 5^h 14^m A. M, facing N.E. by N., only two were seen. As a test of visibility, the small stars ϱ and σ, of the fifth magnitude in the eye of Ursa Major, were observed to be distinct, but those of the sixth magnitude not visible with certainty.

Nov. 13, 8^h 20^m to 9^h 20^m P. M., facing the S.W., three meteors shot from the north and on the left without any train. The flights were about 18°, 12° and 8° of arc, and were timed respectively at 0^s·3, 0^s·4 and 0^s·6,—the first planet-like, and moving at the rate of 60° in one second. The other two were pale and *and wavering.*

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[1] This meteor appeared at 4^h 27^m near the tail of Ursæ Minoris, and was one of the finest seen during the morning. The distance of the observers, 7·73 English miles, was not enough to give an exact determination of the path. Its parallax at disappearance was nearly 6°, which makes its end 31 miles high. The observations for the beginning are not quite consistent. If, however, the meteor was one of those coming from the radiant in Leo, which I think probable, the path seen by Mr. Marsh was about 20 miles long, and the first altitude was 48 miles. He gave 1^s or 1^s·5 for the duration of the flight. H. A. N.

Nov. 14th, 4^h 30^m to 5^h, 7 conform., 2 unconf., facing N.W. by N.
5 " 5 30^m 6 " 2 " "

The conformable flights were *massive* and well established; and three had trains of brief duration. The largest shot 20° in 1^s, and its train was visible 2^s. Others from 5° to 15° of length were timed at $0^s{\cdot}2$ to $0^s{\cdot}4$. One course of 15° long in 1^s of time was *waving*. The sky was brilliant.

Nov. 15th, 1^h 40^m to 3^h 25^m A.M. 10 conform., 3 not conf., facing W.S.W., the conformable generally had transient trains—the others none. Of the number, one flight of 12° was timed $0^s{\cdot}6$; one of 23° at $0^s{\cdot}7$, one of 5° at $0^s{\cdot}3$ and one of 6° at $0^s{\cdot}4$. The longest continuance of a train was $1\frac{3}{4}^s$. Unconformable flights left no traces, and made very obtuse angles with a line from themselves to Leo.

Nov. 16th, 1^h to 2^h A.M., 5 conformable, 4 unconformable. Only one was massive enough to be classed with the ten of yesterday. This one was unconformable, and moved not more than 5° in 1^s. It probably is the only one that could have been seen in the brighter moonlight of yesterday and its somewhat less perfect sky.

Results.—Notwithstanding the prevalence of clouds and rain in the middle of November at every locality thus far reported to the committee, and the consequent general failure of observations upon the mornings of the 12th and 13th, we are able to report a clear sky upon the morning of the 14th, at Germantown, Haverford College and New Haven. The moonlight was strong—the moon's altitude being high.

Tabulating results at these different localities we have,

	Observers.	Agg. hours.	S. Stars.	Confor.	Av. per hour to one observer.
Germantown,	1	2	31	25	15 to 16
Haverford Col.,	3	9	93	73	10 " 11
New Haven,	1	1	17	13	17
Total,	5	12	141	111	12 nearly.

It is not however certain that the two early observers at Haverford College gave attention to wholly separate regions. Probably they did; but the sky may have been less clear than at Germantown and New Haven. The two latter records being positive, and both between 3^h and 5^h in the morning, it may be concluded with certainty that, notwithstanding the strong moonlight, one observer could count 16 stars per hour on the morning of the 14th. This fact stands in constrast with the almost entire absence of the like phenomena on the 11th, at New Haven—there being but two in 80 minutes—under circumstances of observation nearly or quite as favorable as on the 14th; not to speak also of the obvious change in the *character* of the display at the latter place on the 15th, and the absence of all shooting stars at Weld, as observed for 20 minutes, in a clear sky, on the morning of the 16th, by Mr. Masterman.

The average number of meteors above reported as seen on the 14th in the strong moonlight, is very closely the same as was seen in the moon's absence last year. This seems to indicate for the present year an increased number of meteors.

ALEX. C. TWINING, *Chairman.*

Remarks upon Periodic Meteors.—First, It is not alone by their numbers and their relation to a radiant that periodic meteors may be recognized in that character. This will be readily admitted, it is believed, by every one who observed attentively the great display of 1833. The conformable meteors of November and August are distinguished very generally from ordinary shooting stars by a *massive* aspect (as it is termed above), resulting perhaps from a more ardent and copious combustion. Trains or luminous envelopes are more or less a characteristic of both, but predominate greatly in the periodic assemblages. The unconformable meteors, and those of ordinary nights, I have noticed commonly either as white and flitting filimentary lines, or as bright and distinct nuclei, moving often with a comparatively small angular velocity and, in specific instances, quite sluggishly. The same sometimes pursue an erratic course,—darting off laterally at the end of their appearance, or wavering from side to side, or even circliug around in a path resembling a sickle. I speak now of the nucleus. In one instance, in the edge of the evening, a star in the west, which traced horizontally about 9° of arc in about 3^s of time was seen to expire twice at nearly equal intervals in its course, and to reappear farther on without varying its line of motion. Such phenomena are worthy of observation and study for the proof they seem to involve of the action of a gaseous medium, and of irregularities of figure combined with revolution.

Second. The flights of periodic meteors appear to me upon an average—estimating that average by a general recollection and consideration only—not to exceed half a second of time. My own practice is to time the flights, not while in progress, but immediately after,—in other words to time the *conception* of duration impressed on the mind in the immediate presence of those phenomena. With practice this may be done to a tenth of second, as a general thing.

Third. When observations are made in moonlight or in a hazy condition of the vault, tests of visibility (such as nebulæ or clusters of faint stars or even single stars of the small magnitudes) may be employed to make the observations in different localities and by different observers comparable together. In fact since such a precaution will cover as well the observer's personal sensibility to luminous impressions as the external physical circumstances above mentioned, and all others of similar effect, it may perhaps be questioned whether test objects in the sky may not be fixed upon with advantage and employed by common consent. Of this an exemplification is given in the record above, but not the best that could be selected from among objects less variable in their altitude.

A. C. T.

7. *Shooting Stars of January* 1st–3d. (In a letter from STILLMAN MASTERMAN, Esq., to the Editors, dated Weld, Franklin Co., Maine, Jan. 5, 1863).—It is known that the 1st–3d of January has been assumed with some probability as the date of an annual periodic visitation of shooting stars. The night of the first instant was very clear at this place, but the brilliancy of the moonlight, excepting for a short interval before daylight in the morning, together with the coldness of the atmosphere, rendering it uncomfortable being out in the open air for any considerable time, made it very unfavorable for observing for meteors. I observed only as follows:—

1863, Jan. 1, from $18^{h}\ 30^{m}$ to $18^{h}\ 40^{m}$—an interval of only 10^{m}—observed eight bright shooting stars, in the increasing twilight: one very brilliant one describing an arc of about 30° in an interval estimated at $1^{s}\cdot2$, and leaving a bright train lasting 4 or 5 seconds. The radiant was remarkably definite for so few flights; its approximate position being in R.A. $15^{h}\ 52^{m}$, Dec. +46° 26′, near the star *υ Herculis.* Two meteors were observed to appear at the same instant, each within a degree of the radiant point, and describing paths nearly at right angles to each other, which served to determine the radiant position as given above. The path of no one of the eight when traced back passed without cutting a circle of 1° radius about the radiant point. On the previous morning, being out for a short time before daybreak, I saw, for the time, an unusual number of shooting stars, on an average one appearing every 3 or 4 minutes.

8. *On the brilliancy of the variable Star, Mira Ceti;* by STILLMAN MASTERMAN, (in a letter to the Editors).—Below are given the results of my comparisons of the brilliancy of the variable star, Mira Ceti, with that of neighboring stars, made during the wane of its late period of visibility. The late increase of this star occurred at the period during which it was unobservable owing to proximity to the sun.

	h		
1862, July 25,	15·0	*o* 3 *γ*, *α* 3 *o*.	
27,	14·5	*o* 2½ *γ*, *α* 3½ *o*.	
July 30,	14·2	*o* 1½ *γ*,	
Aug. 6,	14·5	*γ* ⅔ *o*,	
8,	14·5	*γ* 3 *o*, *o* 1 *α* Piscium.	
12,	14·5	*γ* 3(?) *o*, *o* ½ *α* Piscium—bright moonlight.	
17,	15·0	*α* Pis. 1 *o*, *o* 2 *δ*.	
24,	15·5	*δ* 2 *o*, *o* 2 *ξ*².	
30,	13·3	[*λ* 1 *o*, *o* 3 *ν*	Bright auroras, (changing the apparent relative brightness of the stars ?) rendered these observations worthless.
Aug. 31,	13·0	*λ* 1½ *o*, *o* 2½ *ν*]	
Sep. 2,	14·4	*o* 1 *λ*, *o* 4 *ν*.	
4,	15·6	*o* = *λ*, *o* 3 *ν*.	
15,	13·0	*ν* 3 *o*.	
19,	15·0	*o* 2 75, *o* 4 70.	
21,	15·0	*o* 1 75, *o* 2½ 70.	
22,	14·5	*o* ½ 75, *o* 2 . 70.	
24,	14·6	*o* 1 70, 75 1 *o*.	
1862, Sep. 30,	13·0	70 2 *o*, *o* 1½ 396 B.	

Weld, Franklin Co., Maine, Nov. 28, 1862.

VIII. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Discovery of Antimony in New Brunswick.* (Extract of a letter to Prof. SILLIMAN, Jr., dated University of New Brunswick, Fredericton, Dec. 9th, 1862).—*My dear sir:* In answer to your enquiries with regard to the deposits of antimony recently discovered in this Province, I take pleasure in sending to you the following remarks upon the principal locality, kindly furnished to me by Mr. Edward Allison, the present owner of the district where the vein occurs. I repeat the description in Mr. Allison's own words.

——"The lode of antimony, recently discovered, occurs in the Parish of Prince William, about 20 miles above Fredericton, on the S.W. side of the St. John River. From the river the rise is gradual till it reaches the summit of the water shed, say from 300 to 400 ft., when the ground falls away towards Lake George and the Pokiok River. The soil of this slope is good agricultural ground, and free from rocks, but near the summit a band of primary rocks protrudes through the soil, as is shown particularly where it intersects the highway. This band of rock contains the lode of antimony referred to; its course is nearly N.E. and S.W. It was discovered in loose boulder rocks which had evidently been detached from this projecting ridge, and upon uncovering the rock, the antimony was discovered imbedded in it. This lode we have traced about one-fourth of a mile by trial pits in this line. The rock is uncovered only in a few places, and lies from 2 to 6 ft. beneath the soil. For the above distance we have found the lode to be associated with the rock, and it probably extends farther.

The lode when uncovered appears to be about 2 ft. wide, with a dip of say 45° to the N. In no case has the vein been penetrated more than 6 ft., and in most places merely uncovered to prove its continuation, therefore I can only describe it as it appears under this partial development.

Samples of this ore have been analyzed by Drs. Hayes and Jackson of Boston, and also in England. The results differ considerably, owing no doubt to the difference in the quality of the samples.

The specimen sent to Dr. Hayes was very inferior, carrying with it a considerable portion of the gangue, which was principally quartz with some carbonate of lime. Dr. Hayes' results were 36 pr. ct. of ore. Dr. Jackson's analysis I have not seen, but understand that he returns 73 pr. ct. of metal. This no doubt arises from the specimens being carefully selected and would not show a fair average of the ore. Messrs. Hayes and Jackson return *silver* as a component. The samples sent to England were very inferior, giving a result for antimony rather less than that shown by Dr. Hayes, but including from 3 or 4 to 12 oz. per ton for silver.

I would say that the mine has not been fairly opened, consequently a current opinion of this deposit can scarcely be given, but from appearances already developed I think it promises a large yield of antimony, and possibly more valuable products may be found in connection with it. About a ton of the ore has been shipped to Liverpool to be operated upon, and we hope that the results will prove satisfactory." * * *

To the foregoing account of Mr. Allison's, I have only to add that in the specimens which I have seen, the antimony, which exists in the state of a sulphuret, penetrates the quartz gangue in irregular veins, with little if any crystalline structure. It is quite brilliant when fresh, but quickly tarnishes upon exposure, becoming of a dull grayish-black color.

Antimony has also been found within three miles of the city of Fredericton, close by the river bank, but only in small detached pieces. These however indicate the near presence of another vein, whose exact site has not yet been ascertained. The ground being now clothed with several feet of snow, no further enquiries can be prosecuted during the present season. These specimens are much more highly crystallized than those of Mr. Allison.

I would also say that a specimen of bismuth, said to be from the Province, has been shown me recently, but the facts of its occurrence have not yet been definitely ascertained. I am very truly yours,

L. W. Bailey.

2. *Prof. H. A. Ward's Geological Museum.*—Rochester University is fortunate in having found friends to contribute *twenty thousand dollars* for the purchase and donation to them of Prof. Ward's well known collections in geology and mineralogy. The aggregate of specimens is stated at about 40,000. Hon. Levi Ward, of Rochester, an uncle of Prof. W., deserves honorable mention for the enlightened zeal and appreciation of science which led him to advance the funds necessary to obtain the collections during the six years of wanderings which were spent by Prof. W. in Europe, Asia, Africa and America. The collections are now being placed in suitable apartments in the University buildings.

IX. BOOK NOTICES.

1. *Sur la Physique du Globe, par A. Quetelet, Directeur de l'Observatoire royal de Belgique, Bruxelles*, 1861, 436 pp. 4to.—This volume contains the results of the experimental researches and other contributions of Mr. Quetelet to the sciences of Meteorology and Terrestrial Physics. After an introduction which presents a summary of the meteorological observations made at Bruxelles, there succeed six chapters, of which Chap. I. treats of the temperature of the air and of the earth; Chap. II. of the electricity of the air; Chap. III. of terrestrial magnetism; Chap. IV. of shooting stars; Chap. V. periodical phenomena of plants and animals; Chap. VI. phenomena of the tides.

The following table shows the result of Mr. Quetelet's observations on the temperature of the earth at different depths, from 1834 to 1847. The temperatures are expressed in degrees of Fahrenheit.

Month.	Surface of the ground.	Depth, 7·5 inches.	Depth 2¼ Fr. feet.	Depth 3 Fr. feet.	Depth 12 Fr. feet.	Depth 24 Fr. feet
January,	36°·12	37°·96	39°·94	42°·44	52°·30	54°·02
February,	36·30	37·76	39·72	41·92	50·56	53·53
March,	38·86	39·96	40·37	42·50	49·21	52·97
April,	44·42	44·08	43·30	44·80	48·69	52·34
May,	52·36	50·47	48·65	49·60	49·14	51·84
June,	58·91	56·32	54·32	55·00	50·65	51·62
July,	61·05	58 69	57 20	58·06	52·66	51·80
August,	60·60	58·86	58·28	59·45	54·72	52·29
September,	56·39	55·76	56·59	58·46	55·94	52·94
October,	49·84	50·63	52·74	55·26	56·48	53·49
November,	42·98	44·69	47·43	50·24	55·87	54·00
December,	37·33	40·28	43·27	46·36	54·36	54·16
Year,	47·93	47·95	48·49	50·32	52·56	52 92

The movements of temperature below the surface of the earth, shown by this table, are very remarkable and full of interest. The mean temperature at 24 feet is but 1°·38 higher than the mean temperature of the year at Brussells—(=10·5 C. or 50°·54 F.). The plane of 24 French feet is therefore a little above the depth at which the exact mean of the year would occur. The minimum temperature at this depth occurs in June and the maximum in December, while the surface extremes are at very near the reverse of these months, the maximum in July, the minimum in January, showing how very gradually the equilibrium of temperature is restored in depth. A geometric construction of the result of Mr. Quetelet's observations would bring out these relations of temperature and depth, at the different parts of the year, beautifully. The depth at which the annual variations of temperature disappear, varies considerably, not only with latitude but with changes in the nature of the soil and rocks in the same place. Thus this depth is found at Zurich at 83·7 French feet; Strasburg at 81·6 ft.; Heidelberg in compact clay 83·3 ft.; Schwelzingen in sandy earth 89·8 ft.; Bonn 72·6 ft.; Paris (in the Observatory garden) 69·4 ft.; Leith (Mr. Ferguson's garden) 54·7 ft.; Edinburgh in trap 55·5, in sand 66·2, in sandstone 96·6; Upsala, 1st series 62·6, 2d series 61·9 ft. The mean of these is 73·1 ft. Only below this mean depth do we encounter the central heat of the earth, which corresponds to about 1° for each 48 feet, and the effect of which on the diurnal and annual variations above the plane of no variation must be inappreciable.[1]

Mr. Quetelet's views of the constitution of the atmosphere differ from those which have hitherto been generally entertained. He supposes (with Bunsen and others) that the atmosphere extends to a height of 150 or 200 miles; that the oxygen and nitrogen are kept mingled by the currents of the atmosphere, so that at all accessible altitudes there is no appreciable difference in the proportions of these two gases. He supposes however that it is only the lower portion of the atmosphere which is maintained in this state of agitation; that the upper portion may be perfectly tranquil, and here the proportions of the two gases may change; and they may perhaps be disposed in separate strata in the order of their specific gravities. He supposes that the cirri, the lightest of the clouds, are formed in this lower portion of the atmosphere, near the boundary which separates it from the upper and undisturbed portion; while it is in the upper portion of the atmosphere that shooting stars and auroras appear. The upper portion he calls the *stable* atmosphere, and the lower portion the *unstable* atmosphere. He conceives that by the study of shooting stars we may ultimately arrive at a knowledge of the composition of the stable part of the atmosphere. We observe these meteors at elevations of 140 to 160 miles; they increase in brightness as they approach the earth; they disappear entirely as they approach the lower part of the atmosphere, as if they entered a medium which had not the elements necessary for their continued brilliancy.

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[1] Mr. Quetelet's observations were undertaken originally with a view to confirm experimentally the well known laws of Fourier on this subject first promulgated in his memoir, "*Sur les mouvements de la chaleur des corps solides,*" in Mem. de l'Inst., tome V. It is remarkable that the observations of Quetelet have perfectly confirmed the mathematical conclusion of Fourier in every essential particular.

He questions whether the time of rotation of the still atmosphere is the same as that of the earth; and suggests that this circumstance may perhaps explain the slow rotation of the magnetic poles of the earth.

[Physicists will be slow to accept Mr. Quetelet's novel ideas, on the constitution of the atmosphere, unsupported as they are by experiment and in conflict with long established laws. The law of Dalton, confirmed by the researches of Graham, is not modified so far as we know by diminished tension, and as the coefficients of expansion for oxygen, nitrogen and carbonic acid, are practically identical, it seems to follow as a necessary consequence of this law that the constituents of the atmosphere above the regions made known by aëronauts have the same uniformity of chemical constitution, as is shown by experiment in all heights hitherto visited. We cannot admit that atmospheric currents have any essential connection with the existence or preservation of this uniformity in the lower parts of the air—as is implied by Mr. Quetelet's statements. His argument requires *three* distinct layers or strata of atmosphere—the lower or unstable atmosphere—above this a stratum of pure oxygen of great rarity, and lastly an outer envelope of nitrogen resting above all. We do not propose to discuss this theory at length, but wish merely in passing to controvert views which seem to us unsustained by either fact or sound philosophy. Mr. Quetelet's *Physique du Globe* is a most valuable contribution to meteorological science, and the theoretical views here objected to are wholly aside from its great merit as a record of prolonged, laborious, and well directed original researches.—S.]

2. *Report of a Geological Reconnoissance of Indiana made during the years* 1859–60, *under direction of the late* DAVID DALE OWEN, M.D., State Geologist; by RICHARD OWEN, M.D. Indianapolis, 1862, 8vo, pp. 368.—We accept this preliminary reconnoissance of the great state of Indiana, issued when all the energies of her people are bent on war, as an earnest of better things to come when returning peace shall permit the resumption of new researches in the field.

We find under the notice of Morgan and Brown counties some mention of the new gold region of Indiana, at Hamlin's fork of Salt Creek. Dr. Owen expresses the opinion that the gold is invariably associated with drifted quaternary material derived from a matrix at least from four to six hundred miles distant in a northerly direction.

As these facts, if fully substantiated, open up questions of great geological importance, it is to be hoped that the region may be further investigated and the origin of the gold be placed beyond doubt.

The mean elevation of the land of Indiana is a little over 678 feet above high sea-level, as determined by Messrs. Stansbury and Williams in the measurement of 208 stations. Lake Michigan is 610 feet above sea-level on authority of the late Mr. Ellet; Messrs. Blodget and Lapham make it 591 and 600 feet. A depression of 80 or 100 feet, therefore, in the level of the state, would open Lake Michigan to the Gulf of Mexico, by the valley of the Mississippi, and in one place in Lake Co., a canal not over 20 miles long and in no place 100 feet deep, would effect this junction through the Illinois river.

This volume embraces a Report by Leo Lesquereux, Esq., on the distribution of the coal of Indiana, with sections of the Coal measures, and such valuable information as he was able to gather in a few weeks reconnoissance.

Prof. Lesley also reports on the topography and geology of the Cannelton coal basin in Perry County.

Prof. Lesquereux expresses the opinion (p. 285) that the mineral oil which is now pumped out in large quantities from different places on the borders of the coal-fields, is mostly derived from the coal-seam 1B.[1]

OBITUARY.

1. JAMES ALFRED PEARCE, U. S. Senator from Maryland, died at his residence in Chestertown on the 20th of December, 1862, of a lingering illness. He was remarkable, in the highest legislative body of the United States, for his warm sympathies with and judicious support of the scientific enterprises of our government. Thus the Exploring Expedition under Com. Wilkes, the Coast Survey, and the Smithsonian Institution found him among the warmest of their advocates. The later appropriations for the works of the exploring expeditions were advocated by him with great zeal and earnestness, as chairman of the Library Committee of Congress. He was always ready in the defence of the Coast Survey, the organization and progress of which he had thoroughly mastered. He was not only active in the matters where the interests of the Smithsonian Institution were at stake in Congress, but gave his time freely as a Regent of the Institution and a member of the Executive Committee of the Regents. A well trained mind enabled him to grasp readily these and other subjects especially of a literary and scientific cast, and to express his conclusions in well turned and effective sentences, with a carefully sustained logic, and with a glowing warmth which produced conviction in his hearers. His intercourse with our scientific and literary men who resided in or visited Washington, will be long remembered for its genial and friendly character.

2. THEODORE PARKMAN, who was killed in December last by the bursting of a shell, at the age of 25, in a skirmish at Whitehall, North Carolina, was the author of a valuable paper on the Carbonates of the sesquioxyds, published in our last volume, and of other important contributions to chemical science. He graduated at Columbia College, N. Y., in 1857, studied a year with Dr. Gibbs at the Free Academy, and passed two years in Germany as a chemical student, acquiring there the degree of Doctor in Philosophy.

"Of a singularly sweet, clear, manly mind; a scholar admirably versed in his department; a youth so pure and noble in his thoughts that his face was beautiful; patient, devoted, from his earliest years, jealous of every moment in which he was not learning something, with a modest reserve of manner secluding him from society, and hiding him in the home where the tenderest love directed his course, he obeyed with simple fidelity the call of his country, hearing in it the voice of human liberty, which he had been always taught to regard as the most sacred of all.

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[1] See his Section in this Journal, xxxiii, p. 120.

"Distrusting his untried military ability, this accomplished young man insisted upon enlisting as a private soldier in the 45th Massachusetts Volunteers, winning by his tranquil courage and steady cheerfulness the hearty love of his comrades.

"Such are the costly lives that buy peace and liberty for the country. Such are the faithful men, unambitious of military renown, who in the fiery test of war, show the quality of the truest heroes. Such lives are ripe whenever God gathers them. Such men do not die; they only go before. "I am content," said Burke, when his only son died, "that my son in this world should be my ancestor in Heaven."

X. PROCEEDINGS OF SOCIETIES.

PROC. BOSTON SOC. NAT. HIST. (continued from p. 305, vol. xxxiv) 1862. Vol. ix.—FEBRUARY.—33, Observations on the terms 'Pénéen,' 'Permian,' and 'Dyas;' *Jules Marcou.*—38, Is the Heath indigenous to the United States; *C. J. Sprague.*—42, Notes on the Surface-geology of the Basin of the Great Lakes; *J. S. Newberry.*—MARCH.—47, Lucernaria the Cœnotype of Acalephæ; *Prof. Henry J. Clark, of Harvard University.*—APRIL.—55, On the habits of *Sphyrapicus varius* Baird, in a letter from *I. A. Lapham, of Milwaukee, Wisc.*—56, Account of the dissection of a Hottentot; *J. Wyman, M.D.*—57, The Hæmal and Neural regions of Brachiopoda; *Edward S. Morse.*—60, Remarks on the Classification of North American Snakes; *F. W. Putnam.*—MAY.—72, Report of the Committee appointed to examine the frozen well of Brandon, Vermont.—JUNE.—88, On the mode of development of the marginal tentacles of the free Medusæ of some Hydroids; *A. Agassiz.*—101, Comparison of Megatherium bones from near Savannah with the South American species; *L. Agassiz.*—103, On the genus Colias in North America; *Samuel H. Scudder.*—113, Notice of a live Chimpanzee (*Troglodytes niger*); *B. G. Wilder.*—116, Catalogue of American species of Tenthredo, as arranged by Hartig; *Edward Norton.*—122, Catalogue of the Birds found in the vicinity of Calais, Me., and about the islands at the mouth of the Bay of Fundy; *George A. Boardman.*

PROCEED. OF ACAD. NAT. SCI. PHILAD., 1862 (continued from vol. xxxiii, p. 306).—JULY.—328, Note on the Family of Scombroids; *Theodore Gill.*—329, Note on some genera of Fishes of Western North America; *T. Gill.*—AUGUST.—332, A report upon Mr. S. B. Buckley's "Description of Plants, No. 3, Gramineæ," published in the Proceedings of the Academy of Natural Sciences of Philadelphia, February, 1862; *Asa Gray.*—337, Notes upon some Reptiles of the Old World; *E. D. Cope.*—SEPTEMBER.—346, Catalogues of the Reptiles obtained during the explorations of the Parana, Paraguay, Vermejo and Uraguay Rivers, by Capt. Thos. J. Page, U.S.N.; and of those procured by Lieut. N. Michler, U. S. Top. Eng., commander of the expedition conducting the survey of the Atrato river; *E. D. Cope.*—359, Additions to the Nomenclature of North American Lepidoptera. No. 2; *A. R. Grote.*—361, List of the Pseudoneuroptera of Illinois contained in the Cabinet of the writer, with descriptions of over forty new species, and notes on their structural affinities; *Benj. D. Walsh, M.A.*—402, Remarks on the species composing the genus Pediocaetes, Baird; *D. G. Elliott, F.Z.S.*—404, Supplementary note to a "Synopsis of the North American forms of the Colymbidæ and Podicepidæ;" *Elliott Coues.*—405, Descriptions of Fossils from the Marshall and Huron Groups of Michigan; *Alexander Winchell.*—430, Synopsis of the Carangoids of the Eastern Coast of North America; *Theodore Gill.*—443, Description of a new generic type of Mormyroids and Note on the arrangement of the genus; *T. Gill.*—445, On the Synonymy and Systematic Position of the genus Etellis of Cuvier and Valenciennes; *T. Gill.*—449, Description of a new Genus and Species of Pholadidæ; *Geo. W. Tryon, Jr.*—451, Notes on American Freshwater Shells, with Descrip of two new species; *Geo. W. Tryon, Jr.*—453, Monograph of the Family Tered *Geo. W. Tryon, Jr.*

[Numerous titles of memoirs received and bibliographical notices in type are unavoidably crowded over to a succeeding number.]

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XVIII.—*Contributions to the Chemical and Geological History of Bitumens, and of Pyroschists or Bituminous Shales;*[1] by T. Sterry Hunt, M.A., F.R.S.; of the Geological Survey of Canada.[2]

The economic importance which petroleum has lately assumed gives a new interest to the chemical and geological history of this and of various related substances. It is proposed in the following pages to bring together some facts and theoretical considerations bearing upon the nature, origin and distribution of bitumens, together with a few remarks on the rocks commonly called bituminous shales. Under the general name of bitumen, as is well known, are included both the liquid forms, petroleum and naphtha, and the solid varieties known as asphalt or mineral pitch. The related substances guayaquillite and berengelite, and the substance known as idrialine, seem from the modes of their occurrence to have a similar origin to asphalt, and thus to be distinct from fossil resins. The characters of fusibility and solubility, in liquids like benzole and sulphuret of carbon, serve to distinguish the solid bitumens from coal and some other matters

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[1] Communicated to this Journal by the Author, Dec. 31, 1862.

[2] Some of the facts and deductions given in this paper have already appeared in an article by me, entitled *Notes on the History of Petroleum*, which appeared in the *Canadian Naturalist* for July, 1861, and has since been reprinted in the *Chemical News*, and in the Report of the Smithsonian Institution for 1862. I had, for [illegible] time previously, maintained that the source of the petroleum of the west was [illegible] as was generally thought, to be found in the Devonian pyroschists, but in the underlying fossiliferous limestones, and had shown the relation of the oil springs to anticlinals.—See a Report of my lecture before the Board of Arts, in the *Montreal Gazette* of March 1, 1861.

about to be noticed. It is to be remarked that the chemical composition of these bodies varies considerably; the earlier analyses of petroleum and naphtha give a composition which approaches C_nH_n; but the later investigations of De la Rue and Muller, on the products distilled from the petroleum of Rangoon, and those of Uelsmann on that from Sehnde, show a slight excess of hydrogen, the various hydrocarbons having, for the most part, the formula C_nH_{n+2}. The first formula C_nH_n may however be adopted, as expressing approximatively the composition of the liquid bitumens. The different analyses of asphalt show a diminished quantity of hydrogen, and small quantities of oxygen. Thus the elastic bitumen from Derbyshire gave to Johnston results which may be represented by $C_{24}H_{22}O_{0\cdot 3}$;[3] of two varieties of asphalt analysed by Ebelmann, the one from Bastennes gave $C_{24}H_{16}O_{0\cdot 7}$, while that from near Naples may be represented by $C_{24}H_{14\cdot 6}O_2$, while an asphalt from Mexico gave to Regnault $C_{24}H_{17}O_2$. The analyses of Johnston show that guayaquillite and berengelite do not differ greatly from these, in the proportions of carbon and hydrogen. Passing from the asphalts to idrialine, the results of whose analysis are represented by $C_{24}H_8$, we have a hydrocarbon with a minimum of hydrogen. It is well in this place to compare the above results with the formula $C_{25}H_{15\cdot 9}O_{1\cdot 6}$, which is deduced from Wetherell's analysis of the so-called albertite or Albert coal. A "lignite passing into mineral resin" gave to Regnault, $C_{24}H_{15}O_{3\cdot 3}$, and five analyses of bituminous coal by the same chemist yield from $C_{24}H_8O_{0\cdot 9}$ to $C_{24}H_{10}O_{3\cdot 3}$, while the mean composition deduced by Johnston, from several analyses of coal, was $C_{24}H_9$, with from O_2 to O_4. From these results it will be seen that some asphalts approach bituminous coals in composition. That of Naples, which is completely fusible at 140° C., contains less hydrogen and more oxygen than the albertite, while the idrialine is near in composition to certain bituminous coals, which are thus almost isomeric with some fusible bitumens; so that it is easy to conceive the same organic matters giving rise either to coal or to asphalt, even without losing their structure. Such appears to be the case in the Tertiary strata of Trinidad and Venezuela, the bitumen of which from Mr. Wall's researches

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[3] In these formulas, which have been calculated for twenty-four equivalents of carbon, to compare with cellulose, $C_{24}H_{20}O_{20}$. I have designed to represent simply the results of analysis, without attempting to fix the constitution of the matters in question. In the notation employed, H=1, C=6, and O=8. As it is not generally used in this Journal, I have not thought necessary to adopt, in this paper, the double equivalent of the latter elements, now employed by so many chemists. I may however call attention to the fact, that I was, I believe, the first to propose such a change, when, in 1853, I asserted that the even co-efficients of oxygen, sulphur and carbon in ordinary formulas seem to furnish a conclusive reason for doubling their equivalents, or for dividing those of hydrogen, chlorine, nitrogen and the metals, according as four volumes or two volumes are taken as the equivalent. —(Theory of Chemical Changes, *Am. Jour. of Science*, [2], xv, p. 280.—*L. E. & D. Phil. Mag.*, [4], v, p. 526, and *Chem. Centralblatt*, 1853, p. 849.)

seems to have arisen from "a special mineralization of vegetable remains in certain strata, which has resulted in the production of bitumen, instead of coal or lignite." This conversion, according to him, "is not attributable to heat, nor of the nature of a distillation, but is due to chemical reactions at the ordinary temperature, and under the normal conditions of climate." Mr. Wall also describes portions of wood from these deposits, which have been partially converted into bitumen, and leave, when this is removed by solvents, a residue of woody tissue. (*Proc. Geol. Soc. London*, May, 1860.) These observations have been confirmed by an eminent microscopist and chemist, whose results, lately communicated to me by himself, are not yet published.

The chemical changes, by which the conversion of woody tissue into peat, lignite and bituminous coal is effected, are too well known to be repeated here. The abstraction of variable proportions of water, carbonic acid and marsh gas may give rise either to hydrocarbons like $C_{24}H_{8}$, which represents idrialine and the basis of most bituminous coals, to $C_{24}H_{16}$, which is the approximate formula of the hydrocarbons of many asphalts, or to $C_{24}H_{24}$, which represents petroleum. The removal of farther amounts of marsh gas $C_{2}H_{4}$, may even convert bituminous coal into anthracite, as Bischoff has pointed out, and we conceive that although heat may have, in many cases, given rise to this conversion, by a subterranean coking, the change has often been the result of decompositions going on at the ordinary temperature. Anthracite, or nearly pure carbon, on the one hand, and petroleum, or carbon with a maximum of hydrogen, on the other, represent the two extremes of the process of which bituminous coals and asphalts are intermediate terms.

Petroleum, as is well known, impregnates certain rocks, from which it flows spontaneously, and the solid forms of bitumen are often disseminated throughout limestones or sandstones, from which they may be in part removed by heat, and more completely by solvents such as benzole. To such rocks the term bituminous may be correctly applied, but it is often inappropriately given to substances like coal and certain combustible schists, which contain little or no bitumen, but yield, by destructive distillation, volatile hydrocarbons, more or less resembling those obtained from asphalt or petroleum. Analogous products are however obtained by the distillation of lignite, peat, and even of wood, so that the epithet bituminous applied to hydrogenous coals and combustible schists, raises a false distinction, and perpetuates an error. We therefore proposed some time since to distinguish these so-called bituminous schists, the *brandschiefer* of the Germans, by the name of *pyroschists.* This is the equivalent of the German term, and has a precedent in the name of pyrorthite, given by Berzelius to a substance which appears to be a mixture of orthite with a combustible hydrocarbonaceous matter. Pyroschists are well known to occur in almost every geological group from the Lower Silurian to the Tertiary, and are often, like coal, employed as valuable sources of volatile hydrocarbons, although like it they contain little or no bitumen. They may be regarded as clays or marls, holding, in a state of intimate admixture, a variable proportion of a matter approaching to coal in its chemical characters. Although frequently dark brown or black in color, they are sometimes light brown or even yellowish-gray, as is the case with the Jurassic pyroschists of the department of the Doub, and those of the Tertiary series near Clermont, both in France. Remarkable examples of this are also given by Prof. J. D. Whitney in the pyroschists from the Utica formation of the Lower Silurian series in Iowa, which were yellowish-brown, weathering to a bluish-ash color. They however blackened when exposed to heat, burning with a bright flame, and contained from eleven to twenty per cent of combustible matter. The black, glazed, and apparently very carbonaceous shales from the valley of the Hudson River, were found by Dr. Chandler to contain from one-half to one per cent of fixed carbon, and to yield no volatile combustible matters.[4] (*Geology of Iowa*, i, p. 359.) A pyroschist of the Utica formation, from Collingwood on Lake Huron, examined by my-

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[4] In the Report on the Geological Survey of Iowa, (vol. i, p. 183) Prof. Whitney has given the results of a series of careful analyses of the pyroschists of the Hudson River group, (in which he includes the Utica formation). These analyses embrace specimens from the lead region of Wisconsin, from Lake Huron, the Ottawa, and the district of Quebec. They were made by Messrs. Chandler and Kimball, who removed the carbonates by the aid of a dilute acid, and determined by combustion the organic elements in the residue. In some specimens, like those noticed above, the mineral matter was almost wholly siliceous; others, like that of Collingwood, were highly calcareous, and some contained a considerable proportion of carbonate of magnesia. We select, from the eight analyses given, five of the more characteristic examples.

I. A dark chocolate, whitish-gray-weathering siliceous shale, from the lead region, without traces of organic remains. When heated in a close vessel it gave off 14·12 per cent of volatile combustible matter, leaving 6·84 of carbon, which was removed by calcination.

II. A dark gray shale, with a few graptolitic markings, from the same region.

III. A dark brown, fine grained, earthy, laminated rock, without fossils, from the islands north of Maple Cape, Lake Huron.

IV. A black bituminous shale, filled with crinoids and trilobites, from Gloucester, near Ottawa.

V. A dark brown rock, imperfectly laminated, and showing traces of graptolites, from the Ste. Anne River, below Quebec.

	I.	II.	III.	IV.	V.
Clay and sand,	73·57	80·65	34·60	48·27	37·26
Carbon,	15·03	3·97	6·63	6·99	·61
Hydrogen,	1·65	·63	·77	1·13	·83
Oxygen,	5·39	4·87	2·96	3·39	1·71
Carb. lime,	1·29	4·77	49·31	20·30	52·60
Carb. magnesia,	·76	3·40	2·53	11·48	3·42
Alumina and iron oxyd,	2·79	1·99	2·09	7·99	3·29
	100·48	100·28	98·89	99·55	99.72

self, gave to dilute hydrochloric acid from fifty-three to fifty-eight per cent of carbonate of lime, besides a little magnesia and oxyd of iron. The insoluble residue was snuff-brown in color, and, when heated, gave off a bituminous odor. When ignited in a close vessel, it lost 12·6 per cent of volatile and combustible matters, and left a coal-black residue, which, by calcination in the open air, lost 8·4 per cent additional, making in all 21·0 per cent of volatile and carbonaceous matters, and left an ash-gray argillaceous residue. This shale however contained but a very small amount of bitumen, for, on treating the residue from a dilute acid with boiling benzole, there was dissolved about one per cent of a brown bituminous matter. The residue, when heated, no longer evolved the odor of bitumen, but rather one like burning lignite, and still gave, by ignition in a close vessel, 11·8 per cent of volatile and inflammable matters. When boiled with a solution of caustic soda, this was scarcely discolored. In its insolubility, therefore, the organic matter of this rock resembles true coal, rather than lignite. Attempts have been made, on a large scale, to distill this calcareous schist of Collingwood, and it was found to yield from three to five hundredths of oily and tarry matter, besides combustible gases and water.

Overlying the Hamilton formation in Western Canada are found black pyroschists, which are supposed to be the equivalent of the Genesee slates of New York. A specimen from Bosanquet lost, by ignition in a closed vessel, 12·4 per cent, and left a black residue, which was not calcareous. A portion in fine powder was digested several hours with heated benzole, which took up 0·8 per cent of brown combustible matter. The residue, carefully dried at 200° F., then lost, by ignition in a close vessel, 11·3 per cent, and by subsequent calcination 11·6 additional, equal to 23·7 per cent of combustible and volatile elements. The calcined residue was gray in color. By distillation in an iron retort, there were obtained from this shale 4·2 per cent of oily hydrocarbons, besides a large quantity of inflammable gas, and a portion of ammoniacal water.

The pyroschists of Bosanquet belong to the Devonian series, and contain the remains of fossil land plants, so that it is not improbable that a partially decayed vegetation may have been the source of the organic matter which is intimately mingled with the earthy base of the rock. Such was probably the case in the abundant pyroschists of the coal period. In the pyroschists of the Utica formation, which are of Lower Silurian age, the chief organic remains to be detected are Graptolites, with a few Brachiopods and Crustaceans. No traces of terrestrial vegetation are known to have existed at that time, nor do the schists contain the evidences of any marine plants. The pyroschists of Mesozoic age, in several parts of Europe, contain, on the contrary, numerous fossil fishes, from the soft parts of which, or other animal matters, the combustible substance of these rocks is generally supposed to be derived (Dufrénoy, *Minéralogie*, iv, p. 603). It will be seen, farther on, that similar questions arise with regard to the origin of the bitumens of various formations, for while in some cases, as in the Tertiary rocks of Trinidad, they are clearly traced to a vegetable source, bitumens are also met with in Lower Silurian and Devonian limestones of marine origin, which abound in shells and corals, but afford no traces of vegetable remains. When however it is considered that the lower forms of animals contain considerable portions of a non-azotized tissue analogous in its composition to that of plants, and that even muscular tissue, *plus* the elements of water, contains the elements of cellulose and ammonia, it is easy to understand that vegetable and animal remains may, by their slow decomposition, give rise to similar hydrocarbonaceous bodies.[*] The various fermentations of which sugar is susceptible suggest analogies to the different transformations of organic tissues which have resulted in the formation of anthracite, coal, lignite, asphalt and petroleum, together with carbonic acid and a gaseous hydrocarbon as accessory products.

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[*] This relation was first pointed out by me in 1849. (*This Journal*, [2], vii, p. 109.) I then endeavored to show that the albuminoid bodies might be regarded as a nitryl of cellulose, or some isomeric hydrate of carbon, and represented by the formula $C_{24}H_{17}N_3O_8$. I had already proposed to regard bone-gelatine as an analogous nitryl, $C_{24}H_{20}N_4O_8$; which corresponds to one equivalent of glucose and four of ammonia, less $8H_2O_2$. These nitryls, it was conceived, might, under certain conditions, re-generate ammonia and a hydrate of carbon. I also adduced evidence that in a case of diabetes, sugar was generated at the expense of ingested gelatine. (*This Journal*, [2.] v, p. 75, vi, p 259, *Silliman's Elem. Chem.*, p. 517.) The analyses of cartilage-gelatine, or chondrine, in like manner correspond very nearly to a nitryl formed from $C_{24}H_{22}O_{22}$ (cane-sugar) and three equivalents of ammonia. The formula thus deduced, $C_{24}H_{19}N_3O_{10}$, requires 14·7 of nitrogen.

In 1856, Dusart, starting, as he tells us, from my theoretical views, endeavored to produce the albuminoid bodies by the action of a solution of ammonia on starch, lactose, or glucose at temperature of 150° and 200° C. In this way he obtained, after several days, an azotized body, which resembled gelatine. It was precipitated by alcohol in elastic filaments, formed an imputrescible compound with tannin, and, when heated, gave off the odor of burning horn. Its proportion of nitrogen was 14·0 per cent, which is near that of chondrine. (*Comptes Rendus*, May, 1861, p. 974.) Schoonbroodt has since asserted the possibility of converting sugar into an albuminoid substance, and reiterated my suggestion that the albuminoids are veritable nitryls of the amyloids; under which convenient term he includes those hydrates of carbon which are susceptible of conversion into glucose. (*Ibid.*, May, 1860, p. 856.)

In 1861, Messrs. Fischer and Boedeker announced the production of fermentescible sugar by the action of dilute acids on cartilage, and showed that the ingestion of gelatine increases the amount of sugar in normal human urine. These authors seem by the abstract before me (*Repertoire de Chimie Pure*, July, 1861, from *Ann. der Chem. und Pharm.*, cxvii, p. 111), to ignore alike my own observations, and those of Gerhardt, who twenty years years since showed that, by long boiling with dilute sulphuric acid, there is formed from gelatine a sweet fermentescible sugar, together with a large amount of sulphate of ammonia.—(*Prècis de Chimie Organique*, ii, p. 521.)

Although we have seen that the solid asphalts, which differ from petroleum in containing less hydrogen, and a portion of oxygen, have in most cases been directly formed from organic matters by a process analogous to that which yields coal and petroleum, it appears that the latter body, like other hydrocarbons, may gradually undergo an oxydizing process, which, by removing hydrogen and adding oxygen, at last converts the liquid bitumen into substances having the characters of asphalt, of coal, or even of anthracite. Mr. Vanuxem in his Report on the Geology of New York (page 33) described many years since, by the name of anthracite, a substance which is found in the Calciferous sand-rock. It occurs in druses or cavities with crystals of quartz and calcite, and often assumes the form of drops or buttons, showing, according to Mr. Vanuxem, that it must have been introduced in a liquid, or at least a plastic state, and have subsequently hardened in a layer above the crystals, conforming to them. He described it as very brittle, pulverulent, of a shining black color, yielding by heat 11·5 per cent of volatile matter, which he regarded as water, and leaving after incineration but a small amount of ash.

A material, similar to this in aspect, occurs in many places in eastern Canada, in the Quebec group, which is regarded as the equivalent of the Calciferous sand-rock of the New York series. It fills veins and fissures, alike in the limestones, shales, and sandstones, and even in the trap rocks which traverse these. Sometimes, like that described by Vanuxem, it forms botryoidal masses; at other times it lines fissures, and, as at Drummondville and Sillery, is spread over a surface which had been previously incrusted with small crystals of calcite. The shrinking of the layer has here given rise to cracks, such as are sometimes seen in a coat of varnish. In other cases it fills fissures several inches in diameter, as on the island of Orleans, where a vein of it in shale would furnish several hundred pounds of the material, and where, as elsewhere, it has been mistaken for coal. At St. Flavien it fills a vein of an inch or two in argillite; the walls of the vein are lined with quartz, and the coal-like matter is itself cut by thin seams of quartz, of later formation. In another specimen from this locality, the vein is nearly filled with crystalline quartz, and the carbonaceous substance is found in small almond-shaped masses in the center of the vein. In the Acton copper-mine it fills irregular cracks and fissures, and sometimes forms masses several inches in diameter.

The matter from these different localities has a resinous lustre, which passes into sub-metallic in some cases. Its color is jet black, and it is very brittle and easily reduced to a velvet black powder, which has been used as a pigment. It has a conchoidal fracture, and flies into fragments when exposed to heat. For the rest, it varies considerably in its chemical characters. The mineral from Acton, which is much harder and more metallic looking than that from the other localities, gives off, when heated to redness in a close vessel, a portion of water, but no inflammable gas or vapor, and loses 6·9 per cent of its weight, leaving a carbon which is difficult of combustion, and gives, when incinerated, 2·2 per cent of ash. Like the specimens described by Vanuxem, it approaches to anthracite in its characters. That from the other localities examined gives off when heated a greater or less proportion of combustible vapor, which condenses, in part, into a tarry liquid, having an offensive odor very distinct from the product of the distillation of coals or pyroschists. Carefully selected specimens yield, by incineration, only a few thousandths of ash, apparently due to accidental impurities. In a specimen from Quebec the volatile matters equalled 19·5 per cent; in one from Orleans Island 21·0; in one from St. Flavien 15·8, and in another, six miles from the last, 24·5 per cent. The latter, when exposed to heat, swells up, and leaves a porous coke, the fragments cohering like those of a caking coal. The same is true, to a less extent, of that of Orleans. These matters are not affected by benzole, with the exception of the last mentioned, which appear to contain a small amount of soluble substance. The mode of occurrence of these matters shows that they have once been in a liquid state, and, as the limestones of this group are in many parts distinctly bituminous, there can be little doubt that the liquid carbonaceous matter was bitumen, which has since been slowly oxydized, indurated, and converted into these insoluble, infusible coaly and anthracitic bodies.

This view is confirmed by the examination of a bitumen which appears to be in the very act of changing. In the Devonian limestones of Canada, there are beds of fossil corals, which are impregnated with petroleum. At the outcrop of these, where the strata have been for ages exposed to the weather, the petroleum is replaced by a black matter, which lines the cells, and, having lost its oily character, no longer repels the water like the still oily corals within. Benzole, which readily dissolves the bitumen from these, does not affect the black color of the weathered corals. A fragment of a *Favosites* impregnated with this black matter was crushed and treated with dilute muriatic acid, which removed the carbonate of lime of which the coral was composed, and left five per cent of a brownish-black residue. This, when exposed to heat, burned with flame, without melting, and left a bulky coherent coaly residue, which gave a little ash. When treated with a large amount of boiling benzole (coal-naphtha) the residue gave up only 16·5 per cent of soluble bitumen, and the subsequent analysis of the insoluble residue gave volatile and combustible matter 28·1, carbon 67·7, ash 4·2=100·0. From these experiments it appears that the soluble and liquid bitumen of the corals is, in the weathered portions, converted, in great part, into an insoluble and infusible hydrocarbonaceous matter, resulting probably from a slow oxydation. It is not improbable that a less advanced stage of this process might afford the solid, but fusible and soluble bitumen which impregnates rocks of the same series in other localities. Thus in Kincardine on Lake Huron, immediately overlying massive beds of a somewhat bituminous limestone of the Corniferous formation, are found thinner slaty beds of a dark chocolate color, interstratified with pale yellowish earthy layers. These latter contain no combustible matter, but the dark colored beds burn with a smoky flame, although the hydrocarbonaceous substance is for the greater part insoluble in benzole. In quarrying at this place however, specimens were obtained of a thin shaly bed, which when pulverized and treated with benzole lost 12·8 per cent of soluble bitumen, and left a nearly white calcareous residue, free from carbonaceous matter. Such a rock as this is rightly designated a bituminous limestone, although the beds at the outcrop, which contain an insoluble hydrocarbon, and approach to a pyroschist in character, are probably but altered portions of the same bituminous rock. The interstices of a porous crystalline dolomite from the Grand Manitoulin Island, are filled with brown asphalt, which melts and exudes by a gentle heat, and is completely soluble in benzole. It forms from 7·4 to 8·8 per cent of the rock. An altered form of petroleum is also found near the oil wells of Enniskillen, where the product of the natural oil springs appears in the form of large superficial beds of a soft solid, which is slightly adhesive at ordinary temperatures, and has a specific gravity about that of water. According to Delesse, it solidifies after fusion at 83° centigrade. He found it to consist of bitumen soluble in benzole 62·5, insoluble organic matters, (the debris of recent vegetation), 24·8, clay and sand 12·7=100·0. The bitumen, left by the evaporation of the benzole, is solid and but slightly ductile.[6] This product evidently results from a drying up, and probably a partial oxydation of petroleum, which has been changed into a matter approaching to asphalt in its properties.

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[6] Delesse, *Matériaux de Construction à l'Exposition de* 1855, page 390. On page 381 of the same volume Delesse has described a peculiar brownish-black compact and tough rock, from Promina in Austria, which consists of 59·0 parts of a crystalline limestone, 9·0 parts of clay, and 32·0 parts of a brownish-black combustible matter, which is fusible, and gives off by heat acid vapors, leaving a residue of only 3·5 parts of fixed carbon. It is almost completely insoluble in benzine, and is, by Delesse, designated as a lignite, from which however it is distinguished by its fusibility. It would seem to be a hitherto undescribed matter intermediate between lignite and asphalt.

It now remains to speak of the geological distribution of petroleum in the Palæozoic rocks of this country. Apart from the matters just described from the Quebec group, bitumen occurs at two distinct horizons in the New York series. For reasons which will be apparent farther on, we recall the principal divisions in this series. At its base are the siliceous sandstones of the Potsdam formation, to which succeeds the Calciferous sand-rock. This is, for the most part, a dolomite, occasionally containing small quantities of gypsum and other earthy sulphates. The bitter saline springs, which issue from this and the succeeding limestones, probably have their source in this dolomitic formation. The Chazy limestone, which immediately overlies this, is magnesian in its lower part, and, lithologically, affords a transition from the dolomites beneath, to the great mass of pure limestones which form the Birdseye, Black River and Trenton formations, and are often included under the general name of the Trenton group. In this we meet for the first time with petroleum, although in much less abundance than in the higher rocks. In the township of Pakenham, the large Orthoceratites of the Trenton limestone sometimes hold several ounces of petroleum in their chambers, and it has been met with under similar conditions in Lancaster. It has also been observed to exude from the fossil corals of the Birdseye limestone at Riviére a la Rose (Montmorenci). The limestones of this group, which are generally more or less bituminous to the smell, are peculiarly so in some parts of the county of Montmorenci, and not only give off a strong odor when struck, but, when burned for lime, evolve an abundant bituminous vapor on the first application of heat. A spring which affords small quantities of petroleum issues from the Utica formation, on the Grand Manitoulin Island, and Dr. Beck has described a similar one from the Hudson River group, in Guilderland, near Albany, New York. Both of these probably have their source in the underlying limestones, which are characterized by beds and nodules of chert, and by silicified fossils, not less than by the presence of petroleum.

To these limestones succeed, in ascending order, the pyroschists of the Utica formation, followed by the shales of the Hudson River group. This terminates the Lower Silurian or Cambro-Silurian[7] system, and, taking the Potsdam of New York as the basis, constitutes a lithological series, which is reproduced, with a very remarkable parallelism, in the Middle and Upper Silurian and Lower Devonian rocks about to be mentioned. The siliceous strata at the base of the first series are repeated in the Oneida and Medina conglomerates and sandstones, while the

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[7] The term Cambro-Silurian, first suggested by Prof. Phillips, is adopted by Jukes to designate the Lower Silurian series of rocks. (*Trans. Royal Irish Acad.*, xxiii, p. 564.

great mass of dolomites, with gypsum and salt, which makes up the Clinton, Niagara, Guelph and Onondaga formations, represents on a great scale the similar dolomites of the Calciferous formation. The lithological representative of the Trenton group next appears in the Corniferous formation, composed, like the former, of pure limestones, with chert beds, silicified fossils, and petroleum. To these succeed in western New York the pyroschists, called the Marcellus shales, closely resembling those of the Utica formation, and followed by the Hamilton group, lithologically similar to that of the Hudson River, and overlaid in its turn, by sandstones of the Portage and Chemung group, which may be compared to those of the Potsdam and Oneida formations.[6] It should be mentioned however that the repetition of the pyroschists at the base of these sandstones, constituting the Genesee slates, has no known representative in the Lower Silurian series.

It is in the Lower Devonian limestone, or Corniferous formation, that the greatest amount of petroleum occurs, although Mr. Hall observed that the dolomites of the Niagara formation in Monroe county, New York, frequently contain mineral pitch; which is sometimes so abundant as to flow from the rock, when this is heated in a lime-kiln. Concretionary nodules holding petroleum have also been observed in the Marcellus and Genesee slates, while the higher Devonian sandstones in New York and Pennsylvania are often impregnated with petroleum, and from these, and from still higher strata, issue the oil springs of those regions. It is probable however that the source of the oil in these superior strata is to be found in the Corniferous limestone, from which the petroleum of western Canada is undoubtedly derived, since in Enniskillen this formation is covered only by 200 or 300 feet of Hamilton shales, the Marcellus pyroschists being absent from that region; while at Tilsonburg the limestone appears at the surface, and wells bored into it have yielded considerable quantities of petroleum. Different observers have noticed the occurrence of petroleum in the rocks of this formation, and remarkable instances of it may be seen in several parts of western Canada. In the township of Rainham, on Lake Erie, the shells of *Pentamerus aratus* are sometimes found to have an inner cavity, lined with crystals of calcite, and filled with petroleum. Coralline beds impregnated with petroleum are found in Wainfleet

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[6] The late Prof. Eaton had a perception of this curious lithological parallelism, in successive geological series, when he classed all stratified rocks in three divisions, carboniferous, quartzose and calcareous; which he supposed to be repeated in the same order in each geological series. By carboniferous, he meant simply argillaceous and slaty rocks, in which, according to him, coal and carbonaceous schists might occur. In the carboniferous division of his primitive series, he placed gneiss and the crystalline schists. (*Geol. Text Book*, 1832, and *this Journal*, [2], xxxiii, p. 281).

and in Walpole, in the latter instance immediately beneath a layer of chert, but I have more particularly examined them in the township of Bertie, which is on the Niagara River, opposite to Buffalo. Here, in a quarry, are seen massive beds, slightly inclined, composed of a solid crystalline encrinal limestone, which appears not only destitute of petroleum, but from the water, by which it is impregnated, to be impermeable to it. In some of these beds are large corals of the genus *Heliophyllum*, the pores of which are open, but contain no oil. Two beds however, one of three, and one of eight inches, which are interstratified with these, are in great part made up of species of *Heliophyllum* and *Favosites*, the cells of which are full of petroleum. This is seen, in freshly broken masses, to be absent from the solid limestone, which forms the matrix of the corals, and resembles in texture the associated beds. As the fractured surfaces of the oil-bearing beds become dry, the oil spreads over them, and thus gives rise to the appearance of a continuous band of dark oil-stained rock, limited above and below by the lighter limestone, from which, however, it is separated by no planes of bedding. The layer of three inches was seen to be twice interrupted in an exposure of a few feet, thus presenting lenticular beds of the oil-bearing rock. Besides the occasional specimens of *Heliophyllum* without oil, disseminated in the massive limestone, a thin and continuous bed of *Favosites* is met with, which is white, porous, and free from oil, although beds both above and below are filled with it. It is from the weathered outcrop of one of these that was obtained the specimen already described on page 164, in the cells of which was found the infusible and insoluble product of the oxydation of petroleum. When the oil-bearing beds are exposed in working the rock, the oil flows out and collects upon the water of the quarry. Besides the two beds noticed above, there are said to be others, which were concealed by water at the time of my visit. The facts observed at this locality appear to show that the petroleum, or the substance which has given rise to it, was deposited in the beds in which it is now found, at the formation of the rock. We may suppose in these oil-bearing beds an accumulation of organic matters, whose decomposition, in the midst of a marine calcareous deposit, has resulted in their complete transformation into petroleum, which has found a lodgement in the cavities of the shells and corals immediately near. Its absence from the unfilled cells of corals, in the adjacent and interstratified beds, forbids the idea of the introduction of the oil into these strata either by distillation or by infiltration. The same observations apply to the petroleum of the Trenton limestone, and if it shall hereafter be shown that the source of petroleum (as distinguished from asphalt) in other regions, is to be found in marine fossiliferous limestones, a step will have been made towards a knowledge of the chemical conditions necessary to its formation.

The natural oil springs, which occur in various parts of western Canada, are upon the outcrop of the Corniferous limestone, or of the overlying Hamilton shales, and are along the line of a broad and low anticlinal, which runs nearly east and west through the district. In the township of Dercham, where small quantities of oil rise to the surface in several places, the Corniferous formation is overlaid by about forty feet of clay and sand, after sinking through which the limestone was bored to the depth of thirty-six feet. From this opening a few barrels of petroleum were obtained. Oil springs abound for several miles along the Thames, about sixty miles to the westward of Dercham, and borings into the limestone beneath have furnished considerable quantities of oil, although not sufficient, perhaps, to be of great economic importance. The principal oil wells of Canada occur in Enniskillen, about twenty miles to the northward of the last. Here numerous oil springs are found, and the thickened petroleum, mixed with earthy and vegetable matters, described on page 165, forms layers of considerable extent at the surface of the ground, and around the roots of growing forest trees. Two of these layers have together an area of more than two acres, and a thickness which varies from a few inches to two feet. They are locally known as gum beds. In sinking a well in the vicinity of an oil spring in this region, there was found, beneath a depth of ten feet of clay, and reposing upon four feet of gravel, a layer of bituminous matter like that just described, from two to four inches in thickness. It is easily separable into thin laminæ, which are so soft as to be flexible, and show upon their surfaces the remains of leaves and of insects, which had become imbedded during the slow accumulation and solidification of the bitumen. This little deposit, which is mingled with a considerable proportion of earthy matter, is instructive, as showing the manner in which beds of bituminous rock may sometimes be produced from previously formed sources of petroleum.

The Corniferous limestone in Enniskillen is overlaid by about two hundred feet of marls and soft shales abounding in the characteristic fossils of the Hamilton formation. To this succeed from forty to sixty feet of Quaternary clays and sands of fresh-water origin, through which the scanty natural oil springs rise. On sinking wells, there is generally found, reposing immediately upon the shales, a layer of coarse gravel, holding large quantities of petroleum, which is the oil of the so-called surface wells, and has accumulated beneath the clays. It is darker and thicker than that obtained directly from the rock below, on boring which fissures or seams are met with, from which petroleum issues in abundance, and often with great force, sometimes attaining the surface, and often rising above it, constituting the flowing wells. These oil-bearing veins are met with at depths varying from forty feet to one and two hundred feet in the rock, and in borings near together the oil is often met with at very unequal depths. Adjacent borings sometimes appear to be connected with the same vein, and to affect each other's supply. The deepest well in this region was estimated to yield, when first opened, 2000 gallons in twenty-four hours, and at present, when it is allowed to flow for some time, the supply in many of the neighboring shallower wells is found to fail. The facts observed in this region seem to show that these veins are fissures running obliquely downwards to the great reservoir of petroleum which is probably in the underlying Corniferous limestone. The oil wells in this township are confined to two districts, the more abundant one being about six miles south of the other. From the results of an unsuccessful boring made on an intermediate point, it appears that these two districts are on two slight anticlinals, subordinate to the great axis already mentioned. This anticlinal structure appears to be a necessary condition of the occurrence of abundant oil wells; the petroleum being lighter than water accumulates in porous strata, or in fissures in the higher part of the anticlinal, and in obedience to a hydrostatic law, rises through openings to heights considerably above the water-level of the region. Large quantities of light carburetted hydrogen gas are found in the Palæozoic rocks of the vicinity, and seem to be in many cases accumulated in the subterranean anticlinal reservoirs, since borings sometimes yield both gas and oil, or gas alone. Water, sometimes, but not always, more or less saline, often accompanies the petroleum, and frequently replaces the latter in wells that have been for some time wrought. I do not conceive that the gas has any necessary connection with the oil, since large quantities of it are found in rocks which underlie the Corniferous limestone. If however, as is not improbable, portions of it were generated, and now exist in a condensed state in the oil-bearing strata, its elasticity would help to raise the petroleum to the surface.

The accumulation of the petroleum along lines of uplift, and its escape through the fissures accompanying this disturbance, must evidently date from a remote geological epoch. Porous beds, like the Devonian sandstones, or the Quaternary gravels, have however served as reservoirs in which the oil has accumulated, while argillaceous and nearly impervious strata, like the marls of the Hamilton group, and the fresh-water clays which overlie the gravels in western Canada, have in a great measure prevented its escape. Hence, it would appear that the Devonian sandstones of Pennsylvania and northeastern Ohio are filled with oil, which has risen from the limestone beneath, while, over a great portion of western Canada, this limestone was ages ago denuded, and has lost the greater part of its petroleum.

In the easternmost part of North America, and at the extremity of the peninsula of Gaspé, petroleum is again met with, issuing from sandstones which belong to the base of the Devonian series. The oil springs are here found over a considerable area, along an anticlinal, and may yet prove to be of economic importance. Beds of thickened petroleum, like those of Enniskillen, are here met with. Near to Cape Gaspé there is a remarkable dyke of amygdaloidal trap, ten or twelve yards in breadth, the cavities of which are often lined with chalcedony, or with crystals of calcite and quartz. Many of these cells are filled with petroleum, which in some cases has assumed the hardness of pitch. The odor of the bitumen, which may be perceived to a considerable distance, has caused the name of Tar Point to be given to the locality.

In concluding these notes, I beg to call the attention of geologists to the importance of determining, as far as possible, the nature and the age of the rock formations to which the petroleum of different regions is indigenous, carefully distinguishing those cases in which its occurrence is evidently the result of a secondary process. As an instance of this, it is most desirable to determine whether the oil wells of the Carboniferous rocks in Ohio and Virginia derive their supplies, like those of Pennsylvania, from the Lower Devonian limestone, or whether there exists, in the Carboniferous system, a third oil-bearing horizon, analogous to those of the Trenton and Corniferous limestones.

Montreal, Dec. 20, 1862.

ART. XIX.—*Origin of the Indian Race of Hayti;* by J. A. VAN HEUVEL, of St. Lawrence Co., New York.

AT the period of the discovery of the West India Islands by Columbus, they were inhabited by two very dissimilar races. The larger and more northern of them, Hayti, Cuba, and Porto Rico, and likewise the Bahamas, were possessed by a people of mild and unwarlike character, who were of the same origin. The smaller islands south of them, extending in a chain to South America, were at the same time inhabited by the fierce and warlike Caribees, who made constant aggressions upon their neighbors. That the inhabitants of the former islands were all of the same race is expressly stated by Columbus. In a letter which, on his return from his first voyage, he addressed to the Treasurer of Spain, he says, "there is no difference in their countenance and manners, and they all speak the same language."[1] Of the gentle

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[1] **Navarette, ii, p. 385 (Paris edition).**

and peaceable character of the Haytians, he in the same letter thus speaks: "They are without arms, which they know not how to use, being of a timid disposition. They have canes dried in the sun, the ends of which are pointed with a piece of hard wood sharpened; but even this weapon they dare not use, for it often happened, that on our sending two or three men to visit some of their towns, all the inhabitants fled in disorder."[2]

They were also of an extremely amiable and benevolent nature. In the intercourse which Columbus had with them, he met with a most friendly and generous reception, accompanied with the greatest respect and even veneration. As he approached Hayti the first time with his vessels, and, in sailing along it, one of them was wrecked on the coast, the Cacique in whose dominions the accident occurred, on hearing of it, directly sent some canoes which brought away all that was in the vessel. He came to the shore, and took care that none of the goods should be lost, himself remaining to guard them, and had them taken to two houses he had appointed, sending a message to Columbus not to be concerned, and he would give all he had to repair his loss.[3] "The Indians," says Herrera, "so affectionately gave them help, that it could not have been better done in Spain, for the people were gentle and loving."[4] In a letter which Columbus addressed to his royal patrons, Ferdinand and Isabella, he observes: "The people are so affectionate and tractable that I swear to you there is not a better people nor a better country in the world. They love their neighbor as themselves, and their conversation is the sweetest in the world, being pleasant and always accompanied with a smile."[5]

Hayti, Cuba, and Porto Rico, at the period of their discovery, were most densely populated. The entire number of their inhabitants, according to Las Casas, was six millions, and those of Hayti were half that number. Oviedo states their whole population at three millions, and that of Hayti at somewhat more than one million; which estimate Bryan Edwards, in his History of the West Indies, thinks to be probably the most correct.[6]

But, being inhabited by a race so gentle and unwarlike, they were without difficulty immediately subjugated by the Spaniards. After their conquest their history is as short as it is melancholy. The rigorous treatment which the Haytians experienced from their invaders in being forced to labor in the mines of their island, which soon broke their constitutions, unused to toil, almost entirely swept off their numerous population, in less than half a century. In 1509, but seventeen years after the first landing of the Spaniards, they were reduced to sixty thousand.

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[2] Navarette, ii, p. 777, &c.

[3] Robertson's America, Book I.

[4] Dees, Book I, Ch. 18.

[5] Robertson's America, Book I, Note 15.

[6] History of the West Indies, Book I, Ch. 3.

After five years more there remained but one third of this number, and in 1533 they amounted to only four thousand.[7] Subsequently a small part of this remnant escaped destruction. "A young Cacique, placing himself at the head of the few that remained, made a resolute resistance to their conquerors. Driven at length to extremities, he retired to the fastnesses of inaccessible mountains, from which he continually sallied forth and harrassed the Spanish inhabitants, who in the end, struck with the heroism and the moderation he showed in the use he made of the advantages of his position, suffered him and his adherents to leave their retreats and reside unmolested in any part of the island. Their descendants continued to inhabit it for a length of time; but their numbers gradually diminished, and in 1716 amounted to only one hundred souls."[8]

The population of Cuba shared the same fate, but the destruction was not so entire. From information given me by intelligent gentlemen from Havana, it appears that there are still at the present time some descendants of the ancient race near St. Jago, having the following villages: Holquin, Cobre, Vallamo, Puerto Principe, and Guanaja, whose aggregate population is two thousand.

From what region this ill-fated race, of so amiable, gentle, and peaceful a character, was derived, is an interesting inquiry. From their greater proximity to North America than to the southern continent, it might at first view be thought that they came from Florida. But their character, so different from that of the tribes in general of that country and the adjacent regions, who are brave and warlike, is opposed to this supposition, and it might be considered more probable that they passed to the islands from the not very distant coast of Yucatan.

But Bryan Edwards advances another theory of their origin. "The antipathy," he remarks, "which the Caribees manifested to the unoffending natives of the larger islands appears extraordinary, but it is said to have descended to them from their ancestors of Guiana They considered them (the Haytians) descended from the Arrowacks of South America, with whom the Caribees of that country are continually at war."[9]

Having once passed some time in British Guiana, and found that the Arrowacks are one of the tribes of that country, and feeling an interest in this question, I endeavored to obtain some information as to their manners and language; and the facts which I collected, on comparing them with the accounts preserved of the Haytians, fully support the tradition preserved by the Caribees as to their origin, as related by Mr. Edwards.

I ascertained that the Arrowacks are spread along the whole

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[7] Ogilby's History of America. [8] Jeffrey's Natural and Civil History of America.
[9] History of the West Indies, Book I, Ch. 3.

coast of British Guiana and Surinam adjoining it. They are at the mouths of the rivers that fall into the Atlantic, but not higher up upon them. Their appearance is very similar to that of the Indian natives of South America in general. They paint their body all over with a red coloring matter made from the bruised seeds of arnotto mixed with oil. They wear strings of beads around the arms, and chains of the same or of shells about the neck. A silver ornament is sometimes worn at the ears, and a longitudinal piece of wood is inserted in an incision made below the under lip. They rely for subsistence on hunting and fishing, and cultivating around their cabins cassava or manioc, maize, potatoes, plantains, &c.—chiefly cassava, which is prepared for food in a remarkable manner. The root, which is the part eaten, is first grated, and the juice, which is poisonous, is expressed. The grated mass is spread on a flat form, and baked into cakes twelve or fourteen inches wide. The juice is divested of its poisonous quality by ebullition, the foam as it rises being continually removed, and is then used as a condiment with their daily dish, which is prepared from a variety of articles, venison, fowl, fish, &c., put together in a pot, and a portion of this juice added, with a large quantity of pepper, and then boiled. It makes a delicious dish, highly valued by the Arrowacks; and, as the pepper is an important ingredient in it, it is called in their language, *hachi-duada*, signifying pepper-pot—from *hachi*, pepper, and *duada*, pot. The cassava cakes are eaten with it.

Their cabins are of a square form, of greater length than breadth, constructed of four stakes planted in the ground, open on all sides, with an angular roof, which is covered with leaves of *troobes,* a species of palm. In them are suspended their hammocks for sleeping, in which also they sit or recline during the day. They are a net-work made of the fibres of the *pita*, another species of palm. In the middle of the cabin a fire is continually kept, to repel by its smoke the approach of mosquitoes, which abound in their torrid clime.

In support of the hypothesis of Bryan Edwards, the following proofs may be adduced:

1. The Arrowacks bear a great resemblance in their character to the Haytians. They are, like them, mild, gentle, and benevolent. As such they have uniformly exhibited themselves to the Europeans with whom they have had intercourse. When the Spaniards, in their first expeditions to the Orinoco, had excited against them the general hostility of the Indians, the Arrowacks alone were friendly to them. Lawrence Keymes, who commanded the second expedition made by Sir Walter Raleigh to this river, in 1596, remarks: "The Caribes, the Ciawanis, Titivivas, and all other nations, far and near, were ready to join against them, except the Arawacas, who were the only nation in

whom they could trust." And again: "The Indians of Moruga (a river near the Orinoco) sought by all the means in their power to unite all nations into an alliance to invade the Arwacees for being guides to the Spaniards, in showing them their towns and betraying them."[10] To the friendship thus early shown to the Spaniards they ever remained constant. Gumilla, in his *History of the Orinoco*, written a century and a half after, observes: "They are much more attached and more faithful to the Spaniards than any of the nations who have been discovered on this river or in the neighboring regions, for as soon as they are informed of any attack intended against them, they secretly inform them of it."[11]

Bancroft, in his *History of Guiana*, says that in temper and disposition they are cheerful, humane, and friendly; but somewhat timid and cowardly. Stedman, in his account of Surinam, remarks of those in that province: "They are not only at peace with other Indian nations, but are peculiarly attached to Europeans, who in return possess for them the strongest esteem. A more peaceable people does not exist in the universe."

2. The existence of an implacable animosity between the Caribees of Guiana and the Arrowacks, alleged by the insular Caribees as the cause of their enmity to the Haytians, whom they considered of the same nation with the Arrowacks, was confirmed by inquiries I made on the subject. At the commencement of the Dutch colonies, Essequibo, Demerara, and Berbice, which now belong to England, forming British Guiana, these nations were engaged in constant wars together. In the old maps of this country are marked three places on the Essequibo river at which they had engagements. The last was a very sanguinary one, so that the river was colored with blood, and the Arrowacks were defeated, and fled to some distance on the river below. Their mutual hatred and antipathy continues to this day as intense as ever. It is the height of offense to an Arrowack to be called a Caribee, and to a Caribee to be thought an Arrowack.

A missionary in Surinam at the close of the last century, in his account of it, observes: "The Arrowacks had long wars with the Caribees, until the government determined to put an end to them, by declaring to both that if either commenced hostilities against the other it would be considered an enemy of the colony."[12]

3. A comparison of the language of the Haytians and Arrowacks supports the identity of the two nations. From the early destruction of the Haytians, and the little care taken to preserve a knowledge of their language, the means of making this comparison are scanty. Yet a few words of it have been preserved, and are placed in the following table, which will be seen to agree

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[10] Cayley's Life of Raleigh, ii, pp. 342, 331.

[11] History of the Orinoco, chap. 10.

[12] Quandt, Nachricht von Surinam.

with the Arrowack, the words of which are taken from a vocabulary I formed of this language:

	Arrowack.	Haytian.
Pepper,	Hachi,[13]	Axi.
Maize,	Mareesee,	Ma-i-zi.[14]
Canoe,	Canoa,	Canoa.
House,	Bahu,	Boa, Bohio.
Hammock,	Hammaka,	Hamaca.
Stone,	Seeba,	Ciba.

The following are the authorities for the Haytian words:

Axi.—"They gave the Spaniards a sort of spice which they called Axi." Herrera, Dec. I, Book I, Ch. 7.

Maizi.—"They gave the Spaniards a sort of grain which they call Maizium." Martyr, Decade I, Book I. The author wrote in Latin, and his translator has rendered the word in English Maizi.

Canoa.—"Their boats they call Canoas." Martyr, Dec. I, Book I.

Hamaca.—"The beds of the Lucayans are called Hamacas." Herrera, Dec. I, Book I, Ch. 12.

Ciba.—"On the second visit of Columbus to the Cacique of Hayti, he presented him, among other valuable jewels, with eight hundred beads of stone, which they call Cibas." Herrera, Dec. I, Book II, Ch. 9.

Boa, Bohio.—"The word of the Haytians for house is Boa." Martyr, Dec. I, Book I. As Columbus sailed from Cuba to Hayti, the Indians he had on board, whom he had brought from the Bahamas, called the latter island Bohio. It seemed that it signified a land full of cottages. Herrera, Dec. I, Book I, Ch. 15.

Martyr was the cotemporary of Columbus, and his work, *Novus Orbis*, was founded on information received from Columbus himself, and from his companions in his voyages.

It may be said that the above Haytian words, which the Spaniards adopted into their language, were spread by them along the coast of Guiana among the Arrowacks; but for this supposition there is no foundation, since it is not probable that the Arrowacks would adopt new words for things well known to them, and for which they must have had names; and, farther, in the language of the Caribees on the Orinoco, who from their frequent intercourse with the Spaniards would equally have adopted them, these words are not found, as is shown in the following table.

	Haytian.	Caribees.
Canoe,	Canoa,	Couriara.
Hammock,	Hamaca,	Acalto.
Stone,	Ciba,	Tebou.
Pepper,	Axi,	Pomoui.
Maize,	Maizi.	Awasse.

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[13] The initial letter H in the Arrowack is only an aspirate.

[14] This word is of three syllables, and taken from a Spanish writer; the vowel *i* has the sound of the English *ee*.

The Arrowack language resembles in its structure the Haytian. Herrera says the Haytian was easy to be pronounced and learned, and Charlevoix says that we may judge of its softness by some words which have passed into our language.[15] Such is the character of the Arrowack, which abounds in vowels and liquids, and is remarkably soft and melifluous. Bancroft, who resided sometime in British Guiana, says, in his history of this province, that it is distinct and harmonious, and not unlike the Italian in softness and multiplicity of vowels.

The following Arrowack words, taken from my vocabulary, show this:

	Arrowack.		Arrowack.
Sun,	Hadalee.	Earth,	Woonabo.
Year,	Weewa.	Water,	Woonee.
Tree,	Ada.	Island,	Careeree.
Hill,	Hoorooroo.	Lightning,	Belbellairo.

4. It is not only very probable, but there are some facts furnishing decided evidence, that the Arrowacks of Guiana passed to the northern islands in the West Indies, Hayti, Cuba, &c. Sir Walter Raleigh, in the narrative of his expedition to the Orinoco in 1595, states that they had spread along the coast as far as this river. "The nations," he says, "that dwell on the south of the Orinoco are Arrowacks;" and, in another place, observes that "he came to a town of the Arrowacks north of the Orinoco."[16] Humboldt mentions them among the nations now in the Spanish province of New Andalusia, which is between this river and the northern coast. Being spread so far to the north, they might easily pass to the island of Trinidad, which lies near the Orinoco. But that they made this transit is not merely conjectural. Sir Robert Duddeley, in the account of his voyage to Trinidad in 1595, found in *Hackluyt's Collection*, vol. iv, gives a list of words of the language spoken in this island, nearly all of which are similar to the Arrowack. But, for brevity's sake, we give only a few in the following table:

	Trinidad.	Arrowack.
Arrow,	Simara,	Simara.
Maize,	Maureesee,	Mareesee.
Bread,	Callit,	Calee.
Stone,	Sebath,	Seeba.
Fire,	Hecket,	Hekeehee.

Du Tertre, in his *History of the West India Islands*, says that the Caribee inhabitants of the smaller islands, in 1640, united in a general war against the Arrowacks in Trinidad;[17] which not only confirms the above account, but also shows that the Arrowacks were then very numerous on this island.

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[15] History of St. Domingo.

[16] Cayley's Life of Raleigh, Appendix No. IX.

[17] Histoire des Antilles.

From Trinidad, the Arrowacks could readily pass through the smaller islands to the larger ones, Hayti, Cuba, and Porto Rico. After reaching St. Vincent's, all the rest of the Caribee Islands are but a short distance from each other.

But that the Arrowacks passed through the smaller islands, there is conclusive evidence in the fact that they once occupied these islands, when the Caribees conquered and became masters of them.

The missionaries Rochefort and Labat, who each wrote a history of the islands, relate that the females in them spoke a different language from the men, the origin of which they thus give. "The women of the Caribee Islands," says Rochefort,[18] "have words and phrases that are never used by the men except in the way of raillery, which had this origin. The Caribees of Dominica say that these islands were once inhabited by Arrowacks, and that they conquered them, and, killing all the men, reserved the females for wives, who retained their language, which resembles that of the Arrowacks of Terra Firma; and it is to be noted that, among the Caribees of the continent, the males and females speak the same language." Labat[19] observes, "the Caribees of the islands have three languages; one common to all, another peculiar to the warriors and elder men, which is used in their public assemblies, and a third spoken only by the females, and wholly different from that of the men, who consider themselves dishonored by speaking it;" from which he concludes that without doubt the Caribees are strangers in these islands, having conquered them, killing all the males and reserving the females. The language of the females," he says, "was easier pronounced and learned than that of the males."

The inhabitants of Hayti were accustomed to navigation, and probably made distant voyages, as they had boats of a large size, some of them having eighty rowers, or forty on each side.

Further, they and the people of the other islands had a knowledge of South America.[20] As Columbus on his first voyage was pursuing his course from the Bahamas in pursuit of further discoveries, some Indians he had on board, whom he had brought with him, pointing to certain land at a distance called it Bohio, others Babeque, by which he thought they meant Hayti; but it appeared afterwards it was not this island, as they called it by another name, Caribana.[21] The northern coast of South America throughout, according to Martyr, was called Caribana, from Caribees being spread along the whole of it. In the second voyage of Columbus, as he sailed through the islands of the Caribees, some females captured by them from the other islands, who fled to him for protection, said that towards the south were many

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[18] Histoire des Antilles, Book II, Ch. 40.

[19] Voyages aux Isles de l'Amérique.

[20] Martyr, Dec. I, Book I.

[21] Herrera, Dec. I, Book I, Ch. 15.

islands, some inhabited, others not, which they called by their names; and that there was a continent which was very great, from which canoes had come to traffic.[22] While at Hayti, the Indians said to him that there was another large island, called Yamaje (Jamaica), and that Hayti and Yamaje were but ten days' sail from Terra Firma, from which canoes had come with abundance of loads to barter.[23]

On the other hand, there is evidence that the Arrowacks were accustomed to make voyages to the West India Islands. Sir Walter Raleigh says that, in going up the Orinoco, "we took two canoes laden with bread bound for Maigueritta in the West Indies, which the Arrowacks in them proposed to carry thither to exchange;" and he speaks of a town on this river "where there was a continual market of women for three or four hatchets, and they are bought by the Arawacas, and by them sold in the West Indies."[24] In a journal kept by a resident of British Guiana, of which I had a perusal, I found an interesting passage relating to this subject. He was by name James Glen, and in 1810 took up a residence for some time in the Indian country at the head of the river Essequibo. He appears to have had the advantages of education and a scientific taste, from several notices in his journal of the Indian nations and the natural history of the interior of Guiana. Some of his remarks I transcribed, among them the following: "Previous to the year 1500, the Arrowacks were accustomed to go from the rivers of Guiana to the large islands"—which could be no other than Hayti and Cuba. The year mentioned was eight years after the discovery of Hayti by Columbus, and the settlement of the Spaniards in it, which probably caused the intercourse of the Arrowacks to cease.

While, however, the general population of Hayti, Cuba, and the Bahamas is shown with the greatest probability to have come from South America, it is not maintained that some of the inhabitants of Hayti and Cuba may not have been derived from other parts. In Hayti was a tribe called Ziguayos, different in their character from the inhabitants of it in general, and who have been supposed to be a Maya colony from Yucatan. It is very probable indeed, from the situation of Hayti and Cuba, that there was an emigration from Yucatan to these islands. In regard to Cuba, two positive facts are stated by Martyr, which give reason to believe that there had been an emigration to it from that part of the continent. At the place on the coast of Yucatan where Grijalva first landed, he made use of Indians of Cuba as interpreters, and at Coluacan, to which he afterwards

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[22] Herrera, Dec. I. Book I, Ch. 12.

[23] Navarette, ii, p. 260.

[24] Cayley's Life of Raleigh, i, pp. 223, 249.

came, the language of the people, he says, resembled that of Cuba.[25]

But it may be said that, allowing that the reasons which have been offered to show the Arrowacks and Haytians to be the same nation are sufficient to establish their identity, it does not necessarily follow that the latter are derived from the former. May not the Haytians have sent colonies to the coast of Guiana from whom the Arrowacks are derived, instead of themselves descending from the Arrowacks? To this we reply, in the first place, that the Arrowacks appear to be the original proprietors of that coast. Its rivers, Essequibo, Berbice, Demerara, have Arrowack names. Essequibo signifies a deer; Berbice is from Guarapuche, the Arrowack name of this river. There is a river of the same name north of the Orinoco. Demerara is from the Arrowack Imirari. The Portuguese who first settled on this coast called it Rio D'Imirari, as they say Rio de Janeiro, whence the name Demerara. Simara, the name of a river north of the Orinoco, is also an Arrowack word, signifying arrow. Orinoco is probably also Arrowack. Water in Arrowack is *Woonie.* In Trinidad, according to Sir Robert Duddely, it is *Orononie*, which name may have been given to this river as "the water" emphatically, from the vast flood which it pours out.

Next, we observe that the principal plants cultivated by the Haytians belong to South America, of which may be mentioned, in particular, cassava or manioc, and their manner of preparing it for food is the same as that of the Arrowacks, which has been described. "The Haytians," says Martyr, "never eat *jucca*, by which name this plant is sometimes called by them, except it is first sliced and pressed, and then baked or sodden; for it is full of liquor which is a strong poison, that causes instant death if drunk, but the bread made of the mass is of good taste and wholesome."[26] "When Columbus," says Herrera, "landed at Hayti, he was invited by the Cacique to go and eat *axi* and *cassabi*, which is their chief diet."[27] Hachi, it has been shown, is the Arrowack word for pepper, and the repast offered to Columbus was doubtless the hachi-duada or pepper-pot of the Arrowacks, with which cassava was always eaten. There was another custom of the Haytians which was evidently derived from South America. Their mode of sleeping was in hammocks, which is the general custom in that continent, but not at all found among the northern Indians, and the word *hamaka*, it has been seen, belongs to the Arrowack language.

Lastly, the Haytians believed that they were derived from the south. "They had a tradition," says Martyr, "that they came from Martinique; that they were compelled to leave it in consequence of dissensions and strifes in it, and, on their arrival at

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[25] Martyr, Decade IV, Book I, Ch. 3 and 4.

[26] Herrera, Decade I, Book I.

[27] Herrera, Dec. I, Book I, Ch. 18.

Hayti, struck with its great size, called it *Quisqueia*, which in their language signifies exceedingly great; but afterwards gave it the name of Hayti, from the craggy mountains that were in it." Martinique was one of the chain of smaller islands inhabited by the Carribees, but which, as has been observed, they conquered from the Arrowacks. It was perhaps the invasion of them by the Carribees that produced the strifes and seditions in Martinique mentioned in the tradition as having caused the Arrowacks inhabiting it to remove to Hayti.

ART. XX.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio:* latitude 39° 25′ N., and longitude 4° 28′ W. of Washington, for the year 1862; by S. P. HILDRETH, M.D.—[Thirty-fifth Annual Report.][1]

MONTHS.	THERMOMETER.			Fair days.	Cloudy days.	Rain & melted snow in inch. and thous'ths.	Prevailing winds.	BAROMETER.		
	Mean.	Maximum.	Minimum.					Maximum.	Minimum.	Range.
January, . .	35°·53	67	13°	6	25	6·673	N., N.W. & S.	29·85	28·95	0·90
February, . .	33·60	56	11	12	16	3·056	N., N.W. & S.E.	29·75	28·85	0·90
March, . .	41·27	75	16	11	20	5·392	N.W., S. & S.E.	29·55	28·65	0·90
April, . .	51·52	81	30	16	14	7·673	E.S.E. & N.	29·65	28·85	0·80
May, . . .	57·15	84	36	22	9	3·783	N., S. & S.E.	29·61	29·10	0·51
June, . . .	65·78	88	44	15	15	2·541	S., S.W. & N.	29·65	29·10	0·55
July, . . .	73·47	93	54	20	11	3·524	S., S.W. & N.	29·75	29·18	0·57
August, . .	73·17	93	46	20	11	3·641	S., S.E. & N.	29·68	29·25	0·43
September, .	68·40	94	38	25	5	0·285	S., S.W. & E.	29·78	29·10	0·68
October, . .	54·57	90	26	18	13	2·564	S., S.W. & N.	29·73	29·00	0·73
November, . .	41·07	69	24	17	13	2·053	S., S.E. & N.W.	29·90	29·00	0·90
December, .	35·87	68	10	16	15	3·372	S., S.W. & N.W.	30·03	28·90	1·13
Mean,	52·62					42·557				

The mean temperature of the year 1862 is 52°·62. The amount of rain and melted snow is $42\frac{557}{1000}$ inches.

Remarks on the winter of 1862.—The mean of the winter months is 33°·33. February was the coldest of the series, being 33°·60. December was 37°·00, which is rather above the mean, some years falling as low as 21°·00, and others rising to 40°·00. January is usually a mild month compared with either December or February. The lowest grade of the mercury in January was 13°, on the fifth day. In February the lowest was 11°, on the 16th day. There was a large amount of rain in January, filling

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[1] Dr. Hildreth's first Abstract of Meteorological Observations (for 1828) was published in the 16th volume of the 1st series of this Journal (1829). The series has been uninterrupted to the present time, and this is therefore the *35th contribution.* By an inadvertence this enumeration was attached to the last abstract published in March, 1862, which error we take this mode of correcting. Our oldest readers will rejoice that the life of our venerable correspondent has been continued to complete another of his annual contributions.—EDS.

all the rivers to the tops of their banks. This excess of rain continued all through the middle and latter portion of the winter. The amount in January was 6·67 inches, and during the winter over 11 inches. The quantity of snow was small, compared with most winters, being only two inches at the greatest fall. Very little ice was formed in the rivers, and navigation remained open during all the winter months. No ice was gathered here but such as was brought from rivers north of us. The moisture of the air and mild temperature was very favorable to the ripening of the young wood of grape vines and fruit trees, especially of the peach, and an abundant crop of blossoms appeared in due season; but a frost, in the latter part of April, destroyed a great deal of the recently set fruit. The ill effects of a winter without hard freezing are seen more in the soil than elsewhere, the plow and the spade turning it up compact and heavy, instead of porous and loose as it is after ordinary winters, showing its effects on the soil during all the season. A very dry time in May or June partly restores that loose texture so necessary to the healthy growth of plants.

Remarks on the spring of 1862.—The mean temperature of the spring, was 53°·31,—which is a fair average for this season of the year. The mean of March was 41°·27; this month varies much; in some years rising to 52°, and in others sinking to 32°. The mean of April was 51°·52, not far from the average temperature. It varies greatly however, rising to 59° and falling to 42°, a difference of seventeen degrees. It is usually considered as indicating the mean for the year. The temperature for May is 57°·15, which is below the average, some years rising to 67° and then falling to 55°, making a diversity both pleasing and useful. The spring was very wet, there falling nearly fifteen inches of rain, about half of which was in April. In this month the larger portion of plowing is done by the farmers, for the summer crops. The earth in most fields was like mortar, and plowing in this condition was hurtful to cultivation. This excess of moisture caused the decay of a large portion of seed corn, requiring a second and sometimes a third planting. The fields in June afforded an unsightly and unpromising appearance. Pastures and meadow lands were benefited by the rains, but the grass and hay were much less nutritious than in common years, although the yield was abundant. The flowering of fruit trees was rather tardy, six or eight days behind the usual time. The healthy setting of the fruit is sometimes injured by heavy rains washing away the pollen of the flowers. This, I believe is more common to forest trees, especially the oak and black walnut, though these are rarely hurt by frosts. The spring fruits were abundant and ripened at the usual time, especially strawberries, new varieties of which are annually added to our abundant varieties. The spring of 1863 is the appointed season here for the appearance of that wonderful insect, the seventeen-year locust, or Cicada.[1]

Remarks on the summer of 1862.—The mean temperature of this season is 70°·80, which is one degree and a half below the average of a series of years. The month of June was cooler than usual, being only 65°·75, whereas it often rises to 70°, and sometimes to 74°, but this is a rare occurrence. July was 73°·47, also rather low. August was near the same, or 73°·17, being an abundant quantity of heat for perfecting the growth and ripening all the fruits and grain adapted to this climate. In July, the temperature sometimes rises to 76° for the whole month, but not often. The summer fruits ripened at the usual time, red cherries early in June, Catawissa raspberries by the twentieth, and early apples the first week of July. Many fields of wheat were ready for harvesting the 22d of June, but the main harvest began the 6th of July. The quality of the grain was excellent, but not so abundant as in some years. A new and more hardy variety, with a thicker covering to the seed, not so easily punctured by insects, has been introduced by the intelligent farmers of Ohio, and this important crop is becoming more certain than in past years. It is also less liable to rust in the hot and wet weather of the last of June, a disaster in some years of immense damage, destroying whole fields when nearly or quite ready for the sickle. The amount of rain in the summer months was but little over half of that in the spring. The effect was disastrous to crops of maize and potatoes, especially on the hills and uplands, these not yielding half the amount of ordinary years. Rich alluvions suffered but little. The prices of these important articles of food rose to double their common value. The season was favorable to sweet potatoes and to melons, which were abundant and of excellent quality. Among the insects injurious to vegetation, appeared a new one on our pear and quince trees, the larva of *Selandria Cerasi*, described by the late Professor Harris. It proved very hurtful, especially to young pear trees. It is the worst of all these pests, as it continues its ravages all summer, by fresh deposits of eggs by the parent Saco-fly. Other insects were less abundant than common.

Remarks on the autumn of 1862.—The mean temperature of the autumnal months is 54°·71, which is a full average for the climate. The month of October was very mild, some of the early days being of the warmth of summer, rising to 90° or more. The season was very dry, there being less than five inches of rain for the three months, whereas in some years September has as much rain as all of them in 1862. This drouth was very injurious to the late crops, especially buckwheat, which in many fields was an entire failure, and in all a very short crop. Late planted potatoes yielded very sparingly. Pasture grounds were much

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[1] The *Cicada septemdecim* appeared at New Haven in June, 1860. See this Jour., xxxiii, 433.—*Eds.*

parched, and some neighborhoods suffered from the drying up of springs and wells. Corn had mostly attained maturity by the middle of September, and suffered less than several other articles. The crop of apples was generally good, especially certain varieties of winter fruit. Pears are but sparingly cultivated on account of "the blight," so certain to attack this tree, especially those of a vigorous growth and in rich soils. The best protection is a poor earth and elevated position, near the top of a hill, with a northerly exposure. This, in my opinion, proves the disease to arise from a profusion of sap and not from insects. The quince tree is liable to the same disease, but not to so injurious an extent, attacking only the extremities of the branches, and seldom fatal to the whole tree. The past year has been free from the terrible storms and tornadoes which sometimes visit us. In general terms, this year has been a favorable one to the farmer, as well as to the health of the people.

Floral calendar and ripening of fruits.—January 1st, Bluebird heard, and has been here all the winter.—March 6th, Robin appears; 7th, Bluebird singing; 9th, various birds heard; 17th, Blackbirds; 19th Wood larks and robins; 21st, Hepatica triloba in bloom, Dwarf Iris; 28th, Daffodil, white and blue Crocus.—April 2d, Hyacinth; 3d, Magnolia conspicua in full bloom: this beautiful exotic is in most years so early in putting out that the blossoms are destroyed by frost, before fully expanded; 4th, Peach in warm exposures; 5th, Japan quince and Golden bell; 7th, Peach in full bloom generally; 10th, Sanguinaria Canadensis; 12th, rose or pink colored Japan quince; 14th, Gooseberry; 15th, Crown imperial; 18th, Pear tree and white Spiræa prunifolia; 19th, June berry and Siberian crab apple, Maple tree in full foliage; 21st, Strawberry; 23d, Apple tree, Yellow root, Harebell; 26th, Ornithogalum, Chickasaw plum and Cherry; 29th, Birthwort; 30th, Tulips.—May 1st, Lilac, Quince tree; 4th, Purple tree Peony; 10th, Horse chestnut, black Haw; 11th, native Crab-apple tree; 14th, Lily of the valley; 15th, Snowball; 16th, purple Magnolia; 17th, Weigela rosea; 18th, yellow and white Calceolaria; 19th, Viburnum fruticosum; 20th, Locust tree, Iris tricolor; 22d, Syringa fragrans, yellow Harrison rose, Magnolia tripetala; 26th, Catawissa raspberry; 27th, new seedling Peonies, ten varieties; 30th, Syringa Philadelphica; 31st, Strawberry ripe.—June 4th, white Iris; 5th, Guernsey Lily; 8th, blight in Quince tree begins; 9th, Rose bugs in vast numbers in the country, destroying the young fruit of apple and peach; 11th, red Cherry ripe; 15th, white garden Lily open, slugs on Pear and Quince trees, making great destruction of the leaves; 17th, Kirtland Raspberry ripe; 19th, Magnolia glauca in bloom; 20th, Catawissa Raspberry ripe, Catalpa in bloom, Wheat harvest begins.—July 1st, Chandler Apple ripe; 4th, Dew-berry ripe; 11th, Blackberry ripe; 16th, American broom in blossom: 17th, Turk's-cap lily, Sweet-bough apple and Hale's early peach ripe.—August 13th, Muskmelon ripe; 14th, Blue plum; 15th, Hildreth, Seckle and butter pears ripe; 16th, Watermelons.—September 5th, Lychnis coronaria in bloom; 6th, Concord grape ripe; 7th, Delaware grape, second crop of Catawissa raspberry ripe; 10th, white Doyenne pear ripe; 12th, Rebecca grape; 16th, Herbemont grape ripe, Portugal quince ripe; 20th, Catawba grape.

Marietta, January 1st, 1868.

Art. XXI.—*Waterglass;* by John M. Ordway. Part IV.

[Continued from vol. xxxiii, p. 36.]

Its Precipitation by alkaline salts.

In specifying the properties of waterglass, Fuchs mentions that[1] "the salts with alkaline bases, especially carbonates[2] and chlorids, produce pasty precipitates in the glass solution;"—but neither he nor any subsequent writer has given an accurate account of the nature of these products. Some, confounding the precipitates thrown down by salts of potash or soda with those resulting from the action of ammonia salts, have supposed the deposits to be mere silica. Kuhlmann, on the other hand, confidently declares that common salt combines directly with silicate of soda, forming an insoluble compound. Biased by his assertion, and having indeed found a notable quantity of chlorid in a well drained precipitate, I temporarily disposed of the matter in Part II by saying[3] "the precipitate with chlorid of sodium in any case appears to be a double combination of silicate and chlorid." But appearances may deceive, and therefore an early opportunity was sought, to investigate the subject in earnest, and either establish or set aside the provisional statement.

A very few trials sufficed to show that, according as both the saline liquids and the waterglass solutions differ in kind, strength, and quantity, the deposits obtained by mixing vary greatly in amount and character, some being partially soluble in water and others entirely so. Of course then, it will not do to wash the precipitates, and no way can be devised of getting them absolutely free from adhering mother-liquor and, at the same time, leaving them otherwise unaltered. Hence, in every instance, the amount of each constituent of the solid product may be made up of two unknown quantities,—one expressing the portion belonging to the precipitate proper, and the other that due to the mother-liquor retained. Analysis gives the sum of the two portions of an ingredient, but the positive ratio of these parts to each other can be found neither by experiment nor by calculation. The only recourse is to a tentative method,—we must make successive assumptions and, following them out to their legitimate consequences, see which gives results squaring most completely with all the ascertainable facts. The following detailed examples will serve to illustrate the nature of the problem and the mode of its solution:—

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[1] *Ueber ein neues nutzbares Produkt aus Kieselerde und Kali.*

[2] The normal carbonates, as will be seen by examples on the following pages, have no claims to preëminence as precipitants. It is possible that Fuchs had in mind the bicarbonates, which many chemists once regarded as normal.

[3] This Journal, [2], xxxii, 340.

1.—50 grams of a liquid containing 20 p. c. of $\dot{\mathrm{Na}}_2\dddot{\bar{\mathrm{Si}}}_5$, mixed with 100 grams of a 20 p. c. chlorid of sodium solution, gave a copious precipitate which contracted greatly by standing 24 hours. The clear supernatant liquor being then decanted, the deposit was washed several times with cold water. Under this treatment, the product changed from a dense curd to a light flocculent matter, which, after drying in the air, weighed only 0·282 grms. It contained 0·224 grms. of silica.

2.—100 grams of the same chlorid of sodium solution having been stirred into 50 grams of the liquid waterglass, after 48 hours the contracted deposit was gathered in a cotton cloth and well squeezed by hand. It weighed 17·2 grams, and was not wholly soluble in water.

a.—Some of this solid matter by drying and ignition lost 55·8 p. c.

b.—Another portion was digested in water and treated with nitric acid in slight excess; then, after saturation with ammonia, the whole was dried down. The filtered solution of the residue, on being tested volumetrically with nitrate of silver, according to Mohr's method, indicated 5·05 p. c. of NaCl as such.

c.—A third quantity, by suitable treatment with water and chlorhydric acid, afforded 31·58 p. c. of SiO_3 and 20·95 parts of chlorid of sodium. Deducting from the latter the 5·05 p. c. of preëxisting NaCl, we have 15·9 parts of chlorid due to the soda and showing 8·23 p. c. of NaO.

By the same mode of examination, the mother-liquor was found to contain 14·09 p. c. of NaCl, 1·41 p. c. of SiO_3, and 0·55 p. c. of NaO; the latter two constituents being in such proportion as to make up $\dot{\mathrm{Na}}\dddot{\bar{\mathrm{Si}}}_{1\cdot8}$[4].

3.—Again, 100 grams of the 20 p. c. chlorid of sodium solution, were mixed with 50 grams of 20 p. c. $\dot{\mathrm{Na}}_2\dddot{\bar{\mathrm{Si}}}_5$. After a time the precipitate was collected in a cloth and subjected to the action of a powerful press. The solid, nearly transparent mass weighed 12·1 grams, and was wholly soluble in cold water.

The hard product by a controlled analysis gave 46·62 p. c. of SiO_3, 11·48 p. c. of NaO, and 0·67 p. c. of NaCl.

The mother liquor contained 13·97 p. c. of NaCl, 1·35 p. c. of SiO_3, and 0·59 p. c. of NaO. These numbers correspond to $\dot{\mathrm{Na}}\dddot{\bar{\mathrm{Si}}}_{1\cdot5}$ in the supernatant liquid; but how shall we tell what silicate makes up the net coagulum?

In the first place, the utter absurdity of presuming on the identity of the well-washed precipitate with the same not subjected to the action of pure water is forcibly shown by comparison of the less than 0·3 grms. of light matter in No. 1 with the 17·2 grms. of dense curd in No. 2, or with the 12·1 grms. of hard pressed matter in No. 3.

Secondly, let us suppose the 55 p. c. of water in the squeezed deposit of No. 2 to be all owing to retained mother-liquor. Then,

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[4] In reducing the composition to a uniform representation by empirical equivalents, it may be an improvement on the course adopted in Part III, to take one of base instead of one hundred, and let the acid come in decimals. Thus "$\dot{\mathrm{Na}}\dddot{\bar{\mathrm{Si}}}_{1\cdot8}$" is more compact than "$\dot{\mathrm{Na}}_{100}\dddot{\bar{\mathrm{Si}}}_{180}$."

since the fluid drained off contains 84 p. c. of water,—84 : 100 : : 55 : 65 p. c. of mother-liquor remaining in the moderately pressed curd. But in 65 parts of the liquid there should be 9 parts of chlorid of sodium, while the whole precipitate actually shows but 5 p. c. of NaCl. This hypothesis therefore has less than nothing to rest on, and falls to the ground.

Its ruins naturally suggest a third assumption, which is that all the chlorid of sodium found in the coagulum belongs to liquor not pressed out. According to such a conjecture, we have 14·09 : 100 : : 5·05 : 35·8 p. c. of mother-liquor contained in the solid product of No. 2, leaving 25 parts of combined water in the precipitate proper,—for the simply adhering fluid cannot differ in composition from the liquid squeezed out. When the amount of imbibed fluid is reduced to a practical minimum by strong pressure, as in No. 3, the chlorid of sodium almost disappears, and the just inference is that there would be none left, were the elimination of extraneous liquor absolute. Certainly, if the chlorid were thrown down in actual combinations, the drier the curd was pressed, the greater would be the percentage of salt in the residue.

Our third assumption proves correct to a moral certainty, by its exact accordance with all the observed facts in the preceding examples as well as in numerous other instances; and we may fairly conclude that the salts of potash and soda, like alcohol, precipitate from waterglass an uncombined silicate.

Having now the needed datum, we may proceed to deduce the true constitution of the product in No. 2. The mother-liquor in it has just been computed to make up 35·8 p. c., and that quantity of mother-liquor accounts for 0·19 p. c. of NaO and 0·5 p. c. of SiO_3. After deducting these amounts from the respective gross numbers furnished by analysis, we find, on carrying out the necessary calculations, that the net precipitate consists of 39 parts of $\dot{Na}\dddot{Si}_{2\cdot 65}$ and 25 parts of water.

So likewise in No. 3, the mother-liquor is reduced to 4·8 p. c., while 58 parts $\dot{Na}\dddot{Si}_{2\cdot 65}$ and 37 parts of water make up the precipitate proper. And since 58 : 37 : : 39 : 25, the products of No. 2 and No. 3 are, as they should be, alike in respect to combined water.

As the subject thus assumed a definite and prehensible form, other experiments were made on the same general plan, with various waterglass and saline solutions. The investigation required far more time and labor than was anticipated; and it may well be thought that more space is here allotted to the matter than waterglass of its own specific self deserves. But waterglass, by reason of its relation to what Graham calls the 'colloids,' has a family importance which entitles it to a still fuller study; for the peculiarities of this natural order of bodies constitute a missing link, or series of links, in the chain of chemical knowledge.

More trials have been fully carried out with chlorid of sodium as a precipitant than with any other salt, on account of the ease and precision with which chlorine may be determined. Many of the precipitates were simply squeezed by hand, because it was only after making considerable progress that I found out the advantage of resorting to mechanical aid,—No. 3, above, being in fact about the fortieth experiment. Among the following instances, the term 'hard pressed' refers to the effect of a screw multiplying the power 680 times, minus the loss by friction. For the sake of uniformity, the numbers have in each case been made to correspond to 100 grms. of waterglass solution though twice or one-half that quantity was sometimes actually used.

4.—100 grms. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 200 grms. of 25 p. c. NaCl, gave a large precipitate, which was well washed with cold water. The ignited residue weighed only 3·22 grms.

5.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 200 g. of 25 p. c. NaCl, yielded 47 g. of a squeezed precipitate wholly soluble in water and containing 34 p. c. of mother-liquor and 42·7 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot83}$.
In the mother-liquor there were 1·7 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{1\cdot56}$.

6.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 100 g. of 25 p. c. NaCl, gave 45·5 g. of a soluble product containing 31 p. c. of mother-liquor and 42·3 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot57}$.
In the mother-liquor there were 2·7 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{1\cdot80}$.

7.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 50 g. of 25 p. c. NaCl, gave 40·9 g. of a soluble curd containing 23 p. c. of mother-liquor and 45·9 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot75}$.
In the mother-liquor there were 4·8 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{1\cdot82}$.

8.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 25 g. of 25 p. c. NaCl, afforded 33·3 g. of a soluble precipitate containing 23 p. c. of mother-liquor and 42·5 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot69}$.
In the mother-liquor there were 10·7 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot15}$.

9.—100 g. of 10 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 100 g. of 10 p. c. NaCl, gave 8·6 g. of an opaque precipitate not wholly soluble in water. It contained 57 p. c. of mother-liquor and 27·4 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{3\cdot57}$.

10.—100 g. of 10 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot5}$, with 50 g. of 10 p. c. NaCl, gave 2·2 g. of a hard pressed, opaque mass not wholly soluble in water and containing 49 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{3\cdot51}$.

11.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot25}$, with 100 g. of 25 p. c. NaCl, gave 31·4 g. of a translucent, soluble curd containing 29 p. c. of mother-liquor and 42·5 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot51}$.
In the mother-liquor there were 6 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{1\cdot84}$.

12.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot25}$, with 50 g. of 25 p. c. NaCl, gave 22·4 g. of a soluble precipitate containing 33 p. c. of mother-liquor and 38·8 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot52}$.
In the mother-liquor there were 12 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot10}$.

13.—100 g. of 10 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot25}$, with 100 g. of 10 p. c. NaCl, yielded 1·15 g. of a partially soluble precipitate containing 30·8 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{3\cdot87}$.

14.—100 g. of 25 p. c. $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2}$, with 400 g. of 25 p. c. NaCl, gave 13·6 g. of a hard pressed, soluble product containing 7·7 p. c. of mother-liquor and 61·2 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{2\cdot62}$.
The mother-liquor contained 12·3 p. c. of $\dot{\mathrm{Na}}\bar{\mathrm{Si}}_{1\cdot50}$.

15.—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_2$, with 200 g. of 25 p. c. NaCl, gave 11·3 g. of a soluble curd containing 10·7 p. c. of mother-liquor and 54·7 p. c. of $\dot{N}a\dddot{S}i_{2\cdot6}$.

The mother-liquor contained 6·3 p. c. of $\dot{N}a\dddot{S}i_{1\cdot8}$.

16.—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_2$, with 100 g. of 25 p. c. NaCl, yielded 6·25 g. of a hard pressed mass containing 18 p. c. of mother-liquor and 50·3 p. c. of $\dot{N}a\dddot{S}i_{2\cdot5}$.

The mother-liquor contained 10·5 p. c. of $\dot{N}a\dddot{S}i_{1\cdot9}$.

17.—In several different trials, chlorid of sodium had little or no effect on sesquisilicate of soda.

18.—100 g. of 25 p. c. $\dot{K}\dddot{S}i_{2\cdot5}$, with 100 g. of 25 p. c. KCl, gave 21·2 g. of a hard pressed, soluble product containing 11·5 p. c. of mother-liquor and 59·6 p. c. of $\dot{K}\dddot{S}i_3$.

The mother-liquor contained 6·35 p. c. of $\dot{K}\dddot{S}i_2$.

Here we have a deposit of 12·6 g. of dry $\dot{K}\dddot{S}i_3$, while in 6,—the parallel soda experiment,—19·2 g. of dry $\dot{N}a\dddot{S}i_{2\cdot6}$ were thrown down. A potash silicate is therefore less precipitable than the corresponding soda waterglass.

The two following trials were made with reference to Berthollet's doctrine of the partition of bases among contending acids.

19.—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot8}$,—containing 5·4 g. of soda,—were mixed with 50 g. of 25 p. c. KCl,—which would be equivalent to 7·9 g. of potash. The hard pressed product weighed 28 g., and, according to the mean of two determinations with bichlorid of platinum, contained 78 parts of potash to 54 parts of soda.

20.—Into 100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot5}$ were stirred 61 g. of 25 p. c. KCl mixed with 41 g. of 25 p. c. NaCl,—so that in the sum of the ingredients there might be 8 g. of sodium and 8 g. of potassium. The hard pressed precipitate weighed 35 g., and, tried by the method of Richter, showed nearly equal quantities of potassium and sodium.

Similar results were obtained in experiments made with silicate of potash and chlorid of sodium, or with a silicate of one alkali and an acetate of the other.

The alkaline acetates are rather more efficient than the chlorids, in throwing down waterglass. Owing to the alkaline reaction of the acetates themselves, it is not easy to analyze with accuracy the contaminated products, and the results given below, claim only an approximation to correctness. The potash or soda was determined by neutralization with a standard chlorhydric acid. The tested stuff being dried down with an excess of the same acid, the quantity of chlorid in the residue, minus the amount of chlorid due to the alkali of the silicate, indicated the percentage of acetate.

21.—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot5}$, with 200 g. of 25 p. c. $\dot{N}aAc$, gave 39·4 g. of a hard pressed, soluble mass, containing 59 p. c. net of $\dot{N}a\dddot{S}i_{2\cdot60}$.

22.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2.5}$, with 50 g. of 25 p. c. $\dot{Na}\bar{A}c$, gave 41·8 g. of a hard pressed product containing 53·4 p. c. net of $\dot{Na}\dddot{Si}_{2.64}$.
The mother-liquor contained 2 p. c. of $\dot{Na}\dddot{Si}$.

23.—100 g. of 10 p. c. $\dot{Na}\dddot{Si}_{2.5}$, with 100 g. of 10 p. c. $\dot{Na}\bar{A}c$, gave 4·8 g. of a hard pressed, opaque mass, not wholly soluble in water, and containing 52 p. c. of $\dot{Na}\dddot{Si}_{3.70}$.

24.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2}$, with 100 g. of 25 p. c. $\dot{Na}\bar{A}c$, gave 36 g. of a hard pressed, soluble precipitate, containing 47 p. c. of $\dot{Na}\dddot{Si}_{2.56}$.

Acetate of soda gave very slight precipitates with sesquisilicate of soda, but only after standing some time.

25.—100 g. of 25 p. c. $\dot{K}\dddot{Si}_{2.5}$, with 100 g. of 30 p. c. $\dot{K}\bar{A}c$, gave 35·4 g. of a hard pressed, soluble mass, containing 61·4 p. c. net of $\dot{K}\dddot{Si}_{2.96}$.
The mother-liquor showed 1·2 p. c. $\dot{K}\dddot{Si}$.

26.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2.5}$, with 100 g. of 25 p. c. nitrate of soda, gave 26·5 g. of a hard pressed, soluble product, containing 24 p. c. of mother-liquor and 48·4 p. c. of $\dot{Na}\dddot{Si}_{2.9}$.
In the mother-liquor there were 6·4 p. c. of $\dot{Na}\dddot{Si}_{2.06}$.

Nitrate of soda had very little effect on the more alkaline silicates.

Sulphate of soda has still less precipitating power than the nitrate, as the following example sufficiently shows.

27.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2.5}$, with 100 g. of 25 p. c. $\dot{Na}\dddot{S}$, underwent no change. 100 g. more of the sulphate solution after a time gave 1·7 g. of a hard pressed, partially soluble precipitate containing 51·6 p. c. net of $\dot{Na}\dddot{Si}_{3.22}$.

28.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2.5}$, with 100 g. of 25 p. c. hyposulphite of soda, gave 12·6 g. of a hard pressed, soluble precipitate, containing gross 43 p. c. $\dot{Na}\dddot{Si}_{3}$.

29.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2.5}$, with 100 g. of 25 p. c. tartrate of soda, gave 10·6 g. of a hard pressed, soluble curd containing gross 53 p. c. of $\dot{Na}\dddot{Si}_{3}$.

30.—100 g. of 25 p. c. $\dot{K}\dddot{Si}_{2.5}$, with 100 g. of 25 p. c. $\dot{K}\dddot{Cr}$, gave 7 g. of a hard pressed precipitate not wholly soluble in water.

31.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2.5}$ gave no precipitate with 100 g., with 200 g., or with 400 g. of 25 p. c. $\dot{Na}\ddot{C}$.

And in other trials of the carbonate with the same and with more alkaline silicates, there was either no deposit at all or an exceedingly slight one appeared only after long standing. Normal carbonate of soda, therefore, is devoid of precipitating power.

When common arseniate of soda is mixed with a waterglass solution, no proper curd is formed at first, but the whole mixture soon becomes a very firm translucent jelly, which in the course of a few days breaks up into a thin liquor and a sort of coagulum capable of being pressed. Among many experiments made with 10 or 25 p. c. arseniate solutions and different silicates, the hard pressed product has in no case proved to be wholly soluble.

Indeed, the precipitates were always found to contain at least 4 equivalents of silica to 1 eq. of alkali. Thus,

32—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_2$, with 100 g. of 25 p. c. $\dot{Na}_2\overset{\cdot\cdot\cdot\cdot\cdot}{As}$, gave 35·3 g. of a hard pressed, opaque mass containing 44·4 p. c. net of $\dot{Na}\dddot{Si}_{5{\cdot}10}$.

The cause of this seemingly anomalous behavior on the part of the arseniate,—and the phosphate acts in the same way,—is to be found in the fact, long ago developed by Graham, that, in the so-called "neutral" arseniates and phosphates, only two-thirds of the proper quantity of alkali is present, and they are therefore in reality acid salts. Hence, when either of them is brought in contact with waterglass, it appropriates a considerable part of the alkali of that feeble combination, and of course gelatinizes the silica. Indeed, its action is similar to that of a bisulphate or a bicarbonate. It is observable that in making the mixture no change takes place till so much of the arseniate or phosphate is added as will seize on all the soda except somewhat less than is needed to form with the silica $\dot{Na}\dddot{Si}_3$. Thus,

33.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_2$, with 50 g. 25 p. c. $\dot{Na}_2\overset{\cdot\cdot\cdot\cdot\cdot}{As}$, suffered no visible alteration, though it was allowed to stand two days. And here $6\dot{Na}\dddot{Si}_2+2\dot{Na}_2\overset{\cdot\cdot\cdot\cdot\cdot}{As}=2\dot{Na}_3\overset{\cdot\cdot\cdot\cdot\cdot}{As}+4\dot{Na}\dddot{Si}_3$. But 25 g. more of the arseniate solution at once gelatinized the whole mass. $6\dot{Na}\dddot{Si}_2+3\dot{Na}_2\overset{\cdot\cdot\cdot\cdot\cdot}{As}=3\dot{Na}_3\overset{\cdot\cdot\cdot\cdot\cdot}{As}+3\dot{Na}\dddot{Si}_4$.

Of course then, to make experiments parallel to those carried on with chlorids, acetates, and the like, it was necessary to start anew and use the really neutral or normal $\dot{Na}_3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ and $\dot{Na}_3\overset{\cdot\cdot\cdot\cdot\cdot}{As}$. These salts were found to have little or no effect on any waterglass.

34.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{2{\cdot}5}$ gave no precipitate with 100 g., or with 200 g. of 25 p. c. $NaO.\,BO_3$.

The following trials were made to ascertain the influence of temperature:

35, *a.*—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_2$ were mixed with 100 g. of 25 p. c. NaCl,—both cooled to 0° C. There was no change. Warmed to 18° the mixture became turbid, and deposited 3·4 g. of a hard pressed mass containing 51 p. c. gross of $\dot{Na}\dddot{Si}_{2{\cdot}5}$.

a'.—The mother-liquor, heated in a water bath to 90° C., gave 16·8 g. of a hard pressed product containing 51·5 p. c. gross of $\dot{Na}\dddot{Si}_{2{\cdot}38}$.

b.—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_2$ and 100 g. of 25 p. c. NaCl, both boiling hot, gave 21 g. of a hard pressed curd containing 50 p. c. gross of $\dot{Na}\dddot{Si}_{2{\cdot}38}$.

The mother-liquor remained clear on cooling.

36, *a.*—100 g. of 25 p. c. $\dot{Na}\dddot{Si}_{1{\cdot}75}$ were mixed with 100 g. of 25 p. c. $\dot{Na}\dot{A}c$,—both at the boiling point. The hard pressed precipitate, weighing 6·7 g., contained 47 p. c. gross of $\dot{Na}\dddot{Si}_{2{\cdot}43}$.

a'.—The mother-liquor cooled to 3° C. gave 6·1 g. of a soft deposit containing 44 p. c. gross of $\dot{Na}\dddot{Si}_{1{\cdot}93}$.

37, *a.*—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot8}$, cooled to 6° C. were mixed with 100 g. of 25 p. c. $\dot{N}a\overset{:\cdot:}{N}$ cooled to 14°. The precipitate hard pressed, and after 48 hours again hard pressed, weighed 38·8 g., and contained 54 p. c. gross of $\dot{N}a\dddot{S}i_3$.

a'.—92 g. of the mother-liquor, heated to 90° C., gave 1 g. of a curd containing 44 p. c. of $\dot{N}a\dddot{S}i_{3\cdot4}$.

b.—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot8}$ and 100 g. of 25 p. c. $\dot{N}a\overset{:\cdot:}{N}$, on being mixed at a boiling heat, gave 34 g. of a hard pressed, transparent, soluble mass containing 58 p. c. gross of $\dot{N}a\dddot{S}i_{2\cdot92}$.

The mother-liquor cooled to 1° C. remained perfectly clear.

38, *a.*—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot8}$ at 2° C. were mixed with 100 g. of 25 p. c. $\dot{N}a\dddot{S}$. The precipitate contained 8·3 g. of $\dot{N}a\dddot{S}i_{3\cdot36}$.

a'.—137 g. of the mother-liquor, heated to 90° C., gave a precipitate in which there were 1·56 g. of $\dot{N}a\dddot{S}i_{3\cdot58}$.

b.—100 g. of 25 p. c. $\dot{N}a\dddot{S}i_{2\cdot8}$ and 100 g. of 25 p. c. $\dot{N}a\dddot{S}$ were heated to the boiling point and mixed. The hard pressed curd weighed 20·6 g., and contained 9·5 g. of $\dot{N}a\dddot{S}i_{3\cdot52}$.

The mother-liquor remained clear on cooling.

These examples, selected from more than a hundred trials, serve to illustrate the following points:—

1. Many neutral potassium and sodium salts cause a precipitation in liquid waterglass; but the various salts are very unequal in precipitating power, the acetates and chlorids being particularly efficient.

2. The less alkaline the silicate is, the more matter is thrown down by a given saline liquid.

3. The more concentrated the solutions are, the more complete is the precipitation.

4. Heat increases the precipitating power of the chlorids, sulphates, and nitrates, and diminishes that of the acetates.

5. With strong liquors, an increase in the quantity of precipitant used is not attended by a proportionate increase in the amount of coagulum; but a little more of the saline liquid than will just produce a disturbance usually suffices to throw down the greater part of all that is precipitable.

6. The deposits have a greater or less tendency to cohere into a hard or pasty mass, and can therefore be in a great measure freed from adhering mother-liquor by strong pressure.

And it may be remarked, in passing, that the solid precipitates, obtained from waterglass by means of alcohol, are deprived of extraneous liquor more readily and completely by the press than by the slow process of absorption recommended in Part III.

7. When the products, thus forcibly cleared of foreign matter, are less siliceous than the tersilicates, they are wholly soluble in cold water. Exposed to the air for a day or two, in a warm place, they lose 20 p. c. or more of their weight, and become dry and hard,—the solubility remaining unimpaired.

8. The salt used as a precipitant, does not enter into the proper composition of the deposit; but the net precipitate consists of silica, alkali, and water united in no definite proportions.

9. Saline liquids, like alcohol, exert a slight parting force on the constituents of waterglass, the deposit being always more siliceous than the original silicate.

10. The more dilute the respective solutions are, before mixing, the less alkaline will the precipitate be.

11. Silicate of potash yields a smaller deposit than silicate of soda does under similar conditions.

12. When a silicate of one alkali is precipitated by a salt of the other, both bases enter into the composition of the solid product, and the relative proportion of potash and soda therein, is very nearly the same as in the average of the liquors mixed.

The method here adopted, for determining the net composition of an unwashed precipitate, might perhaps be found advantageous in many other cases in which pure water is likely to alter a deposited product,—and such cases are probably of more common occurrence than has been heretofore suspected. Of course when a mother-liquor would of itself contain no peculiar substance capable of showing, by the comparative quantity of it found in the drained precipitate, the amount of contaminating liquor, it would generally be easy to add some special indicator.

Decomposition of Waterglass by Water.

It is a question of no little interest, as well as of some practical importance, whether different solutions made from a given vitriform waterglass, will contain the same relative proportion of silica and alkali whatever be the quantity of water used in dissolving. Such an inquiry was first suggested by the finding of a notable disagreement in composition between a dense liquor turned out in the large way and a weak solution prepared in the laboratory, both from one and the same furnace charge of soda silicate. There was $\dot{\mathrm{N}}\mathrm{a}\overline{\mathrm{S}}\mathrm{i}_{2\cdot3}$ in the stronger liquid, while the other contained $\dot{\mathrm{N}}\mathrm{a}\overline{\mathrm{S}}\mathrm{i}_{2}$. The matter came up again in determining for a manufacturer how successful he had been in fluxing a mixture intended for bisilicate of soda. Some of the uniform product was at first sent for examination to a noted analytical chemist who reported that when 25 grains of the sample, reduced to fine powder and sifted, were boiled for four hours in 8 oz. of water,—4 oz. in first boiling and 4 oz. in the second,—the "precipitate and insoluble matter," washed, dried, and burnt, amounted to 13·2 p. c., and proved to be "pure silica and insoluble glass." This account was rather surprising and unsatisfactory, for the vitreous mass showed no sandy particles, and having been made from clean materials it could hardly contain any "insoluble glass." Pulverizing some of the same well vitrified silicate, I boiled 20 grams in about 150 c. c. of water for 30 minutes and obtained only 3·3 p. c. of residue. In view of so great a discrepancy, no one would suppose both determinations to have been correctly made. But finding by another trial that my own result was certainly not below the truth, I made the following experiments to ascertain whether the apparent error in the other case was the fault of the manipulator or of his method:—

1, *a.*—25 grams of the finely powdered glass were boiled briskly for one hour, in a copper vessel, with 100 c. c. of water,—a little water being added from time to time to make up for evaporation. The settled liquor being syphoned off, the sediment was boiled again for one hour with 100 c. c. of water as before. The whole deposit, well washed with cold water and dried at a red heat, weighed 0·28 grams, making 1·12 p. c.

1, *b.*—20 g. of the fine silicate were boiled with 200 c. c. of water for one hour. The undissolved matter was again boiled with 200 c. c. of water for one hour. The sediment after being washed and strongly heated, weighed 1·2535 g., making 6·27 p. c.

1, *c.*—15 g. of the sample were boiled for two hours with 1500 c. c. of water. The scaly deposit was boiled again one hour with 1500 c. c. of water. The washed and ignited residue, amounted to 2·13 g. or 14·2 p. c.

2, *a.*—400 g. of a very finely ground commercial silicate, containing 88 p. c. of $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}_{2\cdot3}$, were boiled four hours in 1600 c. c. of water kept full. The sediment was boiled two hours with 1600 c. c. of water. A third boiling was maintained two hours. The final residue reckoned as free from water, made 9·24 p. c.

The first solution contained $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}_{2\cdot2}$; the second $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}_{1\cdot6}$; the third, $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}_{1\cdot4}$.

2, *b.*—80 g. of the same glass were boiled four hours with 1600 c. c. of water. A second boiling lasted one hour, and a third was kept up three hours. The ignited residue amounted to 21 p. c.

2, *c.*—16 g. of the same powder were boiled four hours with 1600 c. c. of water, and again four hours with 1600 c. c. of water. The ignited residue amounted to 32 p. c.

2, *d.*—8 g. of the same product were boiled four hours with 8 litres of water in a kettle heated by steam,—the carbonic acid of gas flame being thereby avoided. The sediment was boiled again four hours. The ignited residue occupied one third more space than the original silicate. It amounted to 34·5 p. c.

This dehydrated matter contained nearly 97 p. c. of silica; that of *c*, 96 p. c.; that of *b*, 94 p. c.; that of *a*, 86·5 p. c.

3, *a.*—16 g. of a very pure and perfectly vitrified silicate,—$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}_{1\cdot7}$,—of German manufacture, were boiled one hour with 80 c. c. of water.

The residue, after being boiled again, washed, and ignited, amounted to 0·44 p. c.

3, *b.*—15 g. after two boilings, with 1500 c. c. of water each time, left 8·7 p. c. of dry matter containing 94 p. c. of silica.

4, *a.*—20 g. of a remarkably nice commercial soda silicate, $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}_{1\cdot54}$, were boiled an hour with 80 c. c. of water. A second boiling was continued one hour. The ignited residue made only 0·93 p. c.

4, *b.*—10 g. of the same product were boiled one hour with 1000 c. c. of water. After another boiling the dry residue amounted to 1·73 p. c.

It seems then that, in boiling anhydrous waterglass the amount of matter left undissolved depends, in a great measure, on the quantity of water used. In other words, very siliceous waterglass is not integrally soluble in mere water, but dissolves without any considerable decomposition in a strong solution of the silicate itself. When the least practicable proportion of water is taken, the light flocculent deposits actually obtained are made up chiefly of earthy and metallic silicates; and it may be fairly inferred that in such cases an absolutely pure silicate of potash or soda would give no remainder except the very little produced by the first contact of pure water with the outer surface. But the sediment left after the action of a large quantity of water is dense and scaly, and under the microscope appears to consist of purely siliceous filmy skeletons of the original particles of the glass; and there would doubtless be such a residue even though the silicate were completely free from foreign matter. The greater the proportion of alkali, the less decomposable is fused waterglass; and we may safely say that pure products, a little more alkaline than the sesquisilicate, would dissolve without remainder in any quantity of water however great.

Recent applications of Waterglass.

A mere allusion was made in Part III to the admixture of waterglass with soap, because, of the different plans that had been proposed, some were palpably injudicious and others seemed to have been of so little avail that they had not come into continued use. The fault lay, not in the fundamental idea of such an application, but chiefly in the choice of the particular silicate to be used. Good soap is itself sufficiently alkaline, and any addition which increases its causticity, only injures its quality. To use anything so excessively alkaline as *liquor silicum,*—which is what the oldest propositions all direct,—is taking a long stride in the wrong direction. Gossage does better in recommending sesquisilicate of soda; but still this is too sharp, and certainly would not be mended by following his advice to dissolve it in caustic lye instead of water. Any plan for disposing of the soda in excess, by using the silicate liquor in the first or saponifying stage of the soap manufacture, involves a troublesome change in the well established routine of the process, and does not allow the elimination of impurities. The most feasible mode of introducing an addition is to put the given substance with the boiled and purified soap as it is run into the "frames" to cool, and mix the whole by the usual stirring or "crutching." But soap makers who have tried the sesquisilicate on a large scale raise the objection that any considerable percentage of a thick solution will not combine with the soap to form a homogeneous mass. And consumers may consider it fortunate that it is at least difficult to cheapen soap with a substance in which the alkali is so imperfectly mollified.

The older schemes for making silicated soap must therefore be set down as useless or impracticable; but within the last two years it has been discovered that highly siliceous waterglass assimilates perfectly with soap, and decidedly improves its quality. And now a mild silicate, in the form of a thick liquid containing about thirty per cent of a compound ranging from $\dot{\mathrm{N}}\mathrm{a}\overline{\overline{\mathrm{S}}}\mathrm{i}_{2\,3}$ to $\dot{\mathrm{N}}\mathrm{a}\overline{\overline{\mathrm{S}}}\mathrm{i}_{2{\cdot}5}$, is manufactured very largely in New York and Boston, and has already come into general use among the soap makers in this country. It possesses the advantage over resin,—which, till the blockade of the Carolinas, has been the staple material for reducing the cost of common soap,—that it imparts neither color, nor smell, nor clamminess, however great may be the quantity used. Owing to the great difficulty of dissolving very siliceous waterglass, the so-called "soap liquid" costs more than the combination of resin and alkali does in ordinary times; yet it is cheap, and materially reduces the price of the product into which it enters. In fact, as a hard and good looking soap may be made, containing as much as sixty per cent of the fluid silicate, the manufacturer is under some temptation to exceed the proper limit and make 'waterglass in bars' instead of 'silicated soap.' It has never been definitely ascertained what proportions will best secure all the advantages to be derived from the silicate and still have the due amount of frothing power and softening influence, which are conferred only by the fatty acids. But it is certainly quite safe to incorporate twenty-five or thirty pounds of liquid waterglass with every hundred pounds of pure oleostearate of soda. The compound thus produced has greater detersive power than common soap, though the alkaline strength remains about the same, and the causticity is not sensibly increased. It is well known that water, except when it is very hot, splits up and only in part dissolves the alkaline stearates and margarates; and perhaps the principal reason why silicated soap works better than pure is that hydrated waterglass enters readily into complete solution, and tends to hinder the precipitation of the fatty bisalts.

(To be continued).

ART. XXII.—*On the Origin, Growth, Substructure and Chronology of the Florida Reef;* by Capt. E. B. HUNT, Corps of Engineers, U. S. A. (In a letter to Prof. A. D. BACHE, Sup't. U. S. Coast Survey.)

NEW HAVEN, CONN., NOV. 18, 1862.

SIR: The examination of the Florida reef, keys and mainland by Prof. Agassiz, in 1850–51 (Coast Survey Rept., 1851, Appendix No. 10), marks an era in our knowledge of the singular geological problems there exhibited, and especially of their zoological phases. This exploration, made under Coast Survey auspices, was amply justified by the fact that the Florida reef is the great American danger to navigation. One of the best aids in avoiding reef risks is a clear insight into the structure of the reefs and keys, and this can result only from scientific researches, aided by the Coast Survey detailed hydrography, now well advanced. The millions of property wrecked on the reef are in great part sacrificed to a needless ignorance of hydrography, reef structure, currents, winds and even of lights and beacons. Reef pilots are not employed, and ship masters are so poorly supplied with precise knowledge, of the kind needed for ensuring safe navigation amid these dangers, that many wrecks result solely from their ignorance. During the five seasons (1857–62) in which I was charged with the construction of Fort Taylor at Key West, I had good opportunities for knowing the history of the wrecks, occurring at the average rate of about one a week. I am now of the opinion that the loss of property in wrecks, which would be preventable by such accurate knowledge as can be furnished to navigators when the Coast Survey shall have published the complete reef hydrography and its full scientific discussions of reef structure, tides, currents and winds, has regularly exceeded the annual expense of the entire survey. Many shipmasters are incorrigibly ignorant, and many wrecks have, to my knowledge, occurred by masters not knowing new lights, which had been for many months conspicuously advertised in all the Custom Houses and in commercial papers. Would shipping merchants insist on having none but intelligent captains, and then furnish them with the very best information concerning the reef neighborhood, a large portion of the wrecks would be prevented. I think the study of currents and especially of *current variations*, in and near the Florida channel, is now particularly needed for preventing wrecks in this region. The fluctuations of currents from their supposed normal type certainly cause numerous disasters. The lack of distinct ideas as to the relations between the reefs and the keys, and ignorance of the manifest signs of proximity to the reef, are the real causes of many disasters. The Coast Survey has done so much to disarm the reef of its terrors and to make known its true character, that, aside from my own connection with the Coast Survey organization, it seems appropriate for me to present to you some views on the origin, growth, substructure and chronology of the reef, which have resulted from my observations while at Fort Taylor, and which may prove a needful supplement to Prof. Agassiz's Report.

The grand curve of our Atlantic coast terminates in the remarkable crescent of keys and reefs which begins some miles north of Cape Florida and extends in a well defined curve some two hundred and forty statute miles to Tortugas Bank. At Cape Florida its axis is north and south. In moving down the reef, this direction revolves with the sun, until at Tortugas it bears about 5° north of west. This crescent consists of a line of keys and a parallel outer line of reefs, which are separated, on an average between five and six miles, by a navigable channel obstructed by coral heads. The reef terminates about opposite the Marquesas, some fifty miles east of Tortugas Bank. Between the line of keys and the mainland of Florida, is a body of shoal water, shaped much like a cornucopia, which embraces Key Biscayne Bay, Card's Sound, Barnes's Sound and the Bay of Florida. The line from Tortugas to Cape Roman, which may be taken as the mouth of this cornucopia, is one hundred and twenty miles long, the deepest water on it being twenty fathoms, and all within or east of it being still shoaler and characterized by singular evenness of bottom. The Straits of Florida, between the reef and the Cuban coast, are about a hundred miles wide, and the bottom slopes from the reef down to eight hundred fathoms just off the submerged cliffs of Cuba. The hundred fathom curve of the bottom is about seven miles out from Cape Florida, and from thence to Tortugas it gradually separates farther from the keys, being there over twenty miles out.

The well traced curve, along which this grand Florida Bank thrusts itself out into the deep waters of the Gulf, is strikingly significant of some continuous and regular agency in its production. The adjacent flow of the Gulf Stream would most naturally be assumed to govern in some way the production of this curve. It however runs in the wrong direction to serve this explanatory use, and it is in fact rarely found to run close in upon the reef. There is however an eddy counter-current intermitting in character and of variable rate, but on the whole a positive and prevailing current.[1] At Cape Florida it is narrow and precarious; but it widens as it sweeps to the westward, occasionally becoming over ten miles wide at Key West,

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[1] See C. S. Rept., 1858, App. 32. This Journal, 1859, vol. xxvii, p. 206.

and twenty miles off Tortugas. It sometimes runs over two knots, and is a great help to vessels bound west, when their masters know the reef well enough to venture so near. There is much need of more precise observations to make out the characteristics of this current, but its existence and its intermitting and sometimes powerful set are facts attested by all who know these waters thoroughly.

After careful consideration, I am led to ascribe the peculiar shaping and growth of the Florida Bank, including the keys, reefs and substructure, mainly to the sweep of this eddy counter-current. Darwin, Dana and Agassiz have so fully stated the zoological and other ordinary elements of reef and key growth that I need only refer to their works for details.[2] Special circumstances however so far modify the structure of the Florida reef that it is not fully embraced in the principles laid down by these writers. It is not an *atoll*, a *fringing* reef, or a *barrier* reef, in the accepted sense of these designations, but it is a reef or bank, shooting out independently *by its end* into the deep Gulf waters. Such at least is the view to which I have been led by simply considering the existing agencies as actually working.

The reef proper is the main field of coral growth. This growth is not in one compact mass, but in diversified coral heads, or detached masses. The bold slope of the reef towards the Gulf Stream, to the proper depth of growing coral, which here does not exceed a hundred feet, and the broad top-surface of the reef-section are teeming with solid corals and shells. The branching corals grow wherever the violence of the sea does not prohibit, and where moving sand does not forbid a secure foundation for coral colonies.

In general, wherever there are solid surfaces free from sand and mud, and washed by warm, moving salt water, the ova of the coral-polyps, diffused throughout the reef waters, attach themselves and grow, to the limit of their capacity. Thus the stones of the Fort Taylor breakwater and foundations, palmetto piles, iron bars lost overboard, &c., have become coated with branching and solid corals, whose growth, between the date of immersion and that of diving up, gives a measure of coral increase. Throughout the sand-covered bottom between the reefs and keys, along the sand-faced South beach-slope towards the reef, and over the mud bottoms north of the keys, there are no living corals, except on such accidental bases as may occur and in the coral heads which have grown up on these bases. Thus coral masses are mainly produced where the action of storms are most

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[2] The structure and Distribution of Coral Reefs, by Chas. Darwin, Naturalist of the Beagle Expedition (1832–36). On Coral Reefs and Islands, by Jas. D. Dana, Geologist U. S Ex. (1838–42) 1853, and in this Journal, 1851–2, vols. xi, xii, xiii and xiv. Agassiz's Rept., C. S. Rept., 1851, App. No. 10, and Atlantic Monthly, May and June, 1862.

violent, and they are constantly giving way before the assaults of the waves and the corrosions of the numerous and active boring shells. A coral mass once broken loose undergoes active attrition and disintegration into calcareous sand of varying fineness. This sand, and the accompanying detritus of shells and echinoderms, which abound intermixed with the living coral, are by degrees borne on by the waves towards the south beaches of the keys, where some of the sand is thrown up on the slope of the beach ridge. A coral mass or shell once cast loose is killed, and is henceforth untiringly triturated by the waves, until it escapes their action, or is reduced to impalpable powder. Every agitation of the sand by the waves pulverizes it yet further, and brings it nearer to the consistency of the white mud which so largely prevails on the Bank towards its northern side. There is thus constant coral and shell growth and as constant disintegration in progress. All this action however takes place in the limited range of depth of less than 100 feet, within which only can the reef building corals grow. To account for the vast underlying mass, between this limit of depth and the deep original sea floor, is a problem hitherto unsolved and one which I hope to elucidate.

The tidal currents set strongly across the reef and through the channels between the keys, the flood running to the north and the ebb to the south side of the key crescent. When storms occur, the agitation of the waves extends to the bottom, over the shallower portions of the grand Bank, and stirs up the sand violently. This causes the water to take up and maintain in mechanical suspension such finely comminuted particles as have too little sinking force rapidly to reach the bottom again. The finer the particles the longer will they remain suspended, and the very coarse grains will hardly be lifted from the bottom. Between the coarsest and finest are grains of all intermediate sizes, and whether they will be suspended or not depends on the violence of the storm, and their interval of suspension varies with their size and the violence of the waves. It results that, in all storms of much violence, the water over the Florida Bank becomes white with the bottom deposits. In long, severe northers or gales, the water becomes almost milk-white across the whole Bank. This "white water" is a familiar appearance, and is one of the sure signs of proximity to the reef. As storms subside, the white sand and mud are gradually thrown down, and the water clears, after a day or two, to its peculiarly delicate transparency.

During the "white water" periods, the flood tidal currents set the white water over the north side of the Bank into the Bay of Florida, where, by reason of the greater depth, the process of deposition goes on; and thus the floor of this bay has become covered with white mud, and has been brought up with a singular evenness to the prevailing depths. The portion of the Bank north of the keys is mainly composed of this fine mud, and the north shores of the keys have long shallow mud slopes, some portions of which seem to be solidifying. The ebb tide carries the white water out towards the Gulf Stream, and it is recognized at times many miles outside the reef. Abreast the Tortugas, it is sometimes encountered over thirty miles out. The eddy counter-current, setting perhaps two knots per hour, transports this white water and its suspended detritus to the westward into deepening water, where it has opportunity to settle as it goes, and finally reaches bottom some miles west of its point of formation. Once on the bottom, in deep water, below the action of the waves, nothing can remove it. Thus we have, in actual operation, a perfect mechanism for triturating the coral and shell growths, and for transporting the comminuted products, by wave disturbance, tidal currents and the eddy currents, to the deep water farther west. These agencies being all unquestionably real and now active, I find no reason to doubt that they have been the secular causes at work extending the Florida Bank by its western extremity.

A careful examination of the bottoms, as shown on the several Coast Survey charts of the reef, affords signal confirmation of this view. The indications of white mud, white sand, coral and broken shells, over all the south frontage of the reef, halfway to Cuba, to the west around Tortugas and Tortugas Bank, and over the entire long slope by which the west end of the Florida Bank runs down into depths of one hundred fathoms, and of four hundred and sixty to the southwest, as also the bottoms over the Bay of Florida, and westward to the hundred fathom curve, are all consistently indicative that the material of the bottom thus brought to light was originally organic, and has been worn down and transported to its present bed by some agencies like those I have described. The entire lack of any bottoms in the slightest degree tinctured with Mississippi mud is a perfect refutation of the view presented by Prof. Jos. LeConte,[3] that the substructure of the reef, up to the depth where coral growth can begin, is a result of the deposition of Mississippi sediment carried across the Gulf by the Gulf current. I venture the assertion that these bottoms are inconsistent with any view which does not derive them from the living coral, to the east of their present localities. Should it be said that these bottoms only indicate the mere surface character of the sea-bed, it may be replied that the great mass of the Bank substructure, shooting out to the west into the Gulf, and rising above the Gulf bottom on both sides, as is amply shown by the 10, 20 and 100

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[3] This Journal, 1857, vol. xxiii, p. 46.

fathom curves around the west end of the Bank, is unmistakeably a special formation subsequent to the general shaping of the Gulf bed. The actual causes now at work in producing coral and shell material, and in grinding and transporting it, must necessarily result in a building up from the bottom along the line of the eddy current to the westward.

Combine with this the fact that the most effective winds and waves, both of trade and hurricane origin, come in upon the reef from the S.E., and must therefore help to transport detritus to the westward and northwest. Moreover, the heavy waves which wear the front face of the reef must work some of the detritus down along the south slope, and must thus aid in forming the actual double slope in which the bottom expands towards the Cuban cliff coast. It is unlikely that the wave actions extend with appreciable effect below from fifty to a hundred feet, and detritus once placed below their extreme range becomes permanently fixed. It is to be observed that the very zone of coral growth is that of wave agitation, and that this must prevent the lodgment of sand and mud on the growing coral, as, after storms, the swell will always last here until the waters are cleared of white mud. This may perhaps be quite as effective a cause as increased pressure, in limiting the depth of coral growth to about the same range as that of wave actions.

A careful consideration of such facts as are now ascertained leads me to the supposition that the growth of the line of keys and the line of reefs is simultaneous by their western extremities. The reef now ends opposite the Marquesas, while the Quicksands, Rebecca and Isaac Shoals, the Tortugas keys and the Tortugas Bank indicate the extension of the line of keys beyond the line of reefs to the west. It is remarkable that the Tortugas keys are entirely without the solidification so prominent at Key West. Fort Jefferson, resting wholly on sand foundations, has settled in all its circuit, and in some portions it has gone down nearly a foot, showing that a deep sand bed has yielded thus much to compression.

In the sheltered waters among these keys, there is an active growth of branching corals, &c., on sand foundations, which are torn up by storms and tossed on the beaches by the waves, to such an extent as to afford the vast mass of concrete materials used in the masonry of Fort Jefferson. There are however no extended rock masses, and the great vitality of the corals is shown in an active renewal of growth on dead coral sprigs. It is my impression that the mass of materials forming Tortugas keys and banks has been transported westward by the eddy current, and north and northwest by the south and southeast storms and hurricane waves, from the reef abreast and east of Marquesas. The shaping of the bottom indicates this, and it is apparent that a westward extension of the reef must be slowly taking place. It would thus appear that the keys, at least in their substructure, are rather results of the waste from the present line of reefs than an original and anterior reef growth. Concurring with this process is the growth of coral as now at Tortugas, and in such heads or masses as can find foundation on the sand slopes of the keys.

The solidification of the keys must be a slow and later process, and, some thousands of years hence, the sand masses of the Tortugas may assume an oolitic structure like that now seen at Key West. The calcareous marl, wherever found, seems to be preparing for solidification, and in a single instance of hard marl, from the eastern portion of Key West, I observed what could easily be fancied to be the circles of incipient oolitic segregation. The crystallization of the contained salt soon broke up this appearance, and I never again obtained it, though the confirmation of such an observation of oolite *ab ovo* would have great interest, in consideration of the vast masses of this rock in the earth's crust. That the finely comminuted white mud or marl solidifies into oolite, on Key West, is I think fully shown by the fossil traces of a peculiar vegetable scum which forms in the lagoons. This scum, as the lagoons dry up, forms a leathery sheet, which is by drying split into pieces, which roll up at the edges, sometimes with three or four turns. I have found these rolls fossilized and looking much like bones, but distinctly showing the spiral curling in the section. Most of the oolitic rock of Key West, on weathering its fractures, shows a series of thin parallel edges averaging perhaps a half inch apart, which being more resisting rise on the weathered fractures above the softer parts between. These harder layers seem very like fossil scum sheets, but they are found in stones much above the present ponds or lagoons where it is hard to conceive that they are due to this origin.

Whether a calcareous sand-heap wholly above the water can solidify into an oolite is a question hard to answer; but it is only by such agency that I can explain the solid mound, of nearly a mile in diameter, which forms the west part of Key West and is wholly composed of oolite. The summit of this mound is about fifteen feet above high water, and is believed to be the highest point on the whole line of keys. The gale of 1846 raised the water to within seven feet of the apex, and we can readily conceive that, before the reef barrier protected it, a hurricane might have carried up sand to over fifteen feet above ordinary high water.

The oolite, as shown in the wells of Key West, becomes coarser grained and softer in descending. It is so open that the water level of the wells, even in the heart of the key, or half a mile from the sea, fluctuates with the tides, following them at intervals varying according to position, but averaging, as nearly as I could ascertain, about three hours. The whole rocky mass of Key West is of this oolite, there being on the weathered surfaces and occasionally in the mass a yellowish-brown crust, hard enough to receive a polish and usually less than a quarter of an inch thick. The granite foundations of Fort Taylor, located in water of eleven feet, or less, were laid on rock which was dressed to form beds, by the use of a diving bell. The submarine rock thus examined was much like the shore rock, except that the materials were coarser, rather less compact and more brecciated. Occasional shell and coral brecciated masses are found on shore, but such traces are quite rare. In removing the beach sand ridge which skirted the whole south shore, I found a limited stratum, about six inches thick and a few rods long, composed wholly of imperfectly comminuted pieces of small branching corals, averaging about an inch long and a third of an inch thick. Otherwise, this whole ridge, about ninety feet wide and from five to eight feet thick, above high water, was composed wholly of sand, much of which was somewhat blackened by vegetable loam from the ridge scrub growth. It is observable that this calcareous sand is scarcely at all blown about by the winds. Once packed, it resists the blasts of northers and hurricanes so completely, that at a few feet from the reverse slope of the beach ridge, we find only marl and rock. It presents a marked contrast in this respect with siliceous beach sands, which may, as in Provincetown, Cape Cod, build up hills a hundred feet high, or be carried for miles into the interior. When dry and freshly turned up, it blows freely, but it seems never to be moved by winds from the place where the sea deposits it. It is obvious that the sea is washing away the rock along the south side of Key West, while the north mud slope is being augmented. Several hundred feet of the original south beach rock have probably been cut away.

I am indebted to Mr. Chas. Howe, now Collector at Key West, for some account of an artesian well, which in 1839–40 he sunk to a total depth of one hundred and thirty feet, on Indian Key, about eighty miles northeast of Key West. To the depth of fifteen feet, the rock was moderately soft and uniform. It then began to be unsound, the drill occasionally going down three or four feet at once. At forty-five feet, a gravel bed of about five feet was found, below which the rock became harder and continued very solid, with a few interruptions of unsoundness, to ninety-one feet, when another gravel bed of several feet was struck which gave much trouble. Below this the rock became exceedingly hard, and was "tinged with yellow specks." This continued to 130 feet, with several interruptions by "breaking through," the drill once going down five feet at one jump. The water injected to clear the hole brought up pieces the size of pigeons' eggs, but unfortunately the specimens are now lost. I suppose, from Mr. Howe's verbal account, that all this rock was purely calcareous, and that the very hard variety, which was taken to be quartz, was a compact limestone, such as Dana frequently found in the Pacific coral formations. The unsoundness would seem to be due to the interrupted nature of coral beds, whether *in situ* or formed of coral boulders and sand.

In general, the actual structure of the reef seems to result mainly from three grand activities:—1st, the ceaseless and persistent growth of coral animals and shells on every appropriate site, within their proper range of depth, temperature and water-supply, which growth, by secretion, separates the carbonate of lime from the mass of the ocean and gulf water; 2d, the untiring action of the winds, tides and currents (aided by boring shells), in breaking up, triturating, transporting and depositing the calcareous products of the zoological processes; 3d, solidification by time, pressure, segregation and possibly by chemical transformation. It is a complex problem to trace the precise operation of these agencies, as now at work, and from the present to pass back over the past until that time when the Florida Bank did not exist, and when the shore from Cape Sable to Fort Dallas was the open ocean-front of South Florida. It seems however not too audacious to say that the agencies now at work present a general type of operation which requires but unlimited time to realize results no less than the formation, not only of the line of keys and reefs, but of the immense substructure which rises from the great original plane of the gulf bed. This plane along the Cuban coast was over eight hundred fathoms deep, and it could hardly have been less than three hundred fathoms under the present Tortugas group.

The evidence that South Florida and the base of the Bank have recently undergone neither elevation nor depression, to any considerable extent, is quite convincing. There is a remarkable coincidence of general level along the crescent of keys, and no reliable evidence of vertical movement is found on any of them. Prof. Tuomey fancied he saw evidence of elevation through several feet at Key Vaccas.[4] Believing that he had mistaken boulders for masses *in situ*, I inquired of Assistant Hilgard, whose observations on the keys during his surveying labors have been extensive, and he replied that he has "never seen any coral beds raised *in situ* above the water. He paid some attention to the subject, and remembers those at Key Vaccas particularly, where he satisfied himself by using a crowbar that they were boulders bedded in sand." Prof. Agassiz and Prof. LeConte

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[4] This Journal, 1851, vol. ii, p. 390.

report the same impression. During the growth of two hundred and forty miles of keys there has been then no observable change of level. There is a dead fringing reef forming the Punta, or west angle of the entrance to Havana, which seems to have been elevated some six feet, and this is the only case of recent elevation in this vicinity with which I am acquainted.

Prof. Tuomey and Prof. Agassiz fully identify the formations at Fort Dallas with the rocks of the keys. The former reports the descent from the Glades along the Miami river to tide water at six[5] to eight feet, and estimates the height of the ridge where cut by the Miami at twenty to thirty feet. Prof. Agassiz estimates the highest shore bluff in this vicinity as not above thirteen feet. The siliceous sand which caps the beach ridge around to Cape Sable was probably transported by the waves down the east coast. There seems ample reason to suppose that the crescent from Cape Sable, through the Mangrove swamp and Hunting Grounds to Fort Dallas, and thence north along the coast ridge, is an older reef curve, and that the Everglades and Lake Okeechobee were the interior flats, analogous to Key Biscayne Bay, Barnes Sound and the Bay of Florida.

The Everglades, which cover about four thousand square miles, have a substratum of coralline limestone of very rough and irregular surface, which is covered by sand, siliceous in part at least, and soft mud from three to ten feet deep, which covers all but a few points of the limestone and is overgrown with rank saw grass. The water overlying this mud is about three feet deep in dry seasons, and rises after rains from two to three feet. Lake Okeechobee is but a deeper extension of the Everglades, its depth averaging about twelve feet, and its area being nearly twelve hundred square miles The slight elevation of the Everglade region increases gradually to the north, and the Kissimee river, which empties into the north margin of Lake Okeechobee, has a southerly course of near a hundred miles, with a current of half a mile to three miles. There is thus a very gentle rise throughout the peninsula, and in the general slope sweeping the north margin of the Gulf and South Atlantic.

The existence of abundant fossil corals in the Tertiary limestone strata of two hundred to three hundred feet thick, spreading from the Mississippi river around to Cape Fear river in North Carolina, indicates an ancient coral origin.[6] Prof. Tuomey was led by these evidences to a special examination of the Florida Reef, from which he concluded that a continuous process of

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[5] Assistant F. H. Gerdes, U. S. Coast Survey, found the surface of the water in the Everglades to be 6 ft. 2¼ inches above low water-mark at Fort Dallas: see Coast Survey Report for 1849, p. 47.

[6] There are corals in the Tertiary of the coast, but no continuous reef-rock, we believe, warranting the above remark. The many muddy streams have been in the way of the extensive formation of coral reefs on these coasts, even when, as in the Tertiary, the temperature of the ocean favored it.—Eds.

coral growth through geologic ages may have produced this immense coral limestone area. He agrees with Mr. Conrad in calling the Tampa limestone Tertiary. In all this space of limestone strata, there is no point whose altitude approaches to equality with the depth of near a mile, found off the Cuban coast. The whole view of this subject leaves a strong impression that no great changes of level have occurred during the period of formation, not only of the present crescent of reef and keys, and the Cape Sable and Fort Dallas crescent, but even in the more ancient coral period, which produced the North Peninsula and the coral limestones of the great Gulf and Atlantic slope.

Confirmatory evidence is found in the Bahama, Salt key, Cuba and Yucatan reefs, which have attained great expansion with but slight evidence of disturbance. There are no indications of atoll formation by sinking; but Darwin (Appendix, p. 186) appeals only to elevation, and meets the fact of the singular coincidence of level over many disconnected banks of great area in the West Indies, by supposing that the elevated masses of the banks were uniformly washed away by the sea during their elevation. It is evident that the remarkable evenness of soundings over these banks is a measure of the depth to which the destroying action of the waves extends in their several localities. The enormous accumulations on the Florida side of the Gulf Stream make it quite rational to suppose that Salt Key Bank, for instance, may have resulted from a single nucleal peak, now worn away by the sea, which has afforded a basis for the growth of a fringing reef and for a wasting action by the waves, whence an outward expansion may have resulted, which, in the course of ages, has accumulated the larger portion of the great truncated cone, now rising from near four hundred fathoms. To what extent the type of action which I have supposed instrumental in producing the Florida Bank may be applied in the explanation of other cases of coral reef, I am not qualified to decide. It can hardly be supposed that such acute and philosophical minds as Darwin's and Dana's would fail to perceive and give proper weight to this familiar action of attrition, transportation, and deposition.[7] Dana is very explicit in stating it, and I must there-

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[7] It is certainly hardly to be supposed, that Darwin or Dana should have overlooked the effects of "attrition, transportation, and deposition"—causes acting alike whether the material subjected to them be coral and shells, or granite and sandstone. Mr. Dana, in his Report on Coral Reefs and Islands, in fact, attributes the formation of the reef-rock, or the great mass of the reef, to the consolidation of the coral debris made by the triturating waves and distributed by the waves and currents. See pages 41, 42, 57, 62, 105 to 109, 115, 121, 149, (or in this Journal, [2] xi. 366, 367; xii, 32, 36, 330 to 334; xiii, 35, 40; xiv, 78, 79, 83.) where the effects of the triturating waves and distributing currents are particularly described, even to the formation of coral mud in the shallow waters among the reefs.

Speaking of the effects of the currents among the Feejee Islands, he remarks, p. 42 (this Journal, [2] xi, 367): "When the materials from both sources, the shore and the reef, are mingled, the proportion will necessarily depend on the proximity to the mouths of streams, the breadth of the inner waters or channels, and the direcfore suppose, that a satisfactory explanation of the growth of the Pacific coral islands demands vertical movements unlike any exhibited in the West Indies.

If the views now presented are correct, the chronology of the reef becomes stupendous. The most rapid instance of coral growth which I found on the breakwater and foundations of Fort Taylor was a Meandrina of about six inches radius, which was produced within twelve years, or the rate was a half inch per annum. Numerous specimens derived from stones or piles whose dates of immersion were known, and whose surfaces were so rapidly coated by vegetation and corallines that we can safely assume the coral colonies to have been planted soon after immersion, all indicate for the vicinity of Fort Taylor a general rate of growth less than the above. There is no obvious reason why this rate should not be identical with that on the reef proper, as the tidal currents supply ample moving water, and the temperature is much the same.

Bearing in mind that the living reef belt hardly averages a mile in width, and that this is much interrupted, while the shoal part of the Bank averages between fifteen and twenty miles broad, and that this is but a small part of the breadth of the base of this bank, on the original bottom, aside from the marl and sand contributed to the Bay of Florida, we are overwhelmed with the immense demand for time. We ought not to suppose less than three hundred fathoms of detritus built up on an average. Moreover, much of this calcareous material is likely to

tion and force of the currents. These tidal currents often have great strength, and are much modified and increased in force at certain places, or diminished in others, by the position of the reef with reference to the land. Sweeping on, they carry off the coral debris from some regions to others distant; and again they bear along only the shore detritus, and distribute it. It is thus seen that the same region may differ widely in its adjacent parts—may seemingly afford evidence in one place that there is no coral near, and in another no basaltic land, although either is within a few rods, or even close along side. The extent of the land in proportion to the reef will have an obvious effect upon the character of the channel or lagoon depositions. When the island stands, like Bacon's isles (Feejees), as a mere point of rock in a wide sea enclosed by a distant barrier, the streams of the land are small, and their detritus quite limited in amount. In such a case, the reef and the growing patches scattered over the lagoon, are the sources of nearly all the material that is accumulated upon the bottom."

Again, p. 57: "The reef-rock, wherever broken, shows a detritus origin," etc.

Again, p. 121 (this Journal, xiii, 40),—treating of the precautions necessary to determine correctly the rate of growth of reefs, he observes: "It is also necessary to examine into whatever has any bearing upon the marine or tidal currents of the region—their strength, velocity, direction, where they eddy, and where not, whether they flow over reefs that may afford debris, or not. All the debris of one plantation may sometimes be swept away by currents to contribute to other patches, so that one will enlarge at the expense of others; or, currents may carry the detritus into the channels or deeper waters around a coral patch, and leave little to aid the plantation itself in its increase and consolidation."

Again, when explaining the origin of the hard compact limestone, containing rarely a fossil, which constitutes so large a proportion of the reef-rock, he says:

have been more than once used by the coral animals, and some must have been swept into the ocean waters. Taking the living reef at one-twentieth the breadth of the total bank, the depth of the bank at three hundred fathoms, and the rate of growth at $\frac{1}{2}$ inch per annum, we find, aside from the other elements of protraction, 864,000 years as the time for building the bank, when considered in cross section. Considering the growth as being by the west end from Cape Florida to Tortugas Bank, a great increase of time is still demanded, so that we can hardly, on these data, diminish the chronology of the growth of the present Florida Bank even to a million years. Appalling as this estimate of time for building appears, it seems impossible honestly to reduce it. If to this be added the time consumed in building the Cape Sable and Fort Dallas crescent, and again the inconceivable periods demanded in the growth of the main peninsula and the limestone strata of the grand slope of the Gulf and South Atlantic, the imagination is appalled, and can only rest on limitless infinities. We can indeed readily make an arithmetical approximation to this inconceivable total. The nature of coral reefs limits the growing portion to the outer reef line, and it is a liberal allowance if we suppose a zone of one mile broad regularly covered with growing surfaces. The solidified masses derived from this zone, wherever deposited, cannot possibly increase, in the whole, more rapidly than this zone can supply the materials. If we assume these masses at 250 feet thick on their northern margin in Alabama, and 1800 feet thick on the present southern boundary, we can safely assume an average thickness of 900 feet. The length of the general line of

"An explanation of this peculiarity is obvious on the principle already discussed—the action of a triturating sea," etc.

Mr. Dana even considers the question of the transportation of the detritus over the bottom of the adjoining ocean, a point so well illustrated by Captain Hunt. On page 154 (this Journal, xiv, 83), he remarks as follows: "It is an inquiry of some interest, whether, in an archipelago like the Paumotus, coral debris is not carried from the coral islands, and distributed over the bottom of the ocean; and whether limestones, thus originating, are not in process of formation. I venture no positive assertion on this subject, yet would express strong doubts. The fact that soundings off some basaltic islands, as we recede from the reef-growing depths, lose more and more in the proportion of coral sand, till we finally reach a bottom of earth, like the material of the island, bears against the hypothesis. This was found to be the case off Upolu, where the reefs are extensive." The doubts here expressed could not exist in a sea where the reef-islands were swept by a marine current as strong as that passing the Florida Keys; and this is the special fact which gives originality and great interest to the researches above detailed by Captain Hunt, whether the idea that the formation of the reef consisted in a gradual elongation from the eastward, without subsidence—a view also of great interest, and original—be correct or not.

It may be added here, that the possibility, not to say strong probability, of great changes of level during and following the Post-tertiary, in the region of the Mexican Gulf, as well as in the other transverse tropical seas of the globe, the Mediterranean and East Indian, is one among the many sources of doubt that complicate the problem of time connected with the Florida reef.—J. D. D.

average cross section of the growing front cannot be less than 250 to 300 miles, or at the minimum a horizontal formation of 250 times the growing zone can be assumed. Taking the rate as before at 24 years to the foot, we shall have for the total time 24×250×900, on the data as stated; or, we find the total period of 5,400,000 years, as that required for the growth of the entire coral limestone formation of Florida. The rate of coral growth is nearly a rigid one, scarcely subject to fluctuation in any supposable period of time, and the limitation of growth to an outer reef of narrow section is also a necessity of organic habits. If then it be a fact that all the limestone mass now considered is of coral origin, the time of coral growth cannot be reduced below the result given above. It is likely to be much greater, as all the elements have been assumed on the side of a minimum chronology, and no allowance is made for growth by the west end instead of by the front.

The derivation of the substructure of the bank from coral growth makes the seemingly formidable chronology deduced by Prof. Agassiz shrink into insignificance. But is this vastness of time really incredible? Does its shock to our ideas militate against its reality? It is not the method of true philosophy to belittle nature to our ideal standards, but it is rather our duty to seek facts without bias or preconception. Looking thus squarely at the facts of the reef, in the aspect I have regarded them, the aggregate of time given seems really and truly insufficient. There are vast possibilities of error in such estimates, but are we not quite as likely to err through our preconceptions of limited chronology as by boldly submitting to the guidance of estimation from actual bases!

ART. XXIII.—*Catalogue of Mineral Localities in New Brunswick, Nova Scotia, and Newfoundland;* by O. C. MARSH, B.A., of the Sheffield Scientific School, Yale College.

THE following list of mineral localities in New Brunswick,[1] Nova Scotia, and Newfoundland, is the first covering all these regions that has been published. Although necessarily imperfect in many respects, it has been prepared with considerable care, and it is hoped that it may prove of some service to mineralogists who are not familiar with these interesting regions.

The lists of minerals occurring at many of the places mentioned in the Catalogue, especially those in the trap district of the Bay of Fundy, are copied from the writer's notes, which were

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[1] Many of the notices of localities referred to in this Province are given on the authority of Mr. Mathew, which is a sufficient guarantee for their general accuracy.

taken at the localities during several excursions to the Provinces, the first in 1854. Even these lists may, in some cases, be found incomplete; since the destructive tides of that region are constantly changing the outlines of the coast, and thus exhausting the old localities, while at the same time bringing to light others, equally rich in mineral treasures.

The notices of localities which the writer has not visited are derived from the best sources of information to which he had access. A few were taken from the publications of Jackson and Alger, Dawson, and Jukes, which contain much that is valuable in regard to the mineralogy of these Provinces.[2] The writer is also especially indebted to George F. Mathew, Esq., and Charles F. Hartt, Esq., of St. John, for important information in regard to localities, especially in New Brunswick, and to Prof. Forrest Shepherd, of New Haven, for notices of several new localities in Newfoundland.

There is probably no part of the world, except the trap district of India, which is richer in zeolites than the shores of the bay of Fundy; yet the minerals from that region have hitherto received but little attention in comparison with those from other similar sections, and hence no little confusion exists in regard to what species occur at the different localities. In the following lists of minerals from Nova Scotia, thomsonite, prehnite, and one or two other species are marked doubtful. The first is generally believed to be one of the most common minerals in that Province, yet on examining and analyzing specimens of the so-called thomsonite from many of its reputed localities, the writer found them to be invariably mesolite or natrolite,—most generally the former; and it is doubtful if this species has yet been discovered in that region. Prehnite, also, is stated to occur at two places on the bay of Fundy;[3] yet an examination of specimens, so considered, which were collected by the discoverers of the localities, as well as a careful exploration of nearly all the places in that section at which this mineral might naturally be expected to occur, has led the writer to believe that prehnite has not hitherto been met with in Nova Scotia, and that its existence at any locality in that Province is extremely doubtful.

The entire group of zeolitic minerals from the bay of Fundy is well worthy of careful study. The writer has for several years been collecting materials for a full examination of the different species, and hopes at some future time to embody the results of his investigations in a Monograph on the subject.

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[2] Remarks on the Mineralogy and Geology of Nova Scotia, by Charles T. Jackson and Francis Alger; Memoirs of the American Academy, vol. i, 1833; Acadian Geology, by J. W. Dawson, F.G.S., Edinburgh, 1855; Geological Survey of Newfoundland, by J. B. Jukes, F.G.S., London, 1843.

[3] Near Black Rock, Kings Co., and at Clark's Head, Cumberland Co.

The following catalogue is arranged according to the plan used in Dana's Mineralogy. Only localities which afford cabinet specimens are in general included. The names of those minerals which can be obtained in good specimens at the several localities are printed in italics. When the specimens are remarkably good, an exclamation mark (!) is added, or two of these marks (! !) if the specimens are quite unique.

NEW BRUNSWICK.

ALBERT CO. Grindstone Point and Island.—Barytes, iron pyrites, lignite.

Hopewell.—Gypsum (alabaster and selenite); Albert mines,—coal (albertite).

Pallet River—fifteen miles from mouth,—coal.

Shepody Mountain.—Alunite in clay, calcite, iron pyrites, *manganite ?* psilomelane, *pyrolusite.*

Turtle Creek.—Coal.

CARLETON CO. Woodstock.—Copper pyrites (mined), hematite, limonite, wad.

CHARLOTTE CO. Beaver Harbor.—Chlorite, jasper.

Campobello—at Welchpool.—Blende, copper pyrites, erubescite, galena, iron pyrites; at head of Harbor de Lute, galena (4 inch vein); at Head Harbor, copperas, iron pyrites.

Deer Island—on west side.—Calcite (in amygdaloid), magnetite, quartz crystals.

Digdiguash River.—On west side of entrance, *calcite !* (in conglomerate), chalcedony; at Rolling Dam, graphite.

Grandmanan.—Between Northern Head and Dark Harbor, agate, amethyst, *apophyllite, calcite,* hematite, heulandite, jasper, magnetite, natrolite, *stilbite,* thomsonite ?; at Whale Cove, *calcite !,* heulandite, laumontite, stilbite, *semi-opal ! ;* at Fish Head, two miles east of Eel Brook, chlorite in quartz (abundant); at Rosses' Island, quartz crystals; at White Head, chlorite, quartz crystals.

L'Etang Island Harbor.—Chlorite, iron pyrites, marble, serpentine; at La Téte, copper pyrites, erubescite, galena.

Wagaguadavic River.—At entrance, azurite, copper pyrites in veins, malachite; one eighth of a mile east, galena.

New River.—At Mills, actinolite ? (in porphyry).

Seely's Cove.—Hill, half a mile north, calcite, iron pyrites, magnetite, quartz crystals.

St. Stephen.—Four miles north of, graphite in slate, molybdenite in gneiss, quartz crystals; at Mill Farm, iron pyrites.

Wauwig River.—Three miles up, at Cormick's Mills, pyrites in boulders, garnet, feldspar crystals, tourmaline; at Bartlett's Pond, quartz crystals.

GLOUCESTER CO. Bathurst.—Coal, malachite.

Téte-a-gouche River.—Eight miles from Bathurst, copper pyrites (mined), *oxyd of manganese ! !* formerly mined.

KENT CO. Buctouche River.—Coal.

Cocaigne River.—On branch three miles from bridge, coal.

Richibucto River.—Three miles above Ford's Mills, and at Big Brook, coal; at Bassk, iron pyrites; Liverpool, limonite.

Kouchibouguasis River.—Coal.

KINGS CO. Belleisle Bay.—On north shore, galena in limestone, hornstone, jasper; Bull Moose Hill, large bed of magnetite on farm of Northrup and Benson.

Clifton.—Chlorite, epidote, hematite, orthoclase in crystals, prehnite, quartz crystals.

Hammond River.—At Sherwood's, graphite in limestone.

Hampton.—At Darling's Lake, agate, carnelian, jasper.

Kingston.—On ridge south of village, chlorite, magnetite, magnetic pyrites.

Nerapis.—Near Hatfield's Mill, pyrites; near Mather's Inn, amethyst, feldspar, quartz crystals.

Quispamsis.—Copper pyrites, galena, iron pyrites, laumontite.

Sussex.—Near Cloat's Mills, on road to Belleisle, argentiferous galena; one mile north of Baxter's Inn, *specular iron* in crystals, limonite; on Capt. McCready's farm, east of Church, *selenite!!* (crystals containing sand).

Upham.—Salt springs; four miles east of Titus' Mills, gypsum.

NORTHUMBERLAND CO. Boistown.—Coal; also at New Castle and Chatham.

QUEENS CO. Grand Lake.—At Long Point, barytes, copperas, and pyrites in fossil trees; Salmon River, on Crawford's farm, coal, copperas, pyrites, limonite; New Castle River, coal mines; Coal Creek, coal (formerly worked).

Long Reach.—Opposite VanWarts, chlorite.

Washedemoak River.—Two and a half miles from Long's Creek, coal; a few miles above mouth of W. River, on S.E. side of small cove, carnelian, chalcedony, hornstone, jasper, quartz crystals.

RESTIGOUCHE CO. Belledune Point.—*Calcite! serpentine, verde antique marble.*

Dalhousie.—Agate, carnelian.

Point LeNim.—Coal.

SAINT JOHN CO. Black River.—On coast, calcite, chlorite, copper pyrites, *hematite!* in crystals, pyroxene (green earth), quartz crystals.

Brandy Brook.—Epidote, *hornblende*, quartz crystals.

Carleton.—Near Falls, calcite (red).

Chance Harbor.—*Calcite* (deep red) in quartz veins, chlorite in argillaceous and talcose slate.

Little Dipper Harbor.—On west side, in greenstone, amethyst, barytes, quartz crystals.

Moosepath.—Feldspar (red), hornblende, muscovite, black tourmaline.

Musquash.—On East side Harbor, copperas, graphite, pyrites; at Shannon's, chrysotile, serpentine; East side of Musquash, *quartz crystals!* (in conglomerate).

Portland.—At the Falls, large bed of graphite (impure); at Fort Howe Hill, *calcite* (fine crystals in several forms), graphite; Crow's Nest, asbestus, calcite (fibrous), *chrysotile*, magnetite, *serpentine*, steatite; Lily Lake, white augite ?, chrysotile, graphite, serpentine, steatite, talc; How's Road, two miles out, epidote (in syenite), steatite in limestone, *tremolite;* Drury's Cove, graphite, pyrites, pyrallolite ? indurated talc.

Quaco.—At Light House Point, large bed of oxyd of manganese; west of Point, lignite; east of Quaco, at Fuller's Creek, graphite, iron pyrites; farther eastward, asbestus, chrysolite, black tourmaline.

Red Head.—Calcite (fibrous), red jasper.

Sheldon's Point.—Actinolite, asbestus, calcite, epidote, (pistacite and zoisite,) malachite, specular iron.

Cape Spencer.—Asbestus, calcite, chlorite, specular iron (in crystals).

Ten Mile Creek.—Coal (in slate and sandstone).

Westbeach.—At east end, on Evans' Farm, chlorite, talc, *quartz crystals;* half a mile west, chlorite, copper pyrites, magnesite (vein), magnetite.

Point Wolf and Salmon River.—Asbestus, chlorite, chrysocolla, copper pyrites, erubescite, pyrites.

SUNBURY CO. Ormocto River.—Ten miles up north branch, coal.

Lincoln.—Bog iron ore (abundant), wad.

VICTORIA CO. Tabique River.—*Agate, carnelian*, jasper; at mouth, south side, galena; at mouth of Wapskanegan, gypsum, salt spring; three miles above, stalactites (abundant).

Quisabis River.—Blue phosphate of iron, in clay.

WESTMORELAND CO. Bellevue.—Iron pyrites.

Dorcester.—On Taylor's Farm, cannel coal, clay iron stone; on Ayres' Farm, asphaltum, petroleum spring.

Grand ance.—Apatite, selenite (in large crystals).

Memramcook.—Coal (albertite).

Shediac.—Four miles up Scadoue River, coal.

YORK CO. Nashwaak River.—Coal; Jay Creek, coal.

Pokiock River.—Stibnite ? *tin pyrites*, in granite, (rare); Harvey Settlement, wad.[4]

NOVA SCOTIA.

ANNAPOLIS CO. Chute's Cove.—*Apophyllite*, natrolite.

Gates' Mountain.—Analcime, magnetite, *mesolite! natrolite*, stilbite, thomsonite ?[5]

Hadley's Mountain.—Chlorophæite, heulandite.

Margaretville.—Epistilbite ?[6] laumontite, (colored green by copper), stilbite.

Martial's Cove.—*Analcime!* (inclosing native copper), chabazite, *heulandite.*

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[4] See note on Antimony (Stibnite) in New Brunswick in the preceding number of this Journal, p. 150.

[5] See Introduction, page 211.

[6] A mineral from this locality has been described as *epistilbite* by Prof. How, of Kings College, Nova Scotia; but, in a recent communication to the writer, that gentleman expresses a doubt whether it may not prove to be heulandite on further examination. The crystalline form of the mineral could not be ascertained from the specimen analyzed. O. C. M.

MOOSE RIVER.—Beds of magnetite.

NICTAU RIVER.—At the Falls, bed of hematite.

PARADISE RIVER.—Black tourmaline, *smoky quartz !!* (perfect crystals, more than one hundred pounds in weight, have been found in the soil).

PORT GEORGE.—Faröelite, laumontite, mesolite, stilbite; east of Port George, on coast, apophyllite containing gyrolite.

PETER'S POINT.—West side of Stonock's Brook, *apophyllite !*, calcite, heulandite, *laumontite !* (abundant), native copper, stilbite.

ST.CROIX COVE.—Chabazite, heulandite.

WILMOT.—At the Spring, copperas.

COLCHESTER CO. FIVE ISLANDS.—East River, *barytes !*, calcite, dolomite (ankerite), hematite, copper pyrites; Indian Point, malachite, magnetite, red copper, tetrahedrite; Pinnacle Islands, *analcime*, calcite, *chabazite !*, natrolite, siliceous sinter.

LONDONDERRY.—On branch of Great Village River, *barytes*, ankerite, hematite, limonite, magnetite; Cook's Brook, ankerite, hematite; Martin's Brook, hematite, limonite; eastward of Great Village River, on high ground, hematite, limonite; at Folly River, below Falls, ankerite, iron pyrites; on high land, east of river, ankerite, hematite, limonite; on Archibald's land, ankerite, *barytes*, hematite.

SALMON RIVER.—South branch of, coal, copper pyrites, hematite.

SHUBENACADIE RIVER.—Anhydrite, calcite, *barytes*, hematite, oxyd of manganese; at the Canal, iron pyrites.

STEWIACKE RIVER.—Barytes (in limestone).

CUMBERLAND CO. CAPE CHIEGNECTO.—Barytes.

CAPE D'OR.—*Analcime, apophyllite !!* (large crystals, highly modified), chabazite, faröelite, laumontite, *mesolite*, malachite, *natrolite, native copper*, obsidian, red copper (rare), vivianite (rare); Horse-shoe Cove, east side of Cape D'Or, analcime, calcite, stilbite.

ISLE HAUTE.—South side, analcime, *apophyllite !!*, albin ?,[7] calcite, *heulandite !!*, natrolite, mesolite, *stilbite !*

JOGGINS.—Coal, hematite, limonite; malachite and tetrahedrite at Seaman's Brook.

PARRSBOROUGH.—Augite, amianthus, calcite, gypsum, hematite, iron pyrites, magnetite, quartz.

PARTRIDGE ISLAND.—Analcime, *apophyllite !* (rare), *amethyst !* agate, apatite (rare), *calcite !!* (abundant in large and highly modified crystals) ,chabazite (acadiolite), chalcedony, cat's-eye (rare), gypsum, hematite, *heulandite !*, magnetite, *stilbite !!* (very abundant).

CLARK'S HEAD.—Analcime, anhydrite, chlorite, calcite, hematite, prehnite ?, tremolite.

SWAN'S CREEK.—West side, near the Point, calcite, gypsum, *heulandite*, iron pyrites; east side, at Wasson's Bluff and vicinity, *analcime !!* (occasionally enclosing native copper and malachite), *apophyllite !* (rare), *calcite, chabazite !!* (white, wine-yellow, and red (acadiolite) in large and very perfect crystals), gypsum, *heulandite !!*, malachite, *natrolite !*, native copper, red copper (rare), siliceous sinter.

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[7] Specimens of the mineral, from this locality, which has for many years passed under the name of *albin*, have recently been examined by the writer, and proved to be merely a variety of calcite. O. C. M.

Two Islands.—Moss agate, analcime, calcite, chabazite, *heulandite.*

McKay's Head.—Analcime, calcite, heulandite, *siliceous sinter!*

Stronix Brook.—Laumontite.

DIGBY CO. Brier Island.—Native copper, in trap.

Digby Neck.—Sandy Cove and vicinity, *agate, amethyst, calcite, chabazite, hematite!* (in perfect crystals), *laumontite* (abundant), magnetite, *stilbite*, quartz crystals.

Gulliver's Hole.—*Magnetite, stilbite!*

Mink Cove.—Amethyst, *chabazite!* (crystals an inch in diameter), quartz crystals.

Nichol's Mountain.—South side, *amethyst, magnetite!* (in large and perfect crystals).

Trout Cove.—Six miles east of Sandy Cove, *agate, chalcedony.*

William's Brook.—Near source, *chabazite* (green), heulandite, stilbite, quartz crystals.

GUYSBORO' CO. Cape Canseau.—*Andalusite,* abundant in mica and clay slate.

Guysboro'.—Galena, hematite.

HALIFAX CO. Gay's River.—Galena, in limestone.

Halifax.—Southwest of, garnet, staurotide, tourmaline.

Tangier.—*Gold!* (occasionally crystalized) in quartz veins in clay slate, associated with auriferous pyrites, galena, hematite, mispickel, and magnetite.[8] Gold has also been found in the same formation, accompanied by iron pyrites and mispickel, at Country Harbor, Fort Clarence, Isaac's Harbor, Indian Harbor, Laidlow's Farm, Lawrencetown, Sherbrooke, Salmon River, and Wine Cove.

HANTS CO. Cheverie.—Oxyd of manganese (in limestone).

Petite River.—Gypsum, oxyd of manganese.

Windsor.—Calcite, cryptomorphite (boronatrocalcite?), glauber salt, hayesine. The last three minerals are found in beds of gypsum.[9]

INVERNESS CO. Mabon Harbor.—*Fluor spar!* (green).

KINGS CO. Black Rock.—Centrallassite, cerinite, cyanolite;[10] a few miles east of Black Rock, prehnite?, *stilbite!*

Cape Blomidon.—On the coast between the Cape and Cape Split, the following minerals occur in many places: some of the best localities are nearly opposite Cape Sharp,—*analcime!!, agate, amethyst!, apophyllite!*, calcite, chalcedony, chabazite, gmelinite (ledererite), faröelite, hematite, *heulandite!*, laumontite, magnetite, malachite, *mesolite,* native copper, (rare), *natrolite!*, psilomelane, *stilbite!*, thomsonite?, *quartz.*

Cornwallis.—At the Bridge, oxyd of manganese.

Hall's Harbor.—Analcime, *heulandite*, laumontite, *stilbite.*

North Mountains.—Amethyst, bloodstone (rare), *ferruginous quartz, mesolite* (in soil).

Long Point.—Five miles west of Black Rock, *heulandite, laumontite!!, stilbite!!*

Scot's Bay.—*Agate,* amethyst, *chalcedony,* mesolite, natrolite.

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[8] This Journal, [2], xxxii, 395, 1861.

[9] This Journal, [2], xxiv, 230, and xxxii, 8.

[10] Ed. New Phil. Jour., x, 84.

Woodworth's Cove.—A few miles west of Scot's Bay, *agate!*, *chalcedony!*, *jasper*.

LUNENBURG CO. Chester.—Gold River, gold in quartz, iron pyrites, mispickel.

Cape La Have.—*Iron pyrites!*

The "Ovens."—*Gold*, on the beach and in quartz veins, iron pyrites, *mispickel!*

Petite River.—Gold, in slate.

PICTOU CO. Pictou.—*Jet*, oxyd of manganese, limonite; at Roder's Hill, six miles west of Pictou, barytes; on Carribou River, gray copper and malachite in lignite; at Albion Mines, coal, limonite; East River, limonite.

QUEENS CO. Westfield.—Gold in quartz, iron pyrites, mispickel.

Five Rivers.—Near Big Fall, gold in quartz, pyrites, mispickel, limonite.

RICHMOND CO. Plaister Cove.—West of, barytes and calcite in sandstone; nearer the Cove, calcite, *fluor spar* (blue), chalybite.

SHELBURNE CO. Shelburne.—Near mouth of Harbor, garnets (in gneiss); near the town, rose quartz; at Jordan and Sable River, *staurotide* (abundant in clay and mica slates), schiller spar.

SYDNEY CO.—Hills east of Lochaber Lake, iron and copper pyrites, chalybite, hematite.

Morristown.—Epidote in trap, gypsum.

YARMOUTH CO. Cream Pot.—Above Cranberry Hill, gold in quartz, pyrites.

Cat Rock.—Fouchu Point, asbestus, calcite.

NEWFOUNDLAND.

Antony's Island.—*Iron pyrites*, in large cubical crystals.

Cape Bonavista.—Copper pyrites, in quartz veins.

Catalina Harbor.—On the shore, *iron pyrites!* large and perfect crystals, in slate.

Chalky Hill.—Feldspar, in crystals.

Copper Island, one of the Wadham group.—Copper pyrites (abundant).

Codroy's Island.—Gypsum, granular and fibrous.

Great Codroy River.—On left bank, near mouth, gypsum, (abundant); seven miles inland, bituminous coal.

Conception Bay.—On the shore south of Brigus, erubescite and gray copper, in trap.

Great White Bay.—Gold Cove, copper pyrites, in quartz veins.

Grand Pond.—Northeast of, bituminous coal, cannel coal.

Hall's Bay.—In the bank of a river flowing into the bay, copper pyrites in quartz veins, traversing chlorite slate; at the head of the tide on the same river, shell marl, a bed twenty feet in thickness.

Humber River.—Near mouth, marble (abundant), muscovite.

Bay of Islands.—Southern shore, *iron pyrites*, in slate.

Lawn.—Argentiferous galena, horn silver, ruby silver, silver glance.

Placentia Bay.—At La Manche, two miles eastward of Little Southern Harbor, *galena!* very pure and abundant, in a vein of pink calcite traversing metamorphic slate. This vein is now worked, and 1400 tons of galena have recently been taken from it. On the opposite side of the isthmus from Placentia Bay, barytes (flesh-colored), in a large vein, occasionally accompanied by copper pyrites.

Port au Port.—On the Isthmus, native copper, in trap.

St. George's Bay.—Galena in limestone; at Crabb's River, bituminous coal, (vein three feet in thickness), gypsum in bank of a brook, salt springs.

Shoal Bay.—South of St. Johns, copper pyrites.

Tor Bay.—Four miles from St. Johns, a chalybeate spring, noted for its medicinal properties.

Trinity Bay.—Western extremity, barytes (flesh-colored), a large vein.

Harbor Great St. Lawrence.—West side, fluor spar, galena.

Sheffield Labratory, Yale College, Sept. 10, 1862.

Art. XXIV.—*On the Correction of the Elements of the Orbit of a Comet;* by James C. Watson, M.A., Professor of Physics in the University of Michigan.

When a new comet has been discovered, its orbit may be determined approximately from three observations made immediately after its discovery. If the intervals between the observations are nearly equal, the method of Olbers may be applied, but if the intervals are considerably unequal, a nearer approximation may be made by the method of Legendre. When the approximate elements have been found, and it is required to find a system of parabolic elements which will best satisfy all the observations available, the following method will be found very convenient in practice, and will invariably give satisfactory results.

Let t, t', t'', be the times of observation, corrected for the time of aberration and reduced to the same meridian; λ, λ', λ'', the geocentric longitudes, and β, β', β'', the geocentric latitudes of the comet at the date of the first, second and third observations respectively. The observations must be corrected for parallax and reduced to the mean equinox of a fixed epoch, which is usually taken at the beginning of the year. Let us also denote by R, R$'$, R$''$, the distances of the earth from the sun, and by $\odot$, $\odot'$, $\odot''$, the longitudes of the sun, for the dates of the observations respectively.

The coördinates of the first place of the earth, referred to the third, are:

$$x = \mathrm{R}''\cos\odot'' - \mathrm{R}\cos\odot,$$
$$y = \mathrm{R}''\sin\odot'' - \mathrm{R}\sin\odot.$$

If we represent by g the chord of the earth's orbit between the places corresponding to the first and third observations, and by G the longitude of the first place of the earth as seen from the third, we shall have

$$x = g\cos\mathrm{G},$$
$$y = g\sin\mathrm{G};$$

and consequently,

$$\begin{aligned}\mathrm{R}''\cos(\odot''-\odot)-\mathrm{R} &= g\cos(\mathrm{G}-\odot),\\ \mathrm{R}''\sin(\odot''-\odot) &= g\sin(\mathrm{G}-\odot).\end{aligned} \qquad (1)$$

The coördinates of the first place of the comet referred to the third place of the earth are:

$$x_1 = \varDelta \cos\beta \cos\lambda + g \cos G,$$
$$y_1 = \varDelta \cos\beta \sin\lambda + g \sin G,$$
$$z_1 = \varDelta \sin\beta,$$

where $\varDelta$ is the distance of the comet from the earth at the first observation.

Let us now put

$$x_1 = D \cos B \cos L,$$
$$y_1 = D \cos B \sin L,$$
$$z_1 = D \sin B,$$

and we shall have

$$\begin{aligned} D \cos B \cos (L - G) &= \varDelta \cos\beta \cos(\lambda - G) + g, \\ D \cos B \sin (L - G) &= \varDelta \cos\beta \sin(\lambda - G), \\ D \sin B \quad &= \varDelta \sin\beta. \end{aligned} \tag{2}$$

If we represent by φ the angle at the third place of the earth between the first and third places of the comet, we obtain

$$\cos\varphi = \cos B \cos\beta'' \cos(\lambda'' - L) + \sin B \sin\beta''.$$

Let us now put

$$\begin{aligned} n \sin m &= \sin\beta'', \\ n \cos m &= \cos\beta'' \cos(\lambda'' - L), \end{aligned} \tag{3}$$

and we shall have

$$\cos\varphi = n \cos(B - m). \tag{4}$$

Let $\varkappa$ be the chord of the orbit of the comet between the first and third places, and we get

$$\varkappa^2 = D^2 + \varDelta''^2 - 2D\varDelta'' \cos\varphi,$$

or

$$\varkappa^2 = (\varDelta'' - D \cos\varphi)^2 + D^2 \sin^2\varphi, \tag{5}$$

where $\varDelta''$ is the distance of the comet from the earth corresponding to the third observation.

If ψ and ψ'' represent the angles at the earth between the sun and comet at the first and third observations respectively, we shall have

$$\begin{aligned} \cos\psi \ &= \cos\beta \ \cos(\lambda - \odot), \\ \cos\psi'' &= \cos\beta'' \cos(\lambda'' - \odot''). \end{aligned} \tag{6}$$

Then, if we denote by r and r'' the distances of the comet from the sun, at the times t and t'', we obtain

$$\begin{aligned} r^2 \ &= (\varDelta - R \cos\psi)^2 + R^2 \sin^2\psi, \\ r''^2 &= (\varDelta'' - R'' \cos\psi'')^2 + R''^2 \sin^2\psi''. \end{aligned} \tag{7}$$

Let us now put

$$D \sin\varphi = A, \qquad D \cos\varphi = a,$$
$$R \sin\psi = C, \qquad R \cos\psi = c,$$
$$R'' \sin\psi'' = C'', \qquad R'' \cos\psi'' = c'',$$

and equations (5) and (7) become

$$\begin{aligned} \varkappa \ &= \sqrt{(\varDelta'' - a)^2 + A^2}, \\ r \ &= \sqrt{(\varDelta - c)^2 + C^2}, \\ r'' &= \sqrt{(\varDelta'' - c'')^2 + C''^2}. \end{aligned} \tag{8}$$

These equations (8) together with Lambert's equation,

$$(r+r''+\varkappa)^{\frac{3}{2}}-(r+r''-\varkappa)^{\frac{3}{2}}=\mathrm{M}(t''-t), \qquad (9)$$

where log. M= 9·0137327, will enable us to determine Δ'' by successive approximations, when the value of Δ is given.

We may therefore assume a value of Δ by means of the approximate elements of the orbit, and then find the value of Δ'' for which the corresponding values of r'' and $\varkappa$ will satisfy equation (9). It will be observed that the value of Δ'' must be found by trial; and, if we assume also an approximate value of Δ'', we may find r'' from the last of equations (8) and then determine $\varkappa$ from equation (9). Then we obtain a second value of Δ'' from the equation

$$\Delta''=a+\sqrt{\varkappa^2-\mathrm{A}^2}.$$

With the value of Δ'' thus obtained we recompute r'' and $\varkappa$ as before, and in a similar manner find a still nearer approximation to Δ''. A few trials will generally give the correct result.

When Δ'' has thus been determined we find the heliocentric places of the comet by the following:

$$\left.\begin{aligned}\Delta\cos\beta\cos(\lambda-\odot)-\mathrm{R}&=r\cos b\cos(l-\odot),\\ \Delta\cos\beta\sin(\lambda-\odot)&=r\cos b\sin(l-\odot),\\ \Delta\sin\beta&=r\sin b,\end{aligned}\right\} \qquad (10)$$

$$\left.\begin{aligned}\Delta''\cos\beta''\cos(\lambda''-\odot'')-\mathrm{R}''&=r''\cos b''\cos(l''-\odot''),\\ \Delta''\cos\beta''\sin(\lambda''-\odot'')&=r''\cos b''\sin(l''-\odot''),\\ \Delta''\sin\beta''&=r''\sin b'',\end{aligned}\right\} \qquad (11)$$

where b, b'', and l, l'', are respectively the heliocentric latitudes and longitudes of the comet at the times t and t''. The values of r and r'' should agree with those obtained from equations (8).

The elements of the orbit are then found from the heliocentric places by means of the well known formulæ. For the node and inclination, we have

$$\left.\begin{aligned}\operatorname{tang} i\sin(\tfrac{1}{2}(l+l'')-\text{☊})&=\frac{\pm\sin(b''+b)}{2\cos\frac{1}{2}(l''-l)}\sec b\sec b'',\\ \operatorname{tang} i\cos(\tfrac{1}{2}(l+l'')-\text{☊})&=\frac{\pm\sin(b''-b)}{2\sin\frac{1}{2}(l''-l)}\sec b\sec b'',\end{aligned}\right\} \qquad (12)$$

the upper sign being used when the motion is direct and the lower sign when the motion is retrograde, corresponding respectively to the cases where $l''>l$ and $l''<l$. In these equations, ☊ denotes the longitude of the ascending node, and i the inclination of the plane of the orbit to the ecliptic.

The longitudes in the orbit are given by the equations:

$$\left.\begin{aligned}\operatorname{tang}(\theta-\text{☊})&=\operatorname{tang}(l-\text{☊})\sec i,\\ \operatorname{tang}(\theta''-\text{☊})&=\operatorname{tang}(l''-\text{☊})\sec i,\end{aligned}\right\} \qquad (13)$$

where θ and θ'' are the longitudes in the orbit.

As a check on the accuracy of the computation we have

$$\varkappa^2=\{r-r''\cos(\theta''-\theta)\}^2+r''^2\sin^2(\theta''-\theta).$$

For the longitude and distance of the perihelion we put

$$\text{tang}\,(45^\circ+\omega)=\sqrt[4]{\frac{r''}{r}},$$

and then we shall have

$$\begin{aligned}\frac{1}{\sqrt{q}}\sin \text{F}&=\frac{\text{tang}\,2\omega}{\sin\frac{1}{4}(\theta''-\theta)\sqrt[4]{rr''}},\\ \frac{1}{\sqrt{q}}\cos \text{F}&=\frac{\sec 2\omega}{\cos\frac{1}{4}(\theta''-\theta)\sqrt[4]{rr''}},\end{aligned}\qquad(14)$$

where $2\text{F}=\frac{1}{2}(\theta+\theta'')-\pi$, q denoting the perihelion distance, and π the longitude of the perihelion.

Let v and v'' be the true anomalies at the times t and t'', and we have

$v=\theta-\pi$, $v''=\theta''-\pi$, for direct motion, and
$v=\pi-\theta$, $v''=\pi-\theta''$, for retrogade motion.

Then for the time of perihelion passage T, we have

$$T=t\pm\frac{q^{\frac{3}{2}}\sqrt{2}}{75k}\,(25\,\text{tang}^3\tfrac{1}{2}v+75\,\text{tang}\,\tfrac{1}{2}v),\qquad(15)$$

which should agree with the value of T found by using the values of t'', v'', instead of t and v,

$$\log\frac{\sqrt{2}}{75k}=0{\cdot}0398723.$$

The preceding formulæ are all that are required for finding the elements of the orbit from two observations, when one of the geocentric distances is given. To solve the problem proposed, we assume, in the first place, an approximate value of Δ, and compute the elements of the orbit from the first and third observations, by means of these formulæ. With the elements thus obtained we compute the place of the comet for the time t', and compare it with the corresponding observation, and if we denote the computed longitude and latitude by λ'_0, and β'_0 respectively, we shall have

$$\lambda'+u'=\lambda'_0,\ \text{and}\ \beta'+w'=\beta'_0,$$

where u' and w' are the differences between computation and observation. Next, assume a second value of the distance of the comet from the earth at the time t, which we represent by $\Delta+\delta\Delta$, and compute the corresponding system of elements, and we shall have as before

$$\lambda'+u''=\lambda'_0,\ \text{and}\ \beta'+w''=\beta'_0.$$

We also compute a third system of elements from $\Delta-\delta\Delta$, ($\delta\Delta$ being the same as before,) and denote the differences between computation and observation by u and w, then we shall have[1]

$$u=f(\Delta-\delta\Delta),\ \ u'=f(\Delta),\ \ u''=f(\Delta+\delta\Delta),$$

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[1] The assumed values of $\Delta-\delta\Delta$, Δ, and $\Delta+\delta\Delta$, should be so taken that the correct value of Δ—viz., that for which the differences u and w are a minimum—shall be within the limits $\Delta-\delta\Delta$ and $\Delta+\delta\Delta$, which may always be effected.

and similarly for w, w', and w''. If these three numbers are exactly represented by the expression

$$\alpha+\beta\left(\frac{x}{\delta\Delta}\right)+\gamma\left(\frac{x}{\delta\Delta}\right)^2,$$

where $\Delta+x$ is the general value of the argument;—since the values of u, u', and u'' will be such that the third differences may be neglected, this formula may be assumed to express exactly any value of the function corresponding to a value of the argument not differing much from Δ, or between the limits $x=-\delta\Delta$ and $x=+\delta\Delta$.

To find the coefficients α, β, and γ, we have[2]

Argument.	Function.	1st diff.	2d diff.	x	Function.	1st diff.	2d diff.
$\Delta-\delta\Delta$	$f(\Delta-\delta\Delta)$			$-\delta\Delta$	$\alpha-\beta+\gamma$		
		$f'(\Delta-\frac{1}{2}\delta\Delta)$				$\beta-\gamma$	
Δ	$f(\Delta)$		$f''(\Delta)$	0	α		2γ
		$f'(\Delta+\frac{1}{2}\delta\Delta)$				$\beta+\gamma$	
$\Delta+\delta\Delta$	$f(\Delta+\delta\Delta)$			$+\delta\Delta$	$\alpha+\beta+\gamma$		

whence by comparison we find

$$\alpha=f(\Delta);\ \beta=\tfrac{1}{2}\{f'(\Delta-\tfrac{1}{2}\delta\Delta)+f'(\Delta+\tfrac{1}{2}\delta\Delta)\};\ \text{and}\ \gamma=\tfrac{1}{2}f''(\Delta).$$

Now in order that the middle place may be exactly represented in longitude, we shall have

$$\gamma\left(\frac{x}{\delta\Delta}\right)^2+\beta\left(\frac{x}{\delta\Delta}\right)+\alpha=0,$$

from which we find

$$\frac{x}{\delta\Delta}=-\frac{1}{2\gamma}\left(\beta-\sqrt{\beta^2-4\alpha\gamma}\right)=p, \tag{16}$$

or

$$x-p.\delta\Delta=0. \tag{17}$$

In the same manner, the condition that the middle place shall be exactly represented in latitude gives

$$x-p'.\delta\Delta=0. \tag{18}$$

In order that the orbit shall exactly represent the middle place, it requires that both conditions shall be satisfied simultaneously, but it will rarely, if ever, happen, that this can be effected, and we must therefore find the most probable value of x from the equations (17) and (18); viz., that for which the sum of the squares of the residuals shall be a minimum. Having thus determined the most probable value of x, we compute a final system of elements, with the geocentric distance $\Delta+x$ corresponding to the time t.

The application of these formulæ is not limited to the case of three observations. With an approximate value of Δ we may compute the elements from the extreme observations, and compare any number of intervening places, each of which will furnish two equations of condition for the determination of x. Should it be found that the residuals resulting from the final elements exceed the limits of the probable errors of the observations, the orbit cannot be a parabola, and it will be necessary to determine the excentricity.

Ann Arbor, Mich., December, 1862.

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[2] The coefficient β should not be confounded with the latitude β previously used.

ART. XXV.—*Geographical Notices.* No. XIX.

PHYSICAL GEOGRAPHY OF THE REPORT ON THE MISSISSIPPI RIVER, BY HUMPHREYS AND ABBOT.

THE report of Captain Humphreys and Lieut. Abbot of the Corps of Topographical Engineers of the United States Army, on the "Physics and Hydraulics of the Mississippi River," has already been noticed in this Journal, in an article which gave a conspectus of the entire work.[1] The universal interest now felt in everything which illustrates the Physical Geography of the United States, the importance of this elaborate survey of the most characteristic region of our country, and the difficulty of obtaining copies of so costly a volume lead us to refer again to some of the statements which are made by the authors.

The immediate occasion of this work, as the reader will remember, was an act of Congress directing a scientific survey of the Mississippi Delta, including such investigations as might tend to determine the most practicable plan for securing it from inundation, and the best modes of deepening the channels at the mouths of the river. The report, consequently, is chiefly devoted to the Physics and Hydraulics of the river, that is to say, to the laws of velocity and volume, and the possibility of so controlling the current, as to protect the regions adjacent to the delta from destructive floods, and so as to maintain the facilities of navigation in the channels near the gulf. But the topography and hydrography of the entire basin of the Mississippi, including all its various tributaries, are likewise elaborately discussed. It is to this portion of the report, the Physical Geography, that we now call attention. Our object will be to condense within a limited space, some of the geographical facts which the volume contains, so that those who cannot consult the work itself may turn here for such information. In doing this we shall confine ourselves, without comment, to the statements of the authors, generally employing their own language. We regret that the limit of this article compels us to omit some of the interesting details which their scientific zeal and thoroughness have brought together.

Regarding the true Mississippi river as beginning at the confluence of the Upper Mississippi and the Missouri, eight of its tributaries are so important as to be distinguished from all the rest. In the order of the magnitude of their basins, these are the Missouri, Ohio, Upper Mississippi, Arkansas, Red, White, Yazoo and St. Francis. They are described in the order of their geographical position, first the right bank and then the

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[1] [2], xxxiii, 181.

left, beginning with the southernmost, as follows: Red, Arkansas, White, St. Francis, Missouri, Upper Mississippi, Ohio and Yazoo.

1. *Red river Basin.*[2]—Few regions so limited in area, say the authors, are so diversified in character as this basin. While it includes only 97,000 square miles, large tracts of rich alluvion, a range of primitive mountains, numerous lakes, a rolling prairie, and a salt-desert tract are found within its borders. Capt. Marcy, U. S. A., first explored the sources of Red river in 1852. The general course of the stream is thus delineated in his report.

The Red river rises in the eastern rim of the vast desert plain known as *el Llano Estacado* at an elevation of about 2,500 feet above the sea. After flowing through a narrow ravine, some sixty miles in length, the river passes to the south of the Witchita Mts., the highest peak of which, Mt. Scott, is 1135 feet above its base. Beyond this, to the east, the river traverses "the cross timbers," an extensive belt of woodlands, which extend, between twenty and thirty miles in width, from the Arkansas river to the Brazos, some 400 miles. Still farther east, the celebrated Red river raft, an accumulation of drift logs, about thirteen miles long, obstructs the course of the stream. Below this, the river traverses a fertile and populous region, the character of which is well known.

The width of the Red river between its banks, eight miles below the point where it issues from the *Llano Estacado*, is 2700 feet; just below the mouth of the North fork, 2000 feet; about 50 miles below the mouth of this tributary, 2100 feet; at the mouth of the Big Witchita, 600 feet; at Alexandria, 720 feet; at mouth of Black river, 785 feet; at mouth, 1800 feet. These numbers indicate the characteristic variation in width. While traversing the sandy desert, the river spreads out to a width greatly disproportionate to the depth; but when the more fertile and clayey soil is entered, it contracts to the normal dimensions corresponding to its discharge.

The depth of Red river varies inversely as its width, being only 6 or 8 feet, even in floods, throughout the desert, while it is some 50 feet in the fertile region. In extreme low water, a depth of 3 feet may be depended upon below Alexandria, about 4 feet thence to the head of the raft, and one foot thence to Fort Towson.

Steamers of 4 feet draught can ascend to Shreveport at any time except in extreme low water, but to Fort Towson or even Fulton, for only about three months in the year, and they frequently only run in one direction during a single rise.

The river above the raft rises and falls more rapidly than the

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[2] **The river takes its name from the reddish color of the water, probably derived from the red gypsum over which it passes.**

Arkansas, and thus is less favorable to navigation. The raft also is a serious obstacle, as it requires the boats to leave the channel and pass through lakes and bayous.

The high-water area of cross-section throughout the desert country is probably about 12,000 square feet, and in the cultivated region from 30,000 to 40,000.

The range of the river is greatly affected by the raft. Thus at Fort Towson it is some 45 feet, the maximum (January 27, 1843) being 51 feet; at Fulton it is 35 feet; at the head of the raft, 10 feet; at Shreveport, 25 feet; at Alexandria, 47 feet; at the mouth, 45 feet. These numbers illustrate the effect of lakes in moderating floods.

The only important tributary of the Red river is the Black river, formed by the junction of the Washita, (the Indian name for Black,) Little river, and Bayou Tensas. It is only 54 miles in length.

The following figures exhibit the high water slope of Red river.

Locality.	Distance above mouth.	Elevation above gulf level.	Fall per mile.	Authority.
	Miles.	*Feet.*	*Feet.*	
Source, - - - - - -	1200	2450	0·00	Captain Marcy.
At Preston, - - - - -	820	641	4·80	Captain Pope.
At Fulton, - - - - -	595	242	1·80	Railroad levels.
At head of raft, - - - -	405	207	0·20	Mr. C. A. Fuller.
At Shreveport, - - - -	330	180	0·36	Railroad levels.
Mouth of Black River (high water 1828),	30	58	0·41	Delta Survey.
Mouth (high water 1828), - -	00	54	0·14	Delta Survey.

2. *Arkansas and White River Basin.*—This basin includes an area of 189,000 sq. m., the western portion of which lies among the summits of the Rocky Mountains, the middle portion comprises the great sterile plain between the mountains and 97° west long., and the eastern part, the rich alluvion of the Mississippi valley. Although diversified in climate and production, less than half this area is fitted to supply the wants of a civilized people.

Lieut. Pike, U. S. A., explored the sources of the Arkansas river in 1806. They lie among the Mts., west of the South Park, in lat. 39° and long. 106°, about 10,000 ft. above sea level. Half this elevation is lost in the first 150 miles. The stream then traverses a sterile hilly region, the hills gradually diminishing in size, till they subside into the plain westward of Bent's Fort, near 104° W. long. Maj. Emory's Report on Gen. Kearny's route in 1846 describes the river between Bent's Fort and Great Bend. It is seldom over 150 yards wide, and generally fordable. The bottom land a few feet above the water level varies from half a mile to two miles and is generally covered with good nutritious grass. Beyond Bent's Fort to the east, the 'big timber' is found, a thinly scattered growth of large cottonwoods.

Thence to Fort Smith, the river is described by Capt. Bell, who explored it in 1820. The bluffs here approach close to the river bed. Ravines become more abundant and like the river banks are well wooded. The water becomes slightly brackish from the saline springs near the right bank. Below the Cimmaron the river loses its pale clay hue and becomes reddish. Fort Gibson marks the head of navigation, beyond which the river, in the remaining 642 miles, traverses a fertile and settled region.

"The width of the Arkansas undergoes great variations. Near the mountains it does not exceed 150 feet. It gradually increases to about a mile, as it traverses the sandy desert. After entering the hilly and fertile region it varies from 1000 to 2000 feet.

The depth of the Arkansas also varies greatly in different parts of its course. Throughout the prairie region it averages about two or three feet, exclusive of shoals, but there are seasons when the water entirely disappears, being absorbed by the immense beds of sand in which its channel is formed. In the navigable part of the river the least depth found upon the bars in extreme low water, from the mouth to the Post of Arkansas, is from 2·5 to 3·0 feet; thence to Little Rock, two feet; thence to Fort Gibson, one foot.

The range of the river between low and high water is about 45 feet at Napoleon; 40 feet at South bend; 35 feet at Little Rock; 25 feet at Fort Smith; 10 feet at Fort Gibson, and still less at points above. These numbers do not represent the *extreme* ranges, although they are much greater than those that usually occur.

There are generally three annual rises in the Arkansas. As observed by Colonel Charles Thomas, U. S. Army, who served at Fort Gibson many years, they are as follows: One usually begins in February, owing to the winter rains, and lasts, on an average, about fifteen days. The next—the principal rise in the year—is occasioned by the melting snows in the mountains and the late spring or early summer rains. It occurs in May and June, and continues into July, and sometimes into August. The river generally keeps up, between these two rises, some one or two feet above its lowest stage. The last rise is in November, produced by the late autumn rains, and lasts from ten to twenty days.

Steamboats from three to four feet draught can almost always reach a point some 40 miles above Little Rock, and during the floods can reach as far as Fort Smith and Fort Gibson, with a fair prospect of being able to return. Both the Canadian and Arkansas have been navigated with small steamers as far up as the wants of the military service have required. Steamers of eight feet draught have reached Fort Smith, but their return during the same rise is not certain. The river is generally very low after the November rise. During the lowest stage it is difficult for boats of the lightest draught to reach Fort Smith.

The greatest flood of the Arkansas on record occurred in 1833. Authorities differ as to its relative height at Little Rock, but the evidence tends to the conclusion that it exceeded any subsequent flood by at least two feet."

The high water slope of the Arkansas is thus stated:

Locality.	Distance above mouth.	Elevation above sea level.	Fall per mile.	Authority.
	Miles.	*Feet.*	*Feet.*	
Source, - - - - - -	1,514	10,000	0·00	Captain Fremont.
Mouth of Boiling-spring river,	1,364	4,880	34·13	"
Mouth of Apishpa creek, -	1,323	4,371	12·41	Captain Gunnison.
Near Bent's fort, - - -	1,289	3,672	20·56	"
Near Fort Atkinson, - -	1,095	2,331	6·91	"
Great bend, - - - - -	992	1,658	6·53	Major Emory.
Near Fort Gibson, - -	642	560	3·14	
Near Fort Smith, - - -	522	418	1·18	Lieutenant Whipple.
Near Little Rock, - - -	250	252	0·61	Railroad levels.
Mouth, - - - - - -	0	162	0·36	Railroad levels.

The Arkansas has two noteworthy tributaries. The Canadian, which rises in the Raton pass, 6000 feet above sea level, after traversing in a course of 1000 m. the same barren region through which the Arkansas flows, empties into the latter midway between Forts Smith and Gibson. The White River drains the fertile region which crosses the Arkansas above Fort Gibson. Its sources are about 1200 feet above the Gulf.

3. *St. Francis Basin.*—This region, including an area of 10,500 sq. m., consists of the St. Francis bottom and its watershed.

> "By the former is understood the belt of swamp lands and low ridges lying between the Mississippi river and the line of high hills which extends almost continuously from Cape Girardeau to Helena. Some small portions of this area do not drain into the St. Francis river, but, being similar in character, the entire region is properly designated by a general name.
>
> A portion of the southern slope of the Ozark mountains constitutes the chief watershed of this region.
>
> As the St. Francis bottom lands are the most northern of those regions which have been generally considered "vast reservoirs for the flood waters of the Mississippi," great efforts have been made to collect all possible information about their real character. Extended personal inquiries and measurements have been made in many different localities. The surveys of the military road from Memphis to the St. Francis river, made by Dr. William Howard, U. S. civil engineer, in 1833; those of the Memphis and Little Rock railroad company, made in 1854; those of the Fulton and Little Rock railroad company, made in 1855 (?); and those of the route from St. Louis to Fulton, made in 1850, under the direction of the Bureau of Topographical Engineers, War Department, by Joshua Barney, C. E., have all been carefully studied. Much assistance has also been derived from the admirable chapter upon the swamp lands of southeastern Missouri, contained in the report of Messrs. O'Sullivan and Morley, engineers of the St. Louis and Iron Mountain railroad company, and published with the second annual report of the board of directors of that road (St. Louis, 1854). Together with its accompanying maps, this work furnishes nearly all the general information which could be desired about the Missouri portion of these bottom lands.

Boundaries and areas.—The St. Francis bottom is bounded as follows: Starting at Cape Girardeau, on the Mississippi river, the line runs a little south of west to the northwest corner of T. 29, R. 11, east; thence southwest to the St. Francis river, near the northeast corner of T. 26, R. 7, east; thence south along the St. Francis river[3] to the southeast corner of T. 22, R. 8, east; thence southwest to the northeast corner of T. 14, R. 4, east; thence nearly south to the middle of T. 3, R. 3, east; thence to Helena, and thence, following the Mississippi river, to Cape Girardeau. Within these limits there are many isolated ridges entirely above overflow.

The limits of the watershed of the St. Francis basin can be readily and exactly traced upon Hutawa's sectional map of Missouri, by following the divide which separates small streams running to and from the bottom lands. The Ozark slope constitutes fully two-thirds of the entire region.

The following table has been carefully computed in accordance with the above boundary, and is believed to be quite accurate:—

	Square miles.
Watershed of St. Francis bottom lands, ...	3,600
Ridges known to be above overflow in St. Francis bottom lands,......	600
Lands liable to be submerged in " " "	6,300
Total area of St. Francis basin,........................	10,500

Topography.—The northern watershed is a broken, hilly country, sloping very abruptly to the bottom lands. Its mean descent southward is about 1200 feet in 70 miles, or at a mean rate of about 17 feet per mile.

The swamp region is, in general character, a great plain sloping from north to south at a mean rate of about 0·7 of a foot per mile, judging by the fall of the Mississippi between Cape Girardeau and Helena; and from east to west at a mean rate of about 0·5 of a foot per mile, judging by the levels of the Memphis and Little Rock railroad, which crossed the bottom near the middle line. This country is separated from the rolling praries west of it, which drain into White river, by a single narrow ridge averaging 300 feet in height."

4. *Missouri Basin.*—[The account of this basin having already been given in these pages, [2], xxxiii, p. 185, we omit it in this place.]

5. *Upper Mississippi Basin.*—Although the Upper Mississippi is neither the longest tributary, nor the greatest contributor of drainage, nor the branch most like in character to the great Mississippi, it bears its name and has thus always been an object of especial interest to geographers.

"The distinguishing characteristic of this portion of the Mississippi basin is the entire absence of mountains. Near the source of the river, the country is only some 1600 feet above the level of the sea, and is covered with swamps and lakes, divided by hills of sands and boulders be-

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[3] The St. Francis river, when in flood, loses some of its water in this vicinity by bayous connecting with Black river, a tributary of White river of Arkansas.

longing to the Drift epoch. The middle and southern portions of the basin consist of prairie land, and are rapidly becoming cultivated. The agricultural and mineral resources of this basin are great, the climate is salubrious, and the country must eventually sustain a large and wealthy population. Its total area is 169,000 square miles."

Lake Itasca, in which the Upper Mississippi rises, is described by Mr. Schoolcraft as a beautiful sheet of deep water, seven miles long and from one to three broad. Nicollet, in 1836, determined its geographical position and elevation to be 47° 14′ N. lat., 95° 02′ W. of Greenwich. The elevation of the lake, by barometrical observations, he places at 1575 feet above the ocean level.

The Mississippi passes through several lakes and by successive rapids and waterfalls to the Falls of St. Anthony where it falls in less than three quarters of a mile a distance of 65 feet. Two tables given in the report exhibit the most important facts respecting this region.

Low-water slope of Upper Mississippi.

Locality.	Distance above mouth of Missouri	Elevation above sea.	Fall per mile.	Authority.	Remarks.
	Miles.	*Feet.*	*Feet.*		
Utmost source, - -	1330	1680	0·00	Mr. Nicollet.	
Itasca lake, - - -	1324	1575	17·50	"	
Entrance to Lac Travers,	1234	1456	1·32	"	
Entrance to lake Cass,	1189	1402	1·20	"	10 miles through lakes.
Mouth Leech-lake river,	1109	1356	0·57	"	35 miles through lakes.
Head of falls of Peckagama,	1061	1340	0·33	"	
Mouth Swan river, -	998	1290	0·73	"	Rapids intervening.
Mouth Sandy-lake river,	960	1253	0·95	"	Rapids intervening.
Mouth Pine River, -	863	1176	0·79	"	Rapids intervening.
Mouth Crow-wing river,	815	1130	0·95	"	Rapids intervening.
St. Paul, - - -	658	670	2·93	R. road levels.	Sauk rapids, falls of St. Anthony, etc.
La Crosse, - - -	514	639	0·22	" "	
Prairie du Chien, -	453	600	0·64	" "	
Head Rock Island rapids,	310	505	0·66	" "	
Foot " " "	295	483	1·47	" "	Rapids intervening.
Mouth, - - -	0	381	0·35	" "	Des Moines rapids intervening (low-water fall 21 feet).

"These elevations refer to the low water of the Mississippi. The range between high and low water level is about 20 feet near Sandy-lake river; about 20 feet at St. Paul; about 10 feet (extreme, 14 feet) at La Crosse; about 12 feet (in 1858, 18·5 feet) at Prairie du Chien; about 16 feet at Rock Island; about 20 feet at Hannibal, and about 35 feet at the mouth. These ranges are much less than those of the Ohio, and, excepting the Missouri, of the other tributaries of the Mississippi, where they pass through the cultivable region. Their small extent is due to the generally flat character of the basin, from which the drainage is consequently slow; the existence upon it of numberless lakes; the great width of the river; the gradual change in season that takes place along its course; and the comparatively dry climate of the upper part of the basin."

The following table exhibits a correct list of the tributaries.

Name.	Distance of mouth above mouth of Missouri.	Length of Tributary.	Remarks.
	Miles.	Miles	
Source branch,	1324		Itasca lake.
Turtle river,	1180	40	Cass lake.
Leech-lake river,	1109	50	
Mash-kudens river,	1055		
Swan river,	998		Rapids intervening.
Sandy-lake river,	960		"
Willow river,	930		
Pine river,	863	140	"
Crow-wing river,	815		"
Nokay river,	806		
Belle Prairie creek,	796		
Elk creek,	782		
Pike creek,	787		
Swan river,	786		
Two rivers,	777		
Spunk river,	773		
Platte river,	771		
Little Rock creek,	760		
Watab and Winnebago rivers,	757		
Lower Watab,	754		
Sauk river,	752		Rapids 1 mile.
Nechoado river,	744		
Clear-water river,	736		
Elk or St. Francis river,	705	100	
Crow river,	699		
Rum river,	690	150	
Rice river,	683		
St. Peter's river,	663		
St. Croix river,	631	168	
Vermilion river,	630		
Cannon river,	611	82	
Chippeway river,	581	165	
Embarras river,	562		
White river,	560		
Black and La Crosse rivers,	516	128[1]	
Root river,	511	83	
Upper Iowa river	489		
Wisconsin river,	448	338	
Turkey river,	425		
Wabesipinnicon river,	320	205	
Rock river,	291	245	
Cedar river,	245	255	
Skunk river,	205		
Des Moines river,	165	402	
Illinois river,	24	397	
Missouri river,	0		

[1] Black river.

6. *Ohio Basin.*—

"The Ohio river drains the northeast portion of the Mississippi basin —a fertile and populous region throughout nearly its whole extent. The southern tributaries rise in the Alleghany mountains, and flow northward through an undulating and beautiful country to the main stream. The northern tributaries have their source in the crest of the level plateau which lies immediately south of the great lakes, at an elevation varying from 500 to 1000 feet above their water surfaces, and flow southward through a fertile prairie and undulating country to the Ohio. The boundaries of the basin are indicated on plate I, and its character is so well known as to require no description here. Its total area is 214,000 square miles.

Ohio River.—The Ohio is formed by the junction of the Alleghany and Monongahela rivers. The former, which is the principal branch, rises in the mountains of Pennsylvania, the latter in those of Virginia. Throughout its whole length (975 miles) the river flows with a gentle current, uninterrupted by rapids except at the "falls of Ohio" near Louisville, when it descends 26 feet in three miles. It traverses a beautiful valley and is constantly augmented by tributary streams.

The Ohio in low water is a succession of long pools and ripples, with a current alternately sluggish and rapid. The bars in the upper part of the river are mainly composed of gravel, and in the lower part, of shifting sand.

Of the Alleghany branch, nothing need be said except that near its sources it flows between hills, through a very narrow strip of fertile bottom land, and with a more uniform slope than near the mouth, where it traverses a rocky and precipitous ravine, with a bed composed mainly of sandstone or gravel-bars. [Captain Hughes, Topl. Engrs., U. S. A.]

Of the Monongahela branch, some curious facts stated by Dr. William Howard in 1833 merit attention. It rises in the Alleghany mountains and subordinate ranges in Virginia, and is formed by the junction of the East and West branches and Cheat river. The former streams head in Laurel ridge, and flow in rocky channels. The tributaries of Cheat river rise in the summit of the Alleghanies, and form mountain torrents until they unite in a river scarcely less wild than themselves. The Cheat forces its way through deep gorges with nearly perpendicular side slopes to the Monongahela, falling 2400 feet in the last 80 miles. Below the junction the river is gentle in character. It winds with a serpentine course, without islands, through a terraced valley. Its slope here is *less than that of the Ohio.* Thus the fall from the mouth of Cheat river to Brownsville (35 miles) is 44 feet, or 1·26 feet per mile, and from Brownsville to Pittsburg (55 miles) only 31 feet, or 0·56 of a foot per mile; while the corresponding fall of the Ohio near Pittsburg is about one foot per mile. The fall of the Monongahela, above the junction of Cheat river, averages about two feet per mile for over 100 miles. The anomaly in slope near the mouth of this river is less in high than in low water, the usual range at Brownsville being 15 or 20 feet more than that at Pittsburg. At low water the Monongahela is a succession of pools separated by bars composed of gravel and loose stones, not subject to sudden changes. Its water is quite free from sedimentery matter."

Low-water slope of the Ohio, according to Ellet.

Locality.	Distance above mouth.	Elevation above tide.	Fall per mile.
	Miles.	*Feet.*	*Feet.*
Mouth of Ohio,	0	275	0·00
Mouth of Wabash (approximately),	130	297	0·17
Evansville (approximately),	187	320	0·25
New Albany, below the falls,	358	353	0·20
Louisville, above the falls,	361	377	8·00
Cincinnati,	515	432	0·36
Portsmouth,	620	474	0·40
Mouth of Great Kanawha,	714	522	0·51
Head of Le Tart's shoals,	769	555	0·60
Marietta (mouth of Muskingum),	800	571	0·52
Wheeling,	889	620	0·55
Pittsburg,	975	699	0·92
Franklin,	1105	960	2·00
Warren,	1175	1187	3·24
Chautauque lake,		1306	
Olean point,	1225	1403	4·32
Mouth of Oswaya,		1419	
Smithport,		1480	
Coudersport,	1265	1649	6·15
Surface of lake Erie,		565	

"It will be noticed that these elevations correspond to the low-water period. The range between extreme low and extreme high water seems to be about 45 feet throughout the entire river. Thus, at Wheeling, it is 45 feet; at Louisville, 42 feet *on* the falls and 64 feet *below* them;[1] at Evansville, 40 feet; at Paducah, 51 feet; and at the mouth of the river, 51 feet. The usual range does not exceed 25 feet."

7. *Yazoo Basin.*—The Yazoo basin, having an area of 13,850 square miles, consists of the Yazoo bottom and its watershed. The Yazoo bottom is an alluvial tract, oval in shape, bordering on the Mississippi between Memphis and Vicksburg. It consists of 6800 square miles of lands liable to be submerged, 310 square miles of ridges and 6740 square miles of lands draining into the bottom. It is in general a vast densely timbered plain, sloping from the Mississippi toward the east at a mean rate of about 0·4 of a foot per mile. There are three classes of land in the Yazoo bottom, "high land," rarely overflowed, middle land, overflowed during the wet season, and the low "cypress swamps," parts of which always contain water.

The Yazoo river, from its proper source, Horn Lake, to the Mississippi, is about 500 miles long, and is navigable 240 miles to Greenwood, for boats drawing two or three feet. Indian mounds are found through the entire bottom.

8. *Basins of Small Direct Tributaries.*—Four of these will be noticed. Their total area is 32,400 square miles. This country is situated where the rain is greatest, and contributes more than is generally supposed to the discharge of the river.

"*Maramec basin.*—The northern slope of the eastern portion of the Ozark mountains drains into the Maramec river, a stream which enters the Mississippi a few miles below St. Louis. This basin is hilly in character, containing no lands liable to inundation. Its area, taken from Hutawa's sectional map of Missouri, is 5470 square miles. This estimate includes all the country between the Missouri and Cape Girardeau, on the right bank, which drains directly into the Mississippi.

Kaskaskia basin.—Under this head is included all the region draining into the Mississippi on the left bank, between the mouth of the Missouri and the mouth of the Ohio. It is named from its principal stream, although there are others of considerable size—the Big Muddy, for instance. The country is mainly prairie, but, upon the immediate bank of the Mississippi, a considerable area is liable to inundation in great floods. The "American bottom," between the mouths of the Missouri and Kaskaskia rivers, contains the greater part of this swamp country, but there is another limited belt above Cairo. The area of the whole basin is about 9420 square miles.

The Kaskaskia river itself resembles the Illinois. It flows with a very crooked course through a heavily timbered alluvial bottom, liable to be overflowed to a depth of eight or ten feet in freshets. Its bed is almost dry in the summer, but when high the stream has a strong current.

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[1] At a medium stage of water, a rise of one foot on the falls makes a rise of about three feet below them, until the water on the falls is about five feet deep. Subsequently, the rate of rise below is rather less than two feet.

Obion basin.—Between the Ohio river and the head of the Yazoo basin lies an extended tract of country, which, for want of a better name, has been designated the Obion basin. It is drained by four nearly parallel rivers: the Obion, the Forked-deer, the Hatchee, and the Wolf; the Hatchee alone being, properly speaking, a navigable stream. The area of the entire region is about 10,250 square miles.

This region is in the main an upland, hilly country, but, as shown on plate II, the Obion and Forked-deer rivers flow through somewhat extensive swamps near their mouths. It is generally believed that the great earthquake in 1811, which depressed so much country on the opposite bank, materially increased the area of these swamps.

The Hatchee river, before certain railroads were built, was an important avenue for transporting cotton from the interior to the Mississippi. It is navigable to Bolivar—some 150 miles—from four to six months in the year; its usual range between low and high water being about 15 feet at Bolivar and 30 feet at its mouth. Its average high-water width is about 350 feet, and its high-water cross-section about 8000 square feet.

Big-Black basin.—The region draining into the Mississippi between the mouth of the Yazoo river and the alluvial lands below Baton Rouge is classed under this general head. It is drained by many streams, the two principal being the Big Black, which enters the Mississippi just above Grand Gulf, and the Homo Chitto, which enters below Ellis cliffs. Excepting a narrow strip along the immediate bank of the Mississippi, this whole basin is made up of a rolling, hilly country, entirely above any danger of inundation. Its area is about 7260 square miles."

Following this account of the various tributaries of the Mississippi, the authors proceed to discuss the river itself below the mouth of the Missouri. This is done in the second chapter of their volume, the contents of which have been given in the article already referred to (vol. xxxiii, p. 187). We hope to revert again to this portion of the report, and perhaps to other geographical discussions which the volume contains.

The figures which illustrate the character of the main river and also of the tributaries described in the present article, are summed up in the following tables, which will be of permanent value to all who are interested in the study of the great Mississippi valley. In conclusion, we desire to express our admiration of the thorough and comprehensive manner in which the investigations of Messrs. Humphreys and Abbot have been conducted. The work reflects the highest honor upon the fidelity, patience and science of the distinguished authors.

TABULAR VIEW OF THE MISSISSIPPI AND ITS TRIBUTARIES.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks.	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
	Miles.	Feet. low water	Feet.	Feet.	Feet.	Feet.	Sq. feet.
Ohio river.							
Coudersport,	1265	1649					
Olean point,	1225	1403	6·15				
Warren,	1175	1187	4·32				
Franklin,	1105	960	3·24				
Pittsburg,	975	699	2·00	1200			50,000
Wheeling,	889	620	0·92		1·0	45	
Marietta,	800	571	0·55				
Head Le Tart's shoals,	769	555	0·52				
Mouth Great Kanawha,	714	522	0·60				
Portsmouth,	620	474	0·51				
Cincinnati,	515	432	0·40		2·0		
Above falls,	361	377	0·36			42	
Below falls,	358	353	8·00			64	
Evansville,	187	320	0·20	3000	1·5	40	150,000
Mouth Wabash,	130	297	0·25				
Mouth,	0	275	0·17		3·0	51	

Remarks.—Area of basin, 214,000 sq. m.—Downfall of rain, 41·5 in.—Annual discharge, 5,000,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·24.—Mean discharge per second, 158,000 cu. ft.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks.	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
Upper Mississippi.		low water					
Utmost source,	1330	1680					
Itasca lake,	1324	1575	17·50	15			50
Entrance to Lac Travers,	1234	1456	1·32	150			
Entrance to Lake Cass,	1189	1402	1·20	175			1,400
Mouth Leech-lake river,	1109	1356	0·57	120			
Head falls of Peckagama,	1061	1340	0·33				
Mouth Swan River,	998	1290	0·73				
Mouth Sandy-lake river,	960	1253	0·95	300		20·0	
Mouth Pine river,	863	1176	0·79				
Mouth Crow-wing river,	815	1130	0·95	1200			
St. Paul,	658	670	2·93		2·0	20·0	100,000
La Crosse,	514	639	0·22	5000		14·0	
Prairie du Chien,	453	600	0·64			18·5	
Head Rock Isl'd rapids,	310	505	0·66			16·0	
Foot Rock Isl'd rapids,	295	483	1·47		2·0		
Mouth Missouri,	0	381	0·35			35·0	

Remarks.—Area of basin, 169,000 sq. m.—Downfall of rain, 35·2 in.—Annual discharge, 3,300,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·24.—Mean discharge per second, 105,000 cu. ft.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks.	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
Missouri river.		low water					
Source Madison fork,	2908	6800(?)					
Three forks Missouri,	2824	4319	29·52				
Mouth Sun river,	2689	3573	5·54				
Foot of falls,	2670	2964	31·59				
At Fort Benton,	2644	2845	4·56	1500	1·0	6	
At Fort Union,	1894	2188	0·88				
At Fort Pierre,	1246	1475	1·10	2500			
At Sioux City,	842	1065	1·01				
At St. Joseph,	484	756	0·86	3000		20	75,000
At mouth,	0	381	0·77			35	

Remarks.—Area of basin, 518,000 sq. m.—Downfall of rain, 20·9 in.—Annual discharge, 3,780,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·15.—Mean discharge per second, 120,000 cu. ft.

TABLE—CONTINUED.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
	Miles.	Feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.
Arkansas river.		high wat					
Source,	1514	10000		150			
Mouth Boiling spring r.	1364	4880	34·13				
Mouth Apishpa creek,	1323	4371	12·41				
Near Bent's Fort,	1289	3672	20·56	5000			
Near Fort Atkinson,	1095	2331	6·91		0·0	6	30,000
Great bend,	992	1658	6·53				
Near Fort Gibson,	642	560	3·14	1500	1·0	10	70,000
Near Fort Smith,	522	418	1·18			25	
Near Little Rock,	250	252	0·61		2·0	35	
Mouth,	0	162	0·36			45	

Remarks.—Area of basin (including White r.), 189,000 sq. m.—Downfall of rain (including White r.), 29·3 in.—Annual discharge (including White r.), 2,000,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·15.—Mean discharge per second (including White r.), 63,000 cu. ft.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
Red river.		high wat.					
Source,	1200	2450		2000		8	12,000
At Preston,	820	641	4·80			40	
At Fulton,	595	242	1·80	800	1·0	35	40,000
At head of raft,	405	207	0·20			10	
At Shreveport,	330	180	0·36		3·0	25	
Mouth Black river,	30	58	0·41			45	
Mouth,	0	54	0·14				

Remarks.—Area of basin, 97,000 sq. m.—Downfall of rain, 39·0 in.—Annual discharge, 1,800,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·20.—Mean discharge per second, 57,000 cu. ft.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
Yazoo river.		high wat.					
Horn lake,	500	210					
Greenwood,	240	140	0·27	850	2·5	36	17,000
Mouth,	0	103	0·16			48	50,000

Remarks.—Area of basin, 13,850 sq. m.—Downfall of rain, 46·3 in.—Annual discharge, 1,350,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·90.—Mean discharge per second, 43,000 cu. ft.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
St. Francis river.		high wat.					
Source,	380	1150					
Head swamp region,	275	330	7·81				9,400
Chalk bluffs,	225	280	1·00				2,300
M. and L. R. railroad,	55	209	0·42	700		40	21,000
Mouth,	0	200	0·16				37,000

Remarks.—Area of basin, 10,500 sq. m.—Downfall of rain, 41·1 in.—Annual discharge, 990,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·90.—Mean discharge per second, 31,000 cu. ft.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
Main Mississippi.		high wat.					
Mouth of Missouri,	1286	416·0			2·0		
St. Louis,	1270	408·0	0·500			37·0	
Cairo,	1097	322·0	0·497	4470		51·0	191,000
Columbus,	1076	310·0	0·571		5·0	47·0	
Memphis,	872	221·0	0·436			40·0	
Gaines' landing,	647	149·0	0·320	4030	6·0		199,000
Natchez,	378	66·0	0·309			51·0	
Red-river landing,	316	49·5	0·266			44·3	
Baton Rouge,	245	33·9	0·220	3000		31·1	200,000
Donaldsonville,	193	35·8	0·156			24·3	
Carrolton,	121	15·2	0·147	2470		14·4	199,000
Fort St. Philip,	37	5·2	0·119			4·5	
Head of passes,	17	2·9	0·115			2·3	
Gulf,	0	0·0	0·171			0·0	

Remarks.—Drainage area, 1,244,000 sq. m.—Downfall of rain, 30·4 in.—Annual discharge (including 3 outlet bayous), 21,300,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·25.—Mean discharge per second, 675,000 cu. ft.

RECENT EXPLORATIONS ENCOURAGED BY THE SMITHSONIAN INSTITUTION.

Those who have paid attention to the Reports of the Smithsonian Institution are aware that one method by which that establishment has contributed to the advancement of science has been the encouragement of expeditions in different parts of this continent, for the collection of specimens in natural history, and for the observation of physical phenomena. The report recently distributed, which covers the proceedings of the Institution for the year 1861, contains some interesting information respecting the progress of several explorations.

Explorations in the Peninsula of California, by Mr. John Xantus.—Mr. Xantus, having previously distinguished himself as a collector in natural history, by the researches which he made from the summer of 1857 to the autumn of 1858, in the neighborhood of Fort Tejon,—was placed by the superintendent of the Coast Survey, Prof. Bache, in charge of a tidal station at Cape St. Lucas. He reached the cape in April, 1859, and since that time he has made, says Prof. Baird, "collections which vie in thoroughness with those of Fort Tejon, and exceed them in number of species, embracing as they do marine as well as fresh water and land forms." In another connection, we learn from Prof. Baird, the following noteworthy facts. Besides the addition of a larger number of new animals to our fauna than has been made by one person in any single region of North America before, Mr. Xantus has shown that the most interesting relationship exists between the land species of the Cape and those of the region of the Gila, Upper Rio Grandé, and the southern Rocky Mountains. On the other hand, very few of the characteristic species of the coast of Upper California occur at the Cape; while, as far as observed, the same may be said of the strictly Mexican types. The entire Peninsula thus proves to be as specially related to North America in its land fauna as is Florida, although the number of peculiar species is much greater.

The marine fauna of Cape St. Lucas proves to be quite Panamaic in its general features—much more so than that of the opposite coast of Mexico.

The whole of the collection made by Mr. Xantus had not arrived in Washington when the report for 1861 was closed, but sixty boxes, some of large size, had been received. It is known that he has collected about twenty new birds, as many reptiles, large numbers of fishes, crustaceans, and other groups in proportion. The collection of shells is much larger than any ever made on the west coast, with the exception of that made by Mr. Reigen, forming the basis of the report on Mazatlan shells, by Mr. Carpenter, and is superior to any other in the extent of the species preserved entire in alcohol.

In addition to the thorough exploration of the region immediately round Cape St. Lucas and the mountains of the vicinity, Mr. Xantus pushed his examinations many leagues up the coast, both on the ocean and gulf side, and also to a number of the neighboring islands, Socorro, Tres Marias, etc. He also made a visit to Mazatlan, and secured a valuable collection of birds. Mr. Xantus has now returned to the east, and the new species which he discovered are in process of elaboration and will shortly be published. Partial reports have already been made by Mr. Xantus on the Birds; on the Reptiles by Mr. Cope; on the Fishes by Mr. Gill; on the Insects by Dr. Le Conte; on the Crustacea and Asteriadæ by Mr. Stimpson; on the Ophiuridæ by Mr. Lyman; on the Myriapoda by Mr. Wood; on the Bats by Dr. Allen; on the Plants by Dr. Gray. The conchology is in the hands of Mr. P. P. Carpenter.

It is proposed, when all these examinations are completed, to combine their results in one general memoir on the Natural History of the Cape, which will then be as well known, or even better known than the extremity of the corresponding peninsula of Florida.

We copy, from Prof. Baird's report for 1861, the following statements respecting the other recent explorations in which the Smithsonian Institution has been concerned.

"*Exploration of the Hudson's Bay territory by Mr. Kennicott.*—At the date of the last advices from Mr. Kennicott, when the Smithsonian Report for 1860 was presented, he was at Fort Resolution, on Slave lake, where he had spent the preceding spring and summer, principally in collecting eggs of birds. He left Fort Resolution in August, 1860, and returned to Fort Simpson and proceeded immediately down the Mackenzie to Peels river. From Peels river he crossed the Rocky mountains to La Pierre's house, occupying four days in the transit, and arriving September 18th; left the next day for Fort Yukon, at the junction of Porcupine or Rat river and the Yukon or Pelly river, in about latitude 65° and longitude 146°. Fort Yukon, the terminus of his journey, was reached on the 28th of September, 1860.

The latest advices now on file from Mr. Kennicott were written January 2, 1861, up to which time he had made some interesting collections; but these, of course, were limited by the season. He had great expectations of success during the following spring, (of 1861,) which have no doubt been abundantly realized.

No collections were received from Mr. Kennicott in 1861, with the exception of a few specimens gathered in July and August, 1860, on Slave lake. Those made at the Yukon will, however, in all probability come to hand in October or November of 1862.

Mr. Kennicott expected to remain at the Yukon until August, 1861, then to start for La Pierre House and Fort Good Hope, possibly to Fort Simpson, to spend some months, and endeavor by early spring to reach Fort Anderson, near the mouth of Anderson river, (a stream between the Mackenzie and Coppermine rivers,) and in the barren grounds close to the Arctic ocean. At Fort Anderson he expected to collect largely of the skins and eggs of birds, rare mammals, &c., and to return to Fort Simpson in the autumn, (of 1862,) then to arrive at Fort Chipewyan, on Lake Athabasca, by the spring of 1863, so as to get back to the United States by the winter of the same year.

For a notice of the continued aid to Mr. Kennicott, rendered by the gentlemen of the Hudson's Bay Company, I have to refer to the next division of my report.

Exploration of the Hudson Bay territory by officers of the Hudson Bay Company.—The gentlemen of many of the Hudson Bay Company's posts have largely extended their important contributions to science, referred to in the preceding report. A large proportion of the principal stations have thus furnished collections of specimens and meteorological observations of the highest value, which, taken in connexion with what Mr. Kennicott is doing, bid fair to make the Arctic natural history and physical geography of America as well known as that of the United States.

Pre-eminent among these valued collaborators of the Institution is Mr. Bernard R. Ross, chief factor of the Mackenzie River district, and resident at Fort Simpson. Reference was made in former reports to his contributions in previous years; those sent in 1861 are in no way behind the others, embracing numbers of skins of birds and mammals, some of great variety, insects, &c., besides very large series of specimens illustrating the manners and customs of the Esquimaux and various Indian tribes. Mr. Ross has also deposited some relics of Sir John Franklin, consisting of a gun used by him in his first expedition, and a sword belonging to the last one, and obtained from the Esquimaux. Mr. Ross is at present engaged in a series of investigations upon the tribes of the north, to be published whenever sufficiently complete, and illustrated by numerous photographic drawings.

In making up his transmissions to the Institution, Mr. Ross has had the co operation of nearly all the gentlemen resident at the different posts in his district, their contributions being of great value. Among them may be mentioned Mr. James Lockhart, Mr. William Hardisty, Mr. J. S. Onion, Mr. John Reed, Mr. N. Taylor, Mr. C. P. Gaudet, Mr. James Flett, Mr. A. McKenzie, Mr. A. Beaulieu, &c.

Second in magnitude only to those of Mr. Ross are the contributions of Mr. Lawrence Clarke, Jr., of Fort Rae, on Slave lake, consisting of many mammals, nearly complete sets of the water fowl, and other birds of the north side of the lake, with the eggs of many of them, such as the black-throated diver, the trumpeter swan, &c.

Other contributions have been received from Mr. R. Campbell, of Athabasca; Mr. James McKenzie, of Moose Factory; Mr. Gladmon, of Rupert House; Mr. James Anderson, (a) of Mingan; Mr. George Barnston, of Lake Superior; and Mr. Connolly, of Rigolette. Mr. McKenzie furnished a large box of birds of Hudson Bay, while from Mr. Barnston were received several collections of skins, and eggs of birds, new and rare mammals, insects, fish, &c., of Lake Superior.

It may be proper to state in this connexion that the labors of Mr. Kennicott have been facilitated to the highest degree by the liberality of the Hudson Bay Company, as exercised by the directors in London, the executive officers in Montreal, (especially Mr. Edward Hopkins,) and all the gentlemen of the Company, in particular by Governor Mactavish, of Fort Garry, and Mr. Ross. In fact, without this aid the expense of Mr. Kennicott's exploration would be far beyond what the Institution could afford, even with the assistance received from others. Wherever the rules of the company would admit, no charge has been made for transportation of Mr. Kennicott and his supplies and collections, and he has been entertained as a guest wherever he has gone. No charge also was made on the collection sent from Moose Factory to London by the company's ship, and in every possible way this time-honored company has shown itself friendly and co-operative in the highest degree to the scientific objects of the Institution.

Northwest Boundary Survey, under Mr. Archibald Campbell.[3]—This expedition has finally completed its labors in the field and returned to Washington, bringing rich results in physical science, as well as important collections in natural history. These, with what were previously sent hither from time to time, are in progress of elaboration, and reports are in preparation to be presented to Congress when completed.

It is with deep regret that I have to announce the death at sea, on his homeward voyage in February last, of Dr. C. B. Kennerly, the surgeon and naturalist of the Boundary Survey. Connected with this expedition from its beginning, in 1857, and, in conjunction with Mr. Gibbs, making the principal portion of its collections, his report on them would have been one of great value. For many years prior to 1857, however, he had been in intimate relations with the Institution as a collaborator, first while resident at his home, at White Post, Clark county, Virginia, then in 1853, as surgeon and naturalist to the Pacific Railroad Survey of Captain Whipple along the 35th parallel, then in the same relationship to the Mexican Boundary Survey, under Colonel Emory, in 1855. No one of the gentlemen who have labored so zealously to extend a knowledge of the natural history of the west within the last ten or twelve years has been more successful than Dr. Kennerly. Many new species have been first described by himself or from his collections, while his contributions to the biography of American animals have been of the highest interest.

REPORT OF THE SUPERINTENDENT OF THE U. S. COAST SURVEY FOR 1860.

The promise of a paper illustrating the recent progress of the U. S. Coast Survey, has led us to postpone any notice of the report of the Superintendent for 1860, until it is almost time for us to expect the publication of the report for 1861. But as this

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[3] Compare Dr. Hayden's account of this survey, Geog. Notices, No. XVII, this Journal, [2], xxxiv, 99.

Journal reaches many who do not see the Superintendent's elaborate review of the operations of the survey, we here transcribe those paragraphs which exhibit the chief geographical results of the year in question. The importance of the survey has never been more apparent than it is at present. The wisdom, energy and science of the Superintendent are more and more evinced as the work of successive years is made known to the public.

General Statement of Progress.—The Atlantic triangulation, as the accompanying sketch (No. 37) shows, is continuous along the coast of twelve States from Pasamaquoddy to the boundary of North and South Carolina, a stretch of more than twelve hundred miles, measured in the most general way. With an interval of some fifty-four miles, which is diminished every year by the party at work there, the triangulation is again continuous over the coast of South Carolina to Cumberland sound, on the coast of Georgia, two hundred and eighty miles. Then there is an interval of twenty-seven miles, which this season will fill up to the St. John's river, Florida; and the triangles are again continuous to Matanzas inlet, south of St. Augustine. Two parties are working, from Matanzas inlet south, and from Indian river inlet north, to fill up that interval, to which a third will next season be added, proceeding north from Cape Florida. Another season or two at most will fill up the whole space from Cape Florida to Cape Sable, and along the keys from Key Biscayne to Key West and the Marquesas. Charlotte harbor is triangulated, and the work extends from Anclote key to Cedar keys, ninety miles; from Ocilla river, by St. Mark's and Apalachicola, to Cape San Blas, ninety-five miles; over St. Andrews's bay; includes East bay, Maria de Galvez, Escambia, and Pensacola bays; touches the entrance of Perdido bay; extends from Mobile bay one hundred and fifty miles to Lake Pontchartrain, and over Chandeleur and part of Isle au Breton sound to the delta of the Mississippi, the greater part of which it now includes; over Isle Dernière and Caillou bay; over Atchafalaya and Côte Blanche bays; and from East bay (Galveston) two hundred and fifteen miles, passing over Matagorda, Aransas, and Corpus Christi bays and their dependencies, to within one hundred and fifteen miles of the Rio Grande.

The progress on the western coast has not been less satisfactory, taking the newness of the survey there into consideration. It has included all the harbors of California and Oregon, and many of those of Washington Territory, especially those of Washington sound, Puget's sound, and Admiralty inlet, the straits of Haro and Rosario, and part of the Gulf of Georgia, in the northwest.

Having given, in my letter of last year, a statement of the progress of the astronomical and magnetic work, I need not repeat it here. The longitude problem has been steadily kept in view, and the occurrence of the total solar eclipse, the path of which crossed from the northwestern part of the United States, through Washington Territory and the British possessions, leaving the continent on the coast of Labrador, has been made available for the correction of longitudes and of the lunar tables by parties sent out for the purpose in connection with those of other departments of the government, and in correspondence with the great astronomical expeditions of Europe.

The number of geographical determinations published by the Coast Survey, exclusive of those made within the past year, is seven thousand one hundred and seventy-eight; the magnetic variations given are upwards of two hundred; the tidal constants for harbors and coasts, one hundred and ten; and the maps and charts of harbors, bays, inlets, sounds, shoals, &c., drawn, engraved, and published, three hundred, exclusive of progress sketches and diagrams."

Maps and Charts.—"Within the past year, one hundred and eleven sheets have been worked on in the Drawing Division. Of this number, nine are finished charts, thirty-nine are coast maps and charts, twenty-one finished maps of special localities, sixteen preliminary, and two of the number are comparative charts. These are exclusive of twenty-four sketches of various kinds. Fifty-six of the sheets referred to have been completed, and fifty-five are in progress. Of those completed, twelve are maps and charts of the first class, and an equal number charts of special localities. Eight of the number are preliminary charts and two comparative charts; and the remaining twenty are sketches, amongst which are included those showing the field progress.

In the Engraving Division, eight first class maps and new editions of two have been completed during the year, and twenty-four are in progress. Of this class twenty-two were commenced in previous years and twelve within the present year. In addition, seventeen plates have been engraved of second class charts and sketches, and five plates of that class are yet in hand. This gives a total of twenty-seven plates completed and twenty-nine in progress, or of fifty-six plates engraved or engraving within the year.

The complete list, giving the titles of these maps and charts, is appended to the report of the assistant in charge of the office, and a general list of all that have been engraved up to the present date also accompanies it, (Appendix No. 19). The complete list includes three hundred and eleven titles, of which sixty-eight are of first class or finished maps. The total given is exclusive of seventeen plates of progress sketches.

Developments and discoveries.—During the year, in twenty localities important developments and discoveries were made, including the determination of various reefs and ledges, investigation of channels and currents, &c., with other like services to navigation.

Special Surveys.—Three special surveys, at the expense of local authorities, have been conducted during the year, viz: at Mobile, to ascertain the changes and condition of the bay; at Boston, for a like purpose; and on the peninsular of Cape Cod, to determine the feasibility of a canal connecting Buzzard's Bay and Cape Cod Bay.

Tidal Stations.—Six tidal stations have been maintained on the Atlantic coast, three on the Pacific, and two on the Gulf.

Measurements of heights.—In conjunction with the Smithsonian Institution, the Superintendent remarks, we have been engaged for some years in endeavoring to obtain all the data existing for heights in North America. During the past year a new circular has been issued to the engineers, presidents and superintendents of railroads, and to geologists, explorers, and other men of science, to obtain additional results, and with much success. To the entire number issued, two hundred and fifty replies have been received. These furnish data for the height above tide of about thirteen thousand points, of which a large portion has been contributed by the explorations for routes for the Pacific railroad, and a considerable number by other surveys of the Government. The material received has been mapped by Mr. W. L. Nicholson, who is charged with the details of the work, so as to indicate whether the data were likely to suffice for the construction of contour lines of the surface of the continent, and to show where they would be deficient for that purpose. Sources of information have been pointed out, of which we have not yet been fully able to avail ourselves, but the work has, in a general way, made good progress, and will be earnestly prosecuted."

Besides information on these various topics, the report contains an account of the expedition to Labrador, to observe the Solar Eclipse of July 18, Prof. Bache's Lecture on the Results of the Gulf Stream Explorations, a discussion of magnetic declination or variation, and the usual details respecting the apparatus and *personnel* of the establishment.

DESIDERATA IN EAST AFRICAN EXPLORATION.

The following Note was recently addressed to the Bombay Geographical Society, by a Committee of the Royal Geographical Society of London, in reply to certain inquiries.

"Beginning at the south, we may look upon the Nyassa as entirely in the hands of Livingstone and other Zambesi travellers, such as Count Thurnheim. Livingstone, as we know, has established easy access to the southern end of the lake, and announced his intention of exploring the whole of it at the earliest opportunity. It would be a waste of resources to direct new travellers to that same district.

Proceeding northward, the itineraries of native traders supply enough information for the present rude wants of African geography, of the country between Quiloa and Nyassa; and we have received slight but definite knowledge of the same through Röscher's ill-fated expedition, followed up as it was to some degree by Baron von der Decken.

Taking yet another step, we arrive at the track of Burton and Speke, who have certainly left nothing of primary importance undescribed. The fourth and last section of known country is to the eastward of Mombas, whence Baron von der Decken (accompanied by the English geologist, Mr. Thornton) has lately travelled to Kilimanjaro, and where he still proposes to travel.

"Thus there is no urgent call for a new expedition that should leave the coast of Africa between the Zambesi and Mombas; but Eastern Africa is almost untouched between Mombas and the Red Sea. The field that here awaits new explorations is too vast to be exhausted by any single expedition. Three distinct undertakings may be specified.

"The first is to ascend the Juba, the Ozi, and other rivers, as far as they are navigable. They have all been visited by slavers, and opposition might be experienced on entering them, partly from that cause and partly owing to hostilities between the Somauli and the Massai; but no serious obstruction need be apprehended by a well equipped party, large enough to command respect.

"The second and most difficult would be a land exploration through the Somauli. Their language is an obstacle to a traveller from the side of Zanzibar, where interpreters cannot be engaged; while the religious and the political fanaticism of their northern tribes is an equal bar to travellers from Aden, where a suitable expeditionary party might, perhaps, be collected. The most promising course would be to land at Mogadoxo, and to reside there some months, learning the language and acquiring a hold on the good will of the people, before attempting further progress.

"Additional interest is given to this exploration by the fact that Lieut.-Colonel Rigby, H. B. M.'s Consul at Zanzibar, is firmly persuaded that some Englishmen are now in captivity among the Somaulis; for a report to that effect has been confirmed by different witnesses. He believes them to be a part of the crew or passengers of an East Indiaman, supposed to have been wrecked near the Mauritius in 1855, but whose cargo, or rather a number of miscellaneous effects resembling those known to have been carried by her, are come into the possession of the Somaulis. An exploring party would find in this report an intelligible pretext for their presence in the land, and a stimulating object for their earlier movements.

"The last course would be to adopt Mombas as the head-quarters, and thence to pass into the interior by a route to the north of that travelled by Baron von der Decken. The country behind Mombas is a less unhealthy residence than other parts of the coast; and an expeditionary party might be organized there at leisure, with help from Zanzibar. The Rev. Mr. Krapf resides in its neighborhood; the natives are accustomed to Europeans; and the traders mostly speak Hindustani. It would be impossible, at the present time, to plan an exploration in Africa that would afford hope of a more interesting discovery than one leading from Mombas round the northern flank of Kenia, and thence onward toward Gondokoro."

ART. XXVI.—*On the existence of a Mohawk-valley Glacier in the Glacial Epoch*; by JAMES D. DANA.

THE Mohawk river extends in a nearly east-and-west course (averaging about east-by-south,) across the centre of the State of New York, and connects with the Hudson river near Troy, eight miles above Albany. It commences its flow eastward at Rome, west of Oneida lake, the waters above this coming from the Black river country, on the north. The whole distance from Rome to Albany, in an air line, is about 100 miles; the descent to the Hudson is 425 feet—equivalent to 4¼ feet to the mile. 78 feet of the descent, however, is at Cohoes falls, a mile from its mouth, so that, for the rest of its course, the average descent is a little less than 3½ feet per mile.

The valley is a depression between the northern and southern plateaus of the State, and has its highest border on the south—the general height of the northern plateau being from 1000 to 1500 feet, and that of the southern plateau from 1500 to 2500 feet. It is not a synclinal valley; neither is it a valley of denudation, although, beyond doubt, greatly deepened and extended by the action of waters; but it is what the writer has styled a *geoclinal* valley, that is, one formed by the uplift of the crust of the earth on either side, (or else by the depression of the crust along its course,) without any conformity to its slopes in the dip of the enclosing rocks.[1] These enclosing rocks of the Mohawk depression are in fact, on one side, partly (above a height of a few hundred feet) the folded and crystallized Azoic, and, on the other, the Palæozoic rocks which were uplifted at a much later period.

About midway between Albany and Rome, the valley-depression, taking only the part *south* of the Mohawk, measures, at an elevation of 1500 feet, ten or twelve miles in breadth. But just east of this in Schoharie county, it opens southward along the valley of the Schoharie creek, the principal southern tributary of the Mohawk. This Schoharie valley is bounded, on the *west*, by the northwestern prolongation of the Catskill Mountains, having here a height of 2000 to 2600 feet above the sea level; on the *east*, by a spur from the same mountains, called the Hellebark mountains, which increases in height southwardly from 1000 to 2000 feet, and at whose eastern foot, in Albany county, lie the Helderberg hills, 800 to 1200 feet high above the sea-level. The principal heights of the Catskills, between 3400 and 4000 feet in altitude, are situated to the south, not far from the junction of the two ridges. The range of the Catskills has a height, at the Mountain House, according to Guyot's measurements, of 2235 feet above the sea-level. The true *watershed* lies a little to the south and west of this, and is made by Guyot 1970feet in elevation; and from it, flow waters northwestward to the Schoharie and eastward to the Hudson.

On the *north* side of the Mohawk, land 1500 feet in elevation is not met with except at very distant points from the river—as in the Black river region, towards Lake Ontario, which has this height, and in the Adirondack region, towards Lake Champlain, whose highest peak, Mt. Marcy, runs up to 5379 feet.

The Mohawk valley is continued westward in the depression of Oneida lake. The depression continues on farther west, just south of Lake Ontario. The Ridge road, as it is called, having

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[1] The word *geoclinal* is derived from the Greek *γη earth* and *κλινω I incline.* The *Connecticut, Hudson,* and *Mississippi* are other *geoclinal* valleys.

a height of 631 feet above the sea-level, separates this depression from that of the lake; but the ridge is regarded as only a former beach of the lake.[2]

The ridges of Schoharie county form the western boundary of the great Hudson valley depression in that latitude—the *eastern* making the boundary, if we reckon only to a height of 1000 to 1500 feet, but the *western*, through the larger part of Schoharie county, if to a height of 2000 feet.

The preceding facts are mentioned, partly in elucidation of the following observations on glacier-markings along the Mohawk valley, and partly to show what course investigation must take in order to complete our knowledge of the great glaciers of the region in the Drift epoch.

The subject of river-terraces, or stratified Post-tertiary deposits, on the Mohawk and its tributaries, is also one of great interest in this connection, and merits a thorough examination. The deposits have some relation to the Drift, as they belong to the epoch immediately following—the Champlain epoch,—and consist in part, at least, of material that had been transported by the ice. They are of unusual extent on the East and West Canada creeks and other northern tributaries of the Mohawk.

The town of Cherry Valley is situated on the northern border of the southern of the New York plateaus. It is hence near the southern margin of the Mohawk valley, being about fifteen miles in a straight line from the river; at the same time, it is on one of the tributaries of the Susquehannah river, the general course of whose affluents is southward. Observations on the glacial scratches of this region have, therefore, a peculiar interest. The following are the results of important investigations on this subject, made by the Rev. William B. Dwight, as recently communicated to the writer. He states in his letter (dated Englewood, N. J.,) as follows.

"As far as I have observed the glacial scratches of the State of New York, they do not conform in their course so much to the particular courses of the valleys in which they may be found, as they do to the trend of the general system of valleys.

"At Cherry Valley, there are *two* distinct sets of scratches nearly at right angles to each other, and *none between* these two. Both of these sets appear *in the valley itself.* Neither, however,

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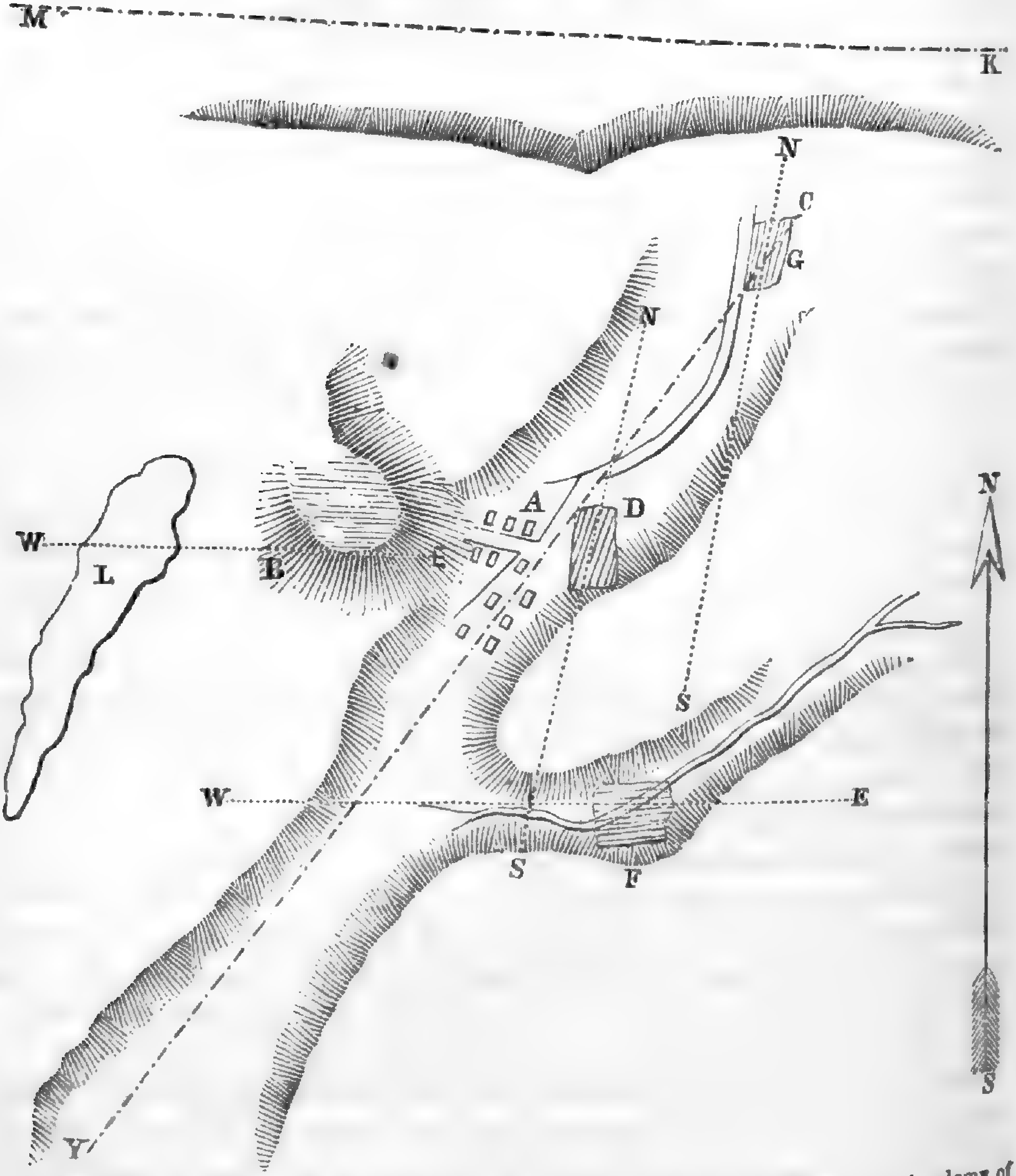
[2] The depression occupied by the Mohawk is situated, like those of nearly all the lakes of North America, and that also of the St. Lawrence, near the line of boundary between the Azoic and Palæozoic areas of the continent; that is, between the area that was comparatively stable dry land from the commencement of the Silurian age onward, and which reaches from Canada northwest to the Arctic and northeast to Labrador, and the area, stretching southward, southeastward and southwestward, from the Azoic, that was during the same time an area of progress and of unstable surface.

exactly conforms to the present trend of the valley, as shown on the accompanying map. The line CY corresponds to the trend of the valley, and MK to that of the Mohawk valley; and the two sets of lines, NS and WE, correspond to the direction of

MAP OF CHERRY-VALLEY REGION.



A, Cherry Valley village; B, Burned Hill; CY, Course of the Cherry Valley; D, Academy of Cherry Valley; F, Locality of Glacier scratches, half a mile below Cherry Valley; G, Id. on road to Fort Plain, north of Cherry Valley; L, Otsego Lake, head waters of Susquehannah; NS, Course of north-and-south system of scratches; WE, Course of east-and-west system of scratches; MK, Course of the Mohawk Valley

the respective glacier courses. The direction of the former sets of these scratches is about *north-northeast* and *south-southwest*, varying to *north-by-east* and *south-by-west*, and that of the latter about *east-by-north* and *west-by-south*.

"The Onondaga limestone of the region is, in many places, (as between the village and Judd's Falls) highly polished and deeply scratched, the scratches being mostly of the southerly system of courses. The same system is well exhibited on the side of the road leading to Fort Plain (at G), one and a half miles north of Cherry Valley; and there is one long scratch in the cellar of the Cherry Valley Academy (D).

"Neither the scratches of the road-side, on the way to Fort Plain, nor that under the Academy, correspond with the general course of the valley, or even with its particular course at the locality of the scratches. They seem in every case to run somewhat into the hill-side.

"On the top of 'Burned Hill,' (B) on the west side of Cherry Valley, 400 feet above it, and 1800 feet above the sea-level, the rocky surface, here the Hamilton sandstone, wherever laid bare, over an area of several hundred acres, is more or less planed and scratched, and the scratches are of the *easterly* system, the course being east-by-north. Half a mile to a mile below Cherry Valley (F), there is another good locality of the east-by-north scratches. These easterly scratches have no apparent connection with any valley in the region.

"About a mile above Cobbles-kill Centre, a few miles east of Cherry Valley, on the Sharon road, there are scratches on the top of a hill of Corniferous limestone, having a *north-by-west* and *south-by-east* course. They have no relation in direction to Cobbles-kill valley, as they cross it nearly at right angles, and are evidently part of the same north-and-south system observed about Cherry Valley." [The Cobbles-kill flows eastward into the Schoharie, and not into the Susquehannah tributaries; but the place where these scratches occur is still near the summit of the plateau. All the above courses are *compass-courses*, requiring a correction of 6° for westerly variation.]

Mr. Dwight continues:—

"The best conclusions that I can gather from these facts is, that there are two systems of scratches in that part of the State, at right angles, nearly, to each other; that *one system* corresponds with the *general* direction of the great valleys running southerly, (those of the principal Susquehannah tributaries, though the correspondence is only one of general courses,) and that *the other system* corresponds with the direction of the Mohawk valley, although, where I have observed it, there is no modern valley in the immediate vicinity to correspond to it."

These conclusions of Mr. Dwight appear to be altogether just. The *east-and-west* courses are well explained by reference to the Mohawk valley; while the *north-and-south* system conforms to the slope of the Susquehannah tributaries, though possibly connected with a grander movement reaching from the far north across the Mohawk valley.

The Mohawk valley needs to be studied for a full elucidation of the subject. But there are some confirmatory facts stated by Vanuxem, who, as long ago as 1842, announced essentially the same general conclusion, as the result of his observations.[3]

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[3] See New York Geological Report, Part III, comprising the Survey of the Third Geological District, by Lardner Vanuxem, 4to, 1842, p. 245.

In Montgomery county, near Amsterdam (on the Mohawk), this able geologist noted scratches at various quarries and localities on the Trenton limestone, which were nearly east-and-west in direction,—agreeing thus, as he remarks, with the course of the Mohawk valley. Again, in the same county, near Sprakers, on the north side of the Nose, the scratches conform, as he states, to the valley of the Mohawk. North-and-south scratches occur in the vicinity of this valley according to Vanuxem; but, at the places observed by him, they conform to one, or another, of the minor tributaries. In Oneida county, between Utica and New Hartford, there are north-and-south scratches on the Oneida conglomerate, which conform to the Sauquoit valley; and on the west of the Oriskany creek, north of Hamilton College, the same system occurs, and corresponds with the Oriskany valley. Vanuxem concludes, from his observations, that *the direction of the scratches corresponds with the direction of the valley in which they occur.*[4]

The question, whether these drift-scratches and other phenomena are a result of glaciers, or icebergs, the writer has discussed in his Geological Manual, and need not take up here.

The absence of well characterized moraines from the most of the country will not be deemed remarkable by those who consider the length of time which has elapsed since the Glacial epoch ended, and the power of running water in wearing to powder loose stones of whatever hardness, and especially those derived from most sedimentary strata.

Again, moraines are always comparatively small where the glacier has no towering peaks or cliffs about its course, to afford avalanches of ice and stones. The glacier of the Mohawk, in order to make scratches about Cherry Valley, 1800 feet above the sea-level must have reached to a height of at least 2000 feet; and with this level, if the region had anything like its present configuration, it would have buried a large part of the southern plateau, while its northern border would have had no limit in New York State, except about the Adirondack Mountains, 70 or 75 miles distant.

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[4] Mr. Vanuxem observes, in concluding his remarks on this subject, that the *glacier-origin* of the scratches harmonizes with the fact that the scratched surfaces are found at no regular or defined elevations; that the surfaces are too much worn, and extend over too great an extent of the same rock, to have been caused by icebergs, especially, as the lines are always straight ones, and the motion of icebergs is oscillatory and rotatory. The direction also of the scratches is in accordance with existing valleys, and hence local, agreeing with glaciers in both respects." He adds further, with his usual discrimination, "As matter of fact from actual observation, the glacier-theory will have preference of the two, especially, should the term *local ice* be substituted, being a more general expression:—glaciers having their origin near the line where perpetual snow ceases, whereas *local ice* embraces the same, as well as all bodies of solidified water, be the cause of the reduction of temperature what it may, whether permanent or transient, that has given rise to it." p. 247.

On the Catskills, the glacier scratches reach to a height of at least 2235 feet—the elevation at the Mountain House, and this implies the existence of ice and snow to a height of at least 2600 feet; and if the snow had this height over the whole southern plateau, it would have almost completely buried it, with the exception of the higher Catskill summits.[5]

Without more extended observation, it is not possible to say whether the east-and-west, or the north-and-south, scratches of the Cherry Valley region are of earlier date. If the former, then, beyond question, the north-and-south are due to a *Susquehannah glacier;* but if the latter, they may have resulted, as already intimated, from a great continental glacier spreading southward from the remote north, of which the Mohawk glacier was a final portion that became partly outlined and independent only in the later part of the Glacial epoch. The fact of the greater average height of the southern plateau than the northern adds to the difficulties of arriving, at present, at sure conclusions; and the uncertainties, arising from our ignorance of the changes in the topography of the country through erosion, during the time which has since elapsed, still further enhance these difficulties. But, whatever the uncertainties, there is sufficient justness in the views of Vanuxem, Dwight and others, as to a frequent conformity between the direction of scratches and of the valleys, (the greater valleys,) to suggest the right method of investigation, and indicate the line in which a large part of the truth lies.

The facts gathered over much of New England appear to point directly to a *Connecticut-valley* glacier; and those between the Green Mountains and the Catskills, to a *Hudson-valley* glacier; and others, in the vicinity of Penobscot Bay, recently studied by Mr. De Laski, to a *Penobscot-bay* glacier, as this observer, after extensive research, has concluded. A *Mohawk-valley* glacier may, with little if any doubt, be added to the number already defined, and probably, also, a *Susquehannah-valley* glacier.

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[5] Ramsay states, in his observations on the drift-scratches of the Catskill region (Quart. Jour. Geol. Soc. Lond., xv, 208), that while the striations on the ascent of the mountain from the east were "nearly north-and-south along the flanks of the escarpment, and not from west to east down the slope of the hill," and "very strong and frequent up to the plateau on which the Mountain House stands, 2850 [2235] feet above the sea," at this summit level, on the watershed, the scratches approximate to east-and-west. He says "on this plateau, numerous main grooves are seen, passing across the hill, and nearly at right angles to most of those observed during the ascent,—seemingly pointing to the fact that the icebergs [Mr. Ramsay adopting in his reasoning the iceberg-theory] which striated the eastern flank of the mountains in a north-and-south direction, when the whole was nearly submerged, here found a passage or strait through which they sometimes floated and grated the bottom, in a direction quite across that which they were forced to follow when passing along the great escarpment that now faces the Hudson." He states, also, that these main grooves are crossed "at various angles" by "minor striations." Mather, as mentioned in his Geological Report, made long since some similar observations on the Catskill scratches; but they were less complete than those by Ramsay.

ART. XXVII.—*On certain Changes in Wine;* by J. NICKLÈS.[1]

AMONG the different substances contained in wine, one of the most characteristic and constant, in connection with alcohol and water, is the bitartrate of potassa. Since a wine will not be accepted as a natural product if it lacks this salt, it is well known that the manufacturers are always careful to add the bitartrate of potassa to spurious wine. Nothing has ever changed this opinion, although numerous chemical researches have been made every year with the different wines produced in France. Natural wine always contains a proportion more or less appreciable of cream of tartar (bitartrate of potassa), if the wine has not undergone any change. Through recent investigations made at Lyons and at Montpellier it has been discovered that the bitartrate of potassa may be wanting in wines which have undergone decomposition, especially in such wine as has become bitter. Wine affected in this manner is known in France under the name of "changed wine" (*vin tourné*). It is very disagreeable to the taste, and gives by distillation volatile acids in much greater quantity than are furnished by normal wine.

It has also been remarked that "changed wine" contains more potassa than wine of the same province which has not been spoiled. But sugar and glycerine are not more abundant in such wine; on the contrary there appears lactic acid, which depends upon sugar for its production, and also another acid with the formula $C_6H_6O_4$, which is the formula for propionic acid, but which, as we shall see below, is here applicable to an isomeric acid.

It was at first thought that this volatile acid was derived from glycerine, which is normally contained in wine. But its origin is now explained, by a fact which we discovered in 1846 and published in a memoir inserted in the *Comptes Rendus* of the Academy of Sciences (vol. xxi, p. 285) entitled, "*Sur un acide particulier produit par la fermentation du tartre brut.*" This acid we call *butyro-acetic acid* because of the facility with which it may be transformed into acetic acid and into butyric acid, and also because it is possible to effect the synthesis of this acid, as we have formerly shown in the *Journal de Pharmacie et de Chimie*, xxxiii, p. 351. We shall refer to this synthesis below.

The production of an acid $C_6H_6O_4$ from the butyric acid or from the acetic acid may be rendered intelligible by means of the following equation:

$$\underbrace{C_4H_4O_4+C_8H_8O_4}_{\text{[Acetic acid + butyric acid.]}}=C_{12}H_{12}O_8 : \text{ and } \underbrace{\frac{C_{12}H_{12}O_8}{2}=C_6H_6O_4}_{\text{[Butyro-acetic acid.]}} \ (2)$$

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[1] Communicated to this Journal by the author.

Although this acid may arise from fermentation of bitartrate of potassa, it has never, for a wonder, been found in wine which has lost its tartaric acid by means of adulteration. This fact confirms the observation, made long since in the practice of wine making, viz: that when the wine became changed in this manner, all the crude tartar which had settled at the bottom of the casks disappeared little by little, an observation which confirms this other fact demonstrated by chemistry, to wit, that "changed wine" contains more potassa than is found in normal wine. This is evidently due to bitartrate of potassa originally deposited in the bottom of the cask, which by redissolving and fermentation has furnished this excess of potassa now dissolved by the aid of the lactic acid and of the butyro-acetic acid produced during fermentation.

The "turning" of wine which is characterized by the designation *changed wine* (*vin tourné*), and which follows when the wine becomes bitter, consists essentially in a transformation of sugar into lactic acid, and tartaric acid into an acid containing the elements of acetic and butyric acids, that is to say of butyro-acetic acid. Under the influence of this change the metamorphism of tartaric acid takes place not only when it is free and in solution, but even when it is combined with potassa and is deposited at the bottom of the cask in the condition of an insoluble bitartrate.

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[2] The notation of Gerhardt shows clearly the difference between the two acids called propionic and butyro-acetic. Take for example the salt of baryta, the crystalline form of which is identical for the two acids (Rammelsberg, *Krystallographische Chemie*, ii, p. 161).

$$\underbrace{\left.\begin{array}{l}\overset{''}{\text{Ba}}\\ \text{Є}_3\text{H}_5\Theta\\ \text{Є}_3\text{H}_5\Theta\end{array}\right\}\Theta_2}_{\text{Propionate of baryta.}} \quad \text{and,} \quad \underbrace{\left.\begin{array}{l}\overset{''}{\text{Ba}}\\ \text{Є}_2\text{H}_3\Theta\\ \text{Є}_4\text{H}_7\Theta\end{array}\right\}}_{\text{Butyro-acetate of baryta.}}$$

To obtain the butyro-acetic acid, it is only necessary to pass a solution of acetate and butyrate into a retort containing hot and dilute sulphuric acid, and to condense in a convenient vessel the vapors which are disengaged. The condensed liquid contains an acid which being neutralized by baryta gives beautiful flat prisms formed of butyro-acetate of baryta. These crystals have a greasy feel, and when pulverized and thrown into water they acquire a gyratory motion similar to butyrate of baryta. In this case the two acids, acetic and butyric, are evolved in the *nascent* state, and combines to form the *butyro-acetic acid* in question.

ART. XXVIII.—*Observations on the Sphagna of New Jersey, with Description of a New Species;* by C. F. AUSTIN, Curator of Dr. Torrey's Herbarium, Columbia College.

THE region in New Jersey known as "The Pines" is literally a region of *Sphagna*. Nine of the ten species and most of the varieties noticed in this paper were collected there by the writer in October last, in the vicinity of Manchester in Ocean county, within the radius of less than half a mile,—the fruits of a few hours search. One of them, *Sphagnum Sullivantianum*, is new to science; another, *S. molluscum*, to the American Continent.

The bottoms of the ponds in this region are covered to a great extent (often to the exclusion of all other plants which usually grow in such places) with *Sphagnum cuspidatum* var. *Torreyanum*, *S. macrophyllum*, large forms of *S. Pylæsii* and with *S. Sullivantianum*. They are entirely submerged (when at a depth of more than three or four feet), or have their tips just peeping from the surface of the water, and were all brought up together on the boat's oar in the pond at Manchester, from a depth of at least six feet.

The more or less inundated marshes on the borders of the ponds are filled with *Sphagnum cuspidatum*, running into the var. *recurvum* in the cedar swamps, where this variety abounds, and into the var. *plumosum* in shallow water,—and this appears to pass regularly into the var. *Torreyanum* in deep water. The forms of this species which run into the var. *recurvum* have a slender state of *S. cymbifolium* abundantly, and of *S. molluscum* sparingly, mixed with them. The common forms of *S. acutifolium* and *S. cymbifolium* form deep extensive turfs in the cranberry bogs,—these places seeming to be made up of their remains.

In sandy, grassy bogs, forming matted masses, *S. cyclophyllum* and *S. Pylæsii* are abundant. *S. rigidum*, var. *humile*, occurs sparingly on the dry margins of the ponds.

Considering the limited time and space over which the search extended, and the number of species collected, it is reasonable to suppose that others may yet be found in the same locality.[1]

The following brief synopsis includes, I believe, all the *Sphagna* that have thus far been found in New Jersey.[2]

1. SPHAGNUM ACUTIFOLIUM Ehrh.—Fruits abundantly on the borders of sandy swamps, where it is of rather a low stature; the taller forms which grow in peat bogs appear to produce only male flowers; color below whitish; above, brownish tinged with red, often changing to bright

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[1] *S. subsecundum* is common in other portions of the State, and may be looked for in the same locality as well as all the American species not peculiar to high latitudes.

[2] Since writing the above, I learn from Mr. Sullivant that he has *S. tabulare* from Quaker Bridge, New Jersey.

purple in drying. A cinerous-green, rather loosely spreading, sterile form is found in miry swamps.

2. Sph. Sullivantianum (sp. nov.): Speciosum robustum submersum vel fluitans: caulis pedalis et ultra firmus simplex vel semel divisus, strato corticali triplici et quadruplici e cellulis hyalinis spirali-fibrillosis porosis formato; ramuli 3–5-fasciculati, quorum 2–3 recurvo-patentes densi julaceo-foliosi basi attenuati, 1–3 deflexi cauli adpressi graciliores laxius foliosi, cellulis corticalibus spiraliter fibrillosis haud porosis in strato duplici dispositis: folia caulina obovato-quadrata toto margine fimbriata, cellulis sine poris et fibrillis; folia ramulorum patulorum inferiora parvula semicirculari-ovata, cætera multo majora, media orbiculata cochleariformi-concava, terminalia elongato-ovata laxiuscula, omnia arcte imbricantia angustissime marginata, basi unguiculata, dorso ad apicem cucullatam papilloso, toto ambitu (foliis terminalibus exceptis) eleganter fimbriata, rete inferne elongato-rhomboideum apicem versus rhombeum, cellulis hyalinis fibrillosis et poris majusculis instructis, cellulis chlorophyllosis ad concavam folii faciem positis inque sectione transversali triangularibus: fructus et flores ignoti.—Manchester Pond, Ocean Co., New Jersey; collected October, 1862.

This fine species has the appearance of an overgrown state of *Sph. cymbifolium*, and possesses *in a superlative degree* most of the distinctive characters of that species, but is at once distinguished by its *clavate branches with elegantly fringed leaves which are very abruptly contracted below into a claw-like base*, and have the back at the apex conspicuously dark-colored, with cross-section as in *S. acutifolium*. The stem-leaves are also quite distinct, being usually nearly quadrate, but little if any longer than broad, and copiously fringed.

3. Sph. cymbifolium, Dill.—Allt he specimens that I have examined, both from this country and Europe, have the stem-leaves reticulated on the border above,—the network often broad and extending slightly beyond the margin, frequently giving the leaf a strongly fringed appearance,—and have the lower branch-leaves slightly spinulose-toothed; spinulæ short, distant, erect-appressed, somewhat club-shaped, with the apex slightly recurved. The following are the forms that I have observed in New Jersey, precisely the same as are found in Europe:—

α. Densely cespitose, low or tall, mostly of a pale reddish-brown color; stems erect; branches short, thick, straightish, remote or crowded; the loosely imbricated or spreading leaves straight on the back.—(*β. condensatum* C. Müll. *Synop.* 1, p. 92.)—Peat bogs and borders of sandy swamps; fruits occasionally; runs into

β. More robust, rather loosely cespitose, mostly of a pale glaucous-green color; stems erectish; branches attenuated, recurved, the lower rather distant, the upper crowded; stem leaves with the cells usually destitute of pores and spiral fibres; branch-leaves slightly recurved above the middle. (*α. pycnocladum* C. Müll. *Synop.* 1, p. 92).—Borders of swamps and in pastures. Very rare in fruit; runs into

γ. Loosely spreading and of a dark bluish-green color; stems zigzag; branches less crowded above,—the leaves acuminate, the upper half somewhat tubular and recurved-squarrulose. (*γ. squarrulosum* C. Müll. *Synop.* 1, p. 92).—Miry swamps partly inundated; sterile.

4. Sph. cyclophyllum, Sull. & Lesqx.—Foliis perichætalibus ut cæteris capsulam globosam includentibus.—Apparently a very distinct species; stem and branch-leaves much larger than in any other, often 2 lines or more broad by 2½–3 lines long, with a clasping-perfoliate, constricted, distinctly heart-shaped base.—Grassy bogs about Manchester. I have seen dwarf forms of this species from Quaker Bridge distributed as "*S. sedoides* Brid."

5. Sph. Pylæsii, Brid.—Also apparently a very distinct species, and, with the preceding (with which it grows, forming thin strata), very distinct from *S. sedoides.*—Color blackish-green; stems 6 inches long with few short recurved-spreading branches. Runs into a large dusky-black form in the water with stems 1–2 feet long.

6. Sph. rigidum, Schimp., var. humile. (*S. humile* Schimp.)—Stems low, 1 inch high, very compact; capsule nearly included.—Dry margin of the pond at Manchester.

7. Sph. subsecundum, Nees & Hornsch.—Rather loosely cespitose, 3–5 inches high; color above, a beautiful golden-brown, below, whitish; branches in fours and fives, somewhat crowded, thickish towards the base, somewhat attenuated, more or less contorted and of unequal lengths; branch-leaves ovate, acuminate, unequally truncate and about 5-toothed at the apex, varying from closely imbricated to spreading, mostly recurved, —some are much so, while others on the same branch are straight or even slightly incurved; cells of leaves larger than in any specimens that I have seen from other localities,—with numerous small pores.—Meadows and pastures in springy places; sterile.—A form growing in sunken holes, in woods partly inundated, is of a pale green color; stems 6–8 inches long, with rather distant branches arranged in fives and sixes; perichæth lateral. At a casual glance it might be mistaken for either *S. cymbifolium* or *S. acutifolium*, but particularly for *S. cuspidatum;* but it is at once distinguished from the first, with which it grows, by its smaller size and acute branch-leaves; from the second by its thickish branches with the leaves irregularly imbricated and recurved; from the last it is very difficult to distinguish it when fresh, but in a dry state this is readily done, for it then has the leaves straight (not wavy) on the margin; male plant very different from the female, as follows:

Compactly cespitose, 2–4 inches high; color brownish-green tinged with yellow; branches very short and thick, ovate-lanceolate, very acute, nearly straight, the deflexed ones are closely appressed beyond, but not at, the tumid base; branch-leaves large, orbicular-ovate, rounded at the 5–12 toothed apex, very compactly imbricated,—the cells mostly without pores.—Very difficult to distinguish from small forms of *Sph. cymbifolium*, var. *α*, with which it grows. Bogs and wet meadows: Bergen Co.

8. Sph. molluscum, Bruch.—Was found mixed with small forms of *Sph. cuspidatum* from about Manchester, and detected by its elliptical, never cuspidate nor recurved, branch-leaves, which are not wavy on the margin when dry; those towards the apex of the branches are smaller than the rest, but of the same outline (not narrowed as in most species). Resembles *S. tabulare* Sull., but is a more slender plant, with cross-section of leaf as in *S. cuspidatum.*

9. Sph. cuspidatum, Ehrh.—Rather loosely cespitose; large and robust

or small and weak; color whitish and greenish; stems erect, or spreading, 5–8 inches long; branches thickish, none closely appressed; stem and perichætal leaves not fibrillose; the latter crowded at the base of the lateral perichæth, often including the capsule; branch-leaves rather large, lanceolate acuminate, broadly margined.—Runs into the var. *plumosum.*—In an inundated peat bog in Bergen Co., there occurs a slender pale-green form with loosely spreading and fibrillose perichætal-leaves, which seems to connect this and the var. *plumosum* with var. *laxifolium.*

Var. RECURVUM. (*S. recurvum* Beauv.).—Densely cespitose, robust; color pale straw-yellow; stems erect, 5 or 6 inches high; branches in fours and fives, the 2 spreading ones very uniformly recurved, the 2 or 3 deflexed ones closely appressed; branch-leaves small, oblong-lanceolate, strongly recurved and conspicuously arranged in 5 straight ranks. Perichæth terminal. Runs into the preceding or typical form.—Cedar swamps about Manchester.—There is a deep green, loosely cespitose form in Bergen Co., which seems to connect this var. with the var. *laxifolium.*

Var. PLUMOSUM.—Larger than the preceding and much more attenuated in all its parts. Sometimes this variety is found scattered and creeping on the banks of the small streams in the cedar swamps, when it is much condensed, with short, very thick, contorted and much crowded branches, giving to the stems an obese appearance, suggestive of huge caterpillars. —Shallow water about Manchester.—Very rare in fruit; runs insensibly into

Var. TORREYANUM. (*S. Torreyanum* Sull., in *Memoirs Amer. Acad. Arts and Sciences,* new series, iv, p. 174).—This fine variety (it appears to be nothing more) and the var. *recurvum* seem to represent the two extremes of this species, between which there are all manner of intermediate forms.—Deep water about Manchester.—Probably does not fruit except when it occurs in water holes that are partially exsiccated during the late summer and early fall months.

Var. LAXIFOLIUM. (*S. laxifolium* C. Müll. *Synop.* 1, p. 97).—Nearly as large as the last and resembling it except in color, which is deep green, stem and perichætal leaves fibrillose except the margins below, the latter loosely spreading; commonly sterile, but I have a number of fine fruiting specimens from partially exsiccated water holes, in low sandy woods in Bergen Co., where this variety is common.

10. SPH. MACROPHYLLUM, Bernhardi.—This species is often found floating free, and has much the appearance of the var. *Torreyanum* of the preceding one, and cannot be distinguished from it when in the water except by its blackish stem and leaves. It is very apt to be mistaken for a decaying state of that plant; for, owing to the complete absence of the elastic spiral fibre in the utricles of the leaves, it has a characteristic dead appearance when removed from the water, and goes into a shapeless mass,—feels as if rotten, and resumes its former fine symmetrical outline but slowly, if again restored to its native element.—Abundant in the ponds in Ocean Co., where only the large sterile form was found.

New York, January, 1863.

ART. XXIX.—*Foreign Correspondence.*

1. *On the Science of the International Exhibition.* In a letter from O. C. MARSH, B. A., to Prof. SILLIMAN, dated London, Nov. 25, 1862.

THE International Exhibition, which has just closed, contained many objects of considerable scientific interest; and, in accordance with your request, I shall endeavor to give a short account of those which seemed most worthy of notice.

In every part of the Exhibition the practical application of the results of scientific research, rather than the results themselves, or the methods by which they had been accomplished, were especially selected for illustration. Hence, many of the classes, under which the various articles exhibited were arranged, contained few if any objects that need here be mentioned. In the present communication I shall notice briefly the principal points of Class I, which embraced Mining, Mineral products, and Metallurgy, and without doubt exhibited a fuller and more instructive collection of these objects than has ever before been brought together.

Gold.—The most striking feature in this division, and perhaps in the Exhibition itself, was the immense quantity of native gold displayed. The British colonies of Australia, New Zealand, British Columbia, and Nova Scotia contributed most of this, yet nearly every part of the world sent its representative specimens, and the collection was interesting, as showing the great number of new gold-fields discovered within the last few years, and as indicating the almost universal distribution of this metal. Most of the gold exhibited possessed in itself nothing of peculiar interest, and the processes for its separation, which were shown theoretically and practically, are generally well known. There was, however, in the Zollverein department, a series of specimens (No. 733[1]) from the arsenic works of Reichenstein, in Silesia, illustrating the extraction of gold by chlorine water, which seemed worthy of more attention than it received. The material used is auriferous mispickel, from which the arsenic is first separated by roasting.[2]

Silver.—The silver, exhibited in Class I, possessed few points worthy of mention, many of the most important mines not being represented, and others very inadequately. Some beautiful specimens of native silver were shown from the government mines of Kongsberg, Norway, and also from the Copper mines of Lake Superior; and a good collection of various ores from the Washoe mines of California. Specimens of silver-glance, horn-silver, and ruby silver, from a new locality in Newfoundland, were also exhibited.

Platinum and the platinum-metals.—The display of platinum, and its associated metals, iridium, osmium, palladium, rhodium, and ruthenium, was a marked feature in this class. A case in the British department (No. 171), containing all of these metals in their natural state, most of their known compounds, and many illustrations of their practical application, was one of the most interesting objects in the Exhibition, and

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[1] The numbers refer to the Official Catalogues of the various departments.

[2] A series of the Reichenstein specimens illustrating Plattner's process was exhibited in the American Exhibition of 1853, No. 278, Class I.

deserves particular notice. A single ingot of pure platinum, weighing 3200 ounces, Troy, was the most conspicuous object in the case, and afforded a good illustration of the progress which this branch of metallurgy has recently made in consequence of the researches of Deville and others. The fusion of this mass of platinum was effected in an iron box, which was lined with small pieces of lime, and covered with a lid of similar construction. Two jets from compound blowpipes, using coal-gas and oxygen, were directed through the cover upon small pieces of platinum, introduced from time to time, and when the whole was completely fused, it was rapidly transferred to a mould. It is claimed that platinum apparatus, made from a solid ingot, will both be cheaper, and less liable to lose its firmness of structure on heating, than when manufactured in the usual manner, and the case contained a great variety of such articles. Among these was a large boiler for the concentration of sulphuric acid, an alembic for separating gold and silver by means of the same acid, and a pyrometer for indicating the variations of heat in boilers. Each of these articles was said to possess, in design and construction, several points of superiority over any similar apparatus hitherto made. Other objects of interest were platinum tubes, soldered with the same metal, and a sheet of copper, plated with platinum, showing that the many difficulties attending the production of these articles have now been successfully overcome. The same case contained an ingot of pure iridium weighing 27½ ounces, and a fine display of the natural and artificial compounds of this metal, among which were specimens indicating that the minute particles of the native alloy of iridium and osmium, formerly considered of little value, may be fused together, and thus used for pointing gold pens as advantageously as grains of larger size. Palladium, rhodium, and ruthenium were also represented by rich series of specimens, in quantities never before seen. Many other rare and interesting substances were exhibited in this case, among which may be mentioned various salts of uranium, boron and silicon, fused and crystallized, which Deville himself had prepared by the process that bears his name.

Aluminium.—Aluminium, also, was well represented in the Exhibition, and can no longer be regarded merely as a curiosity, since it is evidently taking a prominent place among the useful metals. In the British and French departments, its practical applications were illustrated by a great variety of interesting objects. Some of the more noticeable of these were philosophical instruments, for which this metal, from its lightness, strength, and difficulty of oxydization, seems so well adapted. Various alloys of aluminium, with copper, nickel, and other metals, were exhibited, and their usefulness illustrated in a great variety of ways. A series of aluminium tubes, in the French department, indicated that the difficult problem of soldering this metal has been successfully solved. According to the exhibitors, zinc was the solder used, and the operation was performed in an atmosphere of hydrogen.

Mercury.—Mercury and its ores were well represented in various parts of the Exhibition, the specimens of cinnabar from Almaden in Spain, and from the New Almaden mines of California, being especially conspicuous. Lead, zinc, cadmium, nickel, cobalt, arsenic, antimony, and many ores of these metals, were also fully represented, but the collections contained little of especial interest. The display of tin, bismuth, and titanium was quite small, the only representations of the last metal being a few rutiles from the well known Georgia locality.

Copper.—Copper ores from nearly every part of the world were exhibited in this class; some of the most interesting specimens were very fine crystals of the native metal from Lake Superior, boulders of vitreous copper from a serpentine ("gabbro" of the Italians) dyke at Monte Catani in Val di Cecini near Volterra, in Italy, and a series of the Hungarian gray copper ores containing about ten per cent of mercury.

New Metals.—In the French department, the new alkali metals, cæsium and rubidium, with some of their salts, were shown; and also the new metal thallium,[*] the latest result of spectrum analysis. Manganese, obtained by a new process, was the most interesting object in Class I, of the Swiss department.

Iron and Steel.—Iron was naturally the most prominent object in an exhibition like the present, and no small part of the building was occupied by its various ores, illustrations of its Metallurgy and its applications. Although this collection was far superior in many respects to any hitherto made, the recent progress it indicated was rather, greater facilities for the production and application of this metal, than any new scientific information in regard to it. The chemistry of iron seems still to remain comparatively unknown. In the British department, some rolled plates for ships were fine illustrations of iron manufacture. The largest of these was 13 tons in weight; and the shattered fragments of those broken in the recent experiments of the English government were also exhibited. Dr. Percy, the distinguished metallurgist, who directed the experiments, states that an examination of the fractures thus made affords information in regard to the internal structure of iron, which other means of investigation have failed to detect, and that thus far the experiments indicate that the softest iron possible is most efficacious in resisting heavy shot. The exhibition contained many fine specimens of steel made by Bessemer's process, which seems likely to supercede many now in use. The display of cast steel by Krupp of Essen, Prussia, has never been equalled. One of his castings weighed 21 tons, and an examination indicated that its structure was uniform throughout.

Coal and artesian boring.—Different varieties of coal were shown in great profusion in Class I, but do not require comment. The great waste of this substance in the usual methods of mining is now attracting much attention, especially in England, and processes for rendering the small coal available for fuel were abundant in the exhibition. These were either improved grates, or methods for uniting the fine particles of coal, by heat, or by some bituminous cement. The apparatus used in boring through strata, in searching for coal, or in making artesian wells, formed an instructive series in the French department. It was exhibited by Degousée, author of "*Guide du Sondeur*," one of the best works on the subject.

Canadian collections: asterism in Mica.—Among other interesting objects in Class I, may be mentioned a collection of the economic minerals and crystalline rocks of Canada, sent by the directors of the Geological survey. The catalogue describing them is a work of much scientific

[*] Exhibited by Mr. Crookes also in the English Department.

value. In this collection were specimens of a magnesian mica, or phlogopite, from South Burgess, which quite recently has been found to exhibit the rare property of *asterism* in a remarkable degree. This has led to a new examination of the subject, and now this hitherto obscure point in optical mineralogy can be readily and satisfactorily explained. The asterism of this mica was, I believe, first observed by H. Vogel, of Berlin, during a recent visit to the exhibition. On his return he investigated the subject in company with Prof. G. Rose, who had observed a similar appearance, although much less distinct, in some varieties of meteoric iron. Prof. Rose has just communicated the results of the investigation to the Royal Academy of Berlin,[4] and the subject is of such general interest that the main points of his paper may not inappropriately be given in this connection.

If a thin plate of the mica from South Burgess be held between the eye and a light, there will be seen a large and distinct star, composed of six rays, and having the light as its central point. Between these rays, six others, smaller and much less distinct, may be observed. A similar star is seen by reflected light, but this is never so clearly defined. By holding the mica against the light, and examining it with a magnifying glass, a great number of minute prismatic crystals can be detected. Under the microscope these become perfectly distinct, and Vogel succeeded in photographing them when magnified 500 diameters. Most of the crystals are elongated, flattened prisms, having the broad lateral planes parallel with the laminæ of the mica. Their resemblance to crystals of kyanite is quite marked, and it is very probable that they belong to that species. Tabular crystals, also, may be seen, which are apparently quite different from the prisms. The crystals, with few exceptions, have a definite position in the mica, most of the prisms being parallel to the sides of an equilateral triangle, thus making angles of 120° and 60°. A few, however, make with the former an angle of 150°; and occasionally one is seen which has a still different direction. The general position of the crystals is best seen when a low power of the microscope is used.

Since the minute crystals have this regular position in the mica, the asterism is easily explained. It is a mere "trellis-appearance" (*Gittererscheinung*); and the rays of the star stand at right angles to the axes of those prismatic crystals which make with each other angles of 120°, and hence proceed from the center of the star to the middle of the sides of the equilateral triangle, with the sides of which the crystals lie parallel. As there are a few crystals which make angles of 150° with the former, intermediate, and less distinct rays are also observed. If then, a great quantity of minute crystals, regularly arranged in a larger crystal, can produce asterism, as in this mica, it must appear in other minerals also, where this is the case, and probably the cause of the asterism, wherever it has been observed, is the same as in the present instance.

In the same paper, Prof. Rose gave the results of his examination of the asterism in meteoric iron, and referred to the previous investigations on this interesting subject.

London, Nov. 25, 1862.

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[4] G. Rose, *Ueber den Asterismus der Krystalle, insbesondere des Glimmers und des Meteoreisens.* Oct. 30, 1862. See also Phil. Mag., Jan. 1863.

2. *Correspondence of Jerome Nicklès, dated at Nancy, France, Nov. 2,* 1862.

Obituary.—Death has lately made great ravages in the scientific world in France. Among those who have deceased since the date of my last correspondence, should especially be mentioned *De Sénarmont,*[1] who was at once a physicist, a mineralogist and a crystallographer; *Count de Gasparin,* distinguished as an agriculturist, after having sustained an important political position; and *Jomard* the archeologist and geographer and the last survivor of the "*Institut d'Egypt,*" that celebrated institution which was formed during the French revolution in connection with the Expedition to Egypt. The following particulars may be mentioned concerning these three savants.

Henri Hurran de Sénarmont, born at Broué (Eure et Loir) Sept. 6th, 1808, died suddenly July 4th, 1862, at the age nearly of 54 years. Of a distinguished family, he received a complete education, having entered the Polytechnic School in 1826 which he left to enter the School of Mines. In 1848 he was promoted to the rank of engineer in chief of mines, and in 1852 was elected a member of the Academy of Sciences, in the section of Mineralogy, in the place of Beudant. For many years he delivered the course of lectures on Mineralogy at the School of Mines. The works which he has published are numerous and varied, as is well known to the readers of this Journal, in which they have often been noticed.

We enumerate the following titles of his works, viz. "*Modifications que la réflexion sur un miroir métallique imprime aux rayons de lumière polarisée.*" "*Réflexion et double réfraction de la lumière par les cristaux doués de l'opacité métallique.*" "*Conductibilité des substances cristallines pour la chaleur.*" "*Conductibilité des cristaux pour l'électricité de tension.*" "*Formation des minéraux par voie humide dans les gites métallifères concrétionnés.*" "*Formation par voie humide du corindon et du diaspore.*" "*Propriétés optiques bi-réfringentes des corps isomorphes.*" "*Propriétés et formes cristallines des Micas.*" "*Production artificielle du polychroïsme dans les substances cristallisées.*" "*Memoires sur la double réfraction.*" "*Forme cristalline du Silicium.*" "*Modes d'accroissement des cristaux et causes de variations des formes secondaires.*"[2]

He was also connected as joint author with a great number of reports to the Academy upon different questions of physics, mineralogy, and crystallography.

He determined a great number of crystalline forms, which have been published by Rammelsberg in his "*Krystallographische Chemie,*" and has made known in France, by an excellent translation, the treatise of Prof. Miller on Crystallography.

De Sénarmont was highly appreciated by Biot, who aided him much in his career, and left to him his sympathy for young students and his aversion to public functions which do not belong to the domain of science; withal he was exceedingly modest; elected in 1853 to the position of perpetual Secretary in the Academy of Sciences in place of Arago, he declined to accept it:[2] and upon his death-bed he directed that no eulogy should be pronounced at his tomb. He left many uned-

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[1] See this Journal, [2], xxxiv, 304.

[2] This Journal, [2], xvii, 263.

ited works which it is proper to hope will soon be published. His last labors were the publication of the works of Fresnel by virtue of a commission with which he had been charged by the Minister of Public Instruction. He had collected with care the scattered materials and had written a great number of explanatory notes. He had not had time to complete this work so earnestly waited for by men of science, which however will be published ere long.

Adrian Etienne Pierre De Gasparin was born at Orange (Vaucluse), June 29th, 1783. His father was a celebrated member of the Convention, and was distinguished at the siege of Toulon. Bonaparte, the exile of St. Helena, remembered in his will this young commander of artillery, who was afterwards a general, bequeathing a sum of money to the children of this revolutionary hero. They had no need of it, however, as they possessed an ample fortune.

The savant whom we have just mentioned was at first a soldier. Wounded in 1806, in the campaign in Poland, he retired to his home, devoted himself to the study of the natural sciences, and became noted for his interesting memoirs upon agriculture which obtained for him a distinguished position among cotemporary agriculturists. After the revolution of 1830, he was successively prefect, peer of France, Under Secretary of State, then Minister of the Interior (1836), and lastly Minister of Commerce and Agriculture. During his progress to power, he constructed roads in Corsica, reformed the discipline of prisons, and replaced the chain gang by portable cells. Returning to private life, in 1840, he resumed his agricultural studies. At this time he was elected a member of the Academy of Sciences, in the section of Agriculture, in place of Turpin. He devoted himself only to agriculture, and merited the title of successor of Olivier de Serres, whose descendant he was by reason of the marriage of one of his ancestors with the daughter of the founder of French agriculture.

Among his works should be mentioned especially his *Traité d'Agriculture* (6 vols. in 8vo.), his memoirs upon the multiplication of races, upon the contagious diseases of sheep, upon the raising of merino sheep, on the culture of madder, and of the mulberry. He made extensive investigations in meteorology, especially upon the distribution of rain, and published valuable experiments upon solar radiation. He died at Orange, his native village, the 7th of September, 1862. French agriculturists have already commenced a subscription for the erection of a statue to his memory.

Ed. François Jomard was born at Versailles, Nov. 22, 1777. He left the polytechnic school in 1794 and entered as geographical engineer in the school of surveying, (*Ecole de Géographie du Cadastre*). At the age of 21 he joined the expedition to Egypt. At the commencement of the campaign he took part in forming a topographical plan of Alexandria, measured and drew the less known monuments under the direction of Monge, read upon this subject various memoirs at the Institute of Cairo, and collected, in company with the savants and artists chosen for this scientific mission, the materials which have been incorporated in numerous works. On his departure from Egypt, contrary winds having detained him in the Archipelago, he took the opportunity to explore the

Ionian Isles. Having been engaged on the "*Description de l'Egypte*," he afterwards became secretary of the commission appointed to publish the labors of the Egyptian Institute, which was important chiefly by reason of the interest which it inspired for Napoleon, and because most of its members became distinguished men.

In 1826, after much effort, he succeeded in establishing the Egyptian school of Paris. Every year the Egyptian government sends to Paris a certain number of young men to pursue their studies. The Viceroy of Egypt, Saïd-Pacha, is a graduate of this school. In 1828 Jomard was appointed administrator of the *Bibliothèque* for the new department of geography and travels, and was at the same time charged with the organization of this service, an organization of great advantage to history, science, commerce and travels. The most of the works of Jomard relate to geography, of which they include all branches.

Publication of the works of Lavoisier.—It was in 1836 at the College of France, in the course of his celebrated lectures on chemical philosophy, that Dumas undertook, as he says, the solemn engagement of collecting and publishing the complete works of Lavoisier. Since that time he has never ceased to be occupied with this idea; searching for documents in the papers of the family of Lavoisier, in the collections of autographs of various amateurs, and in the registers of the laboratory of the founder of chemistry. Dumas has succeeded in producing a complete work, full of new documents, as we have already mentioned, in our correspondence of the month of April, 1861, vol. xxxii, p. 99.

The funds for printing it have not been wanting: on the one hand the French booksellers could not do better than to undertake the publication of this work; on the other, the family of Lavoisier demanded the honor of publishing this monument to his memory; the city of Paris also claimed the same honor, and the Minister of Public Instruction, in the name of the state, claimed the right of paying this sacred debt of science to genius and misfortune. Consequently, the works of Lavoisier will be published at the expense of the government, but the family of the illustrious chemist add to the first volume a portrait of the philosopher.

The volume about to be published is the second: it contains 61 memoirs of Lavoisier composed during 22 years comprised between the dates of 1770 and 1792. "These are," says Mr. Dumas, "the memoirs characteristic of his work. After a careful examination I have resolved to arrange them in their chronological order giving to each its proper character and nomenclature, and to avoid adding, without the most absolute necessity, the least note to a text which in its admirable clearness had no need of annotation."

The note from which we cite these quotations was read lately by Dumas to the Paris Academy of Sciences. It is full of new and unpublished details in regard to the scientific life of Lavoisier, and a most interesting appreciation of his services. The reader will find it in the *Comptes Rendus* for Sept. 29th, 1862, pp. 526–528.[3]

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[3] In the session of the Academy Nov. 10th, Becquerel communicated a notice of a number of manuscripts of Lavoisier discovered in the public library of the city of Orleans by Loiselell, the librarian; he enumerates and analyzes the chief of these documents, treating of political economy, of canals, of the junction of the Loire to

Ozone and Nitrous Acid.—Fixation of Nitrogen in Plants.[4]—For some time we have observed a certain change in the results of the labors of Schönbein. Where once he recognized only ozone he discovers now only nitrous acid or nitrite of ammonia. We are far from denying the importance, utility and scientific bearing of the researches of the learned chemist of Basle. But as one becomes somewhat acquainted with this subject it is evident that Schönbein has done justice tardily to those who have preceded him in this question. Of this number is T. Sterry Hunt, who, as our readers will remember, long since showed that nitrite of ammonia may be formed by means of nitrogen and water (*this Journal*, [2], xxxii, 109), and thus led the way to a new theory of nitrification. This is what Boettger arrived at, who first announced that nitrite of ammonia is a constant product of all combustion in the air.

The important discoveries which Schönbein has since made, and which are explained in the *Journal fur Prakt. Chemie*, lxxxvi, 129, and in the *Journal de Pharmacie et de Chimie*, xli and xlii, fully show that this point was entirely developed by T. Sterry Hunt, and became thus the occasion of objections which have been frequently made to the employment of paper saturated with starch and iodid of potassium (or ozonometric paper) for determining the presence of ozone in the air. Since by the sole fact of the evaporation of the water an appreciable quantity of nitrous acid or of nitrite of ammonia is produced, and since this product is increased when the water contains calcareous substances, it is evident that the coloration which is observed upon the ozonometric paper which has been exposed to moisture in contact with air does not indicate the presence of ozone, but only the greater or less energy with which the nitrite of ammonia is produced during the evaporation of the water which moistens the sensitive paper.

Another point of the highest importance which follows from these researches relates to vegetable physiology, viz., the assimilation of nitrogen by plants. This great question, which has been for some years so vigorously debated in France, and over the whole world of science, and which experiments tend to resolve affirmatively, the last researches of Schönbein elucidate by a fact previously unnoticed. Nitrite of ammonia is formed simply by the evaporation of the moisture collected by the leaves of plants (*Journal de Pharmacie et de Chimie*, Oct. 1862, p. 340); it is also formed every time that a body is burned in the air (Boettger confirmed by Schönbein); in the same manner its production accompanies a great number of chemical reactions, when they take place in the presence of air.

We thus find more sources of $AmONO_3$ than are necessary to explain the important fact, discovered by Boussingault,[5] of the nitrifica-

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the Eure and to the Seine, on savings' banks, assurance, &c. He ends by the exclamation "Honneur au grand chimiste! honneur au grand citoyen!"

Abbé Moigno remarks in *Cosmos* (Nov. 14), 'it was not difficult to see that this communication annoyed M. Dumas, who considered himself alone entitled to explore the rich mine of the inedited works of Lavoisier.'

[4] An abstract of Schönbein's results has already been given on p. 111-113 of this volume. See also beyond, Hunt's note of reclamation on this discovery; also Prof. Hunt's correspondence, p. 271 (beyond).

[5] See his work entitled, "*Agronomie, Chimie Agricole et Physiologie.*" See also this Journal, [2], xix, p. 409.

tion of fallow land, to account for the origin of nitrogen in plants which have been raised out of contact with sources of ammonia.[6]

In a similar way we can explain the source of nitrogen in mycoderms, without supposing the intervention of a peculiar property of these cryptogams as was done recently by Jodin, a physiologist who observed that solutions containing sugar, tartaric acid, glycerine and phosphates, and free from nitrogenous compounds, organic or mineral, were yet able to produce rich mycodermic vegetables containing in the dry condition 4 to 6 per cent of nitrogen.

Enclosed in tubes hermetically sealed, in presence of an artificial atmosphere of oxygen and nitrogen, we easily show, says Jodin, a very notable absorption of nitrogen, and this absorption continues, within certain limits, even when the liquid contains an appreciable proportion of ammonia or of an albuminoid substance, such as milk. The absorption is measured by the development of vegetation. This absorption of nitrogen is explained by the formation of nitrite of ammonia which, as Schönbein has shown, always takes place in these conditions. The mycodermic plants are able to facilitate it by reason of their avidity for the salts of ammonia, which they take up in proportion to their production, and constantly freeing the soil they maintain it in a condition to form new proportions of nitrites.

The process employed by Schönbein to detect the presence of nitrous acid consists, (as is well known,) in the use of a solution of starch containing iodid of potassium, which he pours into the liquid to be examined, and to which he adds a little very dilute sulphuric acid. We may observe that this reaction serves quite as well to recognize the presence of ozone, chlorine, bromine, or iodine, as of aqua-regia, hypochlorous, or hypobromous acid: in fine, that, without wishing to throw any doubt upon the results obtained by Schönbein, we may still inquire whether it is proper to attribute to nitrous acid all the colored reactions produced in starch. For example, Schönbein admits that both the mortar of old walls and urine contain *great quantities of nitrous acid* (*Journ. de Pharmacie et de Chimie*, xli, 431), but it is sufficient that these substances contain chlorids, which is a constant fact—and frequently also nitrites. In presence of sulphuric acid, the alkaline chlorids give chlorohydric acid, which, with nitric acid, also set free, produces aqua-regia, the action of which upon iodid of potassium is well known.

Since this objection was presented to Schönbein (who formally rejected it), he appears suddenly to have taken it into consideration, for now he does not know whether the nitrous reaction produced by urine is due to the nitrous acid which it contains as such, or whether the aqua-regia is produced as we have just suggested.—(See *Journ. de Pharmacie*, for November, 1862.)

Electro-metallurgy.—A new kind of industrial Painting.—This new kind of painting, which is just now being applied to many monuments recently constructed in Paris, was invented by the artizan who established in France the *electro-metallurgy of copper*, Mr. Oudry, who, by a very simple process, has succeeded by the aid of electricity in covering

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[6] On these questions see also "*Leçons faites à la Société Chimique de Paris en 1861*," p. 138, &c. *Paris*, chez Hachette.

statues and other ornaments in iron or brass with a thin layer of copper. One of his last works was the galvanic coppering of the monumental fountains in the *Place de la Concorde.* Three months sufficed him for covering 190,000 kilograms of iron with a layer of copper two millimetres in thickness, weighing nearly 16,000 kilograms. Persons who know that iron rapidly oxydizes in the presence of a layer of copper which covers it galvanoplastically would not anticipate very great durability for these works of art. They will have a different opinion when they know that the layer of galvanoplastic copper is nowhere in contact with the nucleus of iron, and that the two metallic surfaces are completely isolated from each other by a kind of varnish or glazing, which is applied with a brush and which dries very rapidly by reason of the benzine which it contains. The real novelty of the process consists in the application of this enamel and in the means employed for handling easily the huge pieces of metal on which the copper is to be deposited.

It is well known that the glazing is rendered a conductor by a layer of graphite. The piece to be coppered is plunged into the bath of the sulphate of copper and there acts as the negative metal; it is connected with the zinc pole or positive metal contained in porous vessels filled with acidulated water; these porous vessels are also placed in the bath. The whole as we see is an inversion of the pile of Daniell. Frequently also the porous vessels are replaced by bladders. The coppering of the two monumental fountains at the *Place de la Concorde* required the employment of 5700 bladders.

When the layer of varnish is well applied there is no danger of the oxydation of the iron. It is thought that a greater difficulty may arise from the unequal expansion of the two metals. The coefficient of dilation of cast iron is 0·00111, while the coefficient for copper is 0·00171. Although this danger is exaggerated, we should remember that the galvanoplastic copper is very porous. The copper is also very friable and easily pulverized. It is with this copper, reduced to an impalpable powder, that Mr. Oudry has effected his new style of painting; the powdered copper is diffused in varnish prepared in benzine, which serves for a coating to the brass or iron which it is proposed to cover with copper by this process.

As we see, the preparation of this color is not difficult, and it is prepared without very great expense. It is easily applied to wood, plaster, cement, brass or iron, and also to the hulls of ships. It forms a perfect covering, dries rapidly, and takes an agreeable lustre susceptible of receiving, by means of chemical agents, the tone of bronze, bright or dark, verd-antique, or Florence green, which has never before been communicated to pure copper. Ornaments in brass or statues in plaster, when painted in this manner, lose none of their most delicate details, and they assume completely the appearance of objects in bronze. Even statues in plaster appear to resist remarkably inclement conditions of the atmosphere. Oudry has recently mingled with his glazing colors having a basis of lead, zinc, or other substances commonly used for painting buildings, and he has learned that this substitution may be made with advantage. Painting with the glazing, which at Paris they call *metallic painting* because it contains a small quantity of porphyrized copper, dries more rapidly than the old kind of paint, after the second day it ceases to emit any odor, and furthermore it presents a very fine grain and shines with vivid brightness. Since by reason of the discovery of nitro-benzine and aniline the price of benzine has considerably advanced, Oudry has commenced to use instead the mineral oil which Canada and Pennsylvania send to Europe in such great quantities. This new employment, if it becomes general, cannot fail to dethrone oil of turpentine and the drying oils.

By mixing the powder of galvanoplastic copper with certain fatty oils, Oudry obtained very beautiful greens of varied hues.

Oxygen Gas to counteract Gangrene.—In our last communication we referred to the satisfactory results obtained by the use of carbonic acid gas in the treatment of obstinate ulcers. In the Hospital *Hotel Dieu* at Paris, experiments have been made which induce the belief that it is possible to cure gangrenous limbs by exposing them to an atmosphere of oxygen. The following circumstances have led to these experiments. Quite recently a young physician, in a thesis submitted to the Faculty of Medicine, put forth this opinion that "*Gangrene consisted essentially in the diminution or absence of the oxygen necessary to the integrity of the life of a tissue.*" The author of this proposition, Maurice Raynaud, deduced it from chemical analyses of gangrenous parts.

Upon this conclusion, Dr. Laugier, Surgeon-in-chief at *Hotel Dieu*, bases the treatment under consideration. At the very time when he read the thesis of Dr. Raynaud, he had a case of spontaneous gangrene under his care at *Hotel Dieu;* the idea occurred to him to expose the gangrenous parts to an atmosphere of oxygen. The patient was 75 years of age; the disease was seated in one foot, one toe being already mortified; the skin upon the small part of the foot was painful and altered in color, and the foot itself even in danger of destruction. The member was placed in a simple apparatus which was arranged to disengage oxygen continuously without requiring to be renewed. In a very little time, says Dr. Laugier, the gangrene was arrested, and the parts menaced returned to a healthy state. The eschar upon the toe disappeared little by little, a cicatrix formed and the disease was cured.

A second experiment was made in the same hospital upon another patient also 75 years of age. A rapid change took place in the condition of the ulcer which promptly advanced to a cure.

If these facts are confirmed in other cases of spontaneous gangrene, this observation will prove of great service to humanity, and a new proof of the advantage to physicians from the pursuit of chemistry. The following fact, taken from the works of French physicians, shows that what is here claimed for chemistry may also be affirmed of natural history.

Treatment of Tubercular Leprosy, or the Red Disease of Cayenne.—About 30 years ago, Dr. Guyon, residing in a tropical country, was a witness of the liveliest anxiety of a family in which the elder son, from ten to twelve years of age, became affected with tubercular leprosy developed spontaneously. A son and a daughter still remained to the parents. Dr. Guyon, having been requested to examine the young patients, recognized upon their little bodies indications of the dreaded disease. These indications consisted in rose-red spots upon the skin, with insensibility. This was the *red disease of Cayenne*, the first stage, within the tropics, of tubercular leprosy. As he was reminded of this terrible disease, Guyon advised to remove the young patients from the influence of the climate, and to send them as soon as possible to France, basing his opinion upon a well known fact in natural history.

The *Red Disease of Cayenne* is said to be a product of the country: it ought therefore to happen with this disease as with plants of the same country, the seeds of which when transported to France do not develop, although some of them may germinate.

The afflicted family were in affluent circumstances, and their decision was soon formed, they settled their affairs and removed to France. This took place in 1826, and what was the result? Just what had been anticipated. The disease was not indeed healed, for the marks which already existed remained as they were; but its progress was arrested and the spots did not increase in extent. Becoming adults, the two young people were married, and both had children, of both sexes, without the occurrence of anything extraordinary in regard to the health of either.

Preservation of Wood.—It has long been known that wood may be preserved by carbonizing its surface, and in the country this method is generally adopted when piles or posts are planted in the earth, because that wood thus treated very completely resists the action of both air and water. At the commencement of the present century, Berthollet proposed to carbonize the interior of casks designed to contain portable water for the use of mariners, but he did not succeed in any prompt and sure method of effecting this carbonization in a uniform manner. Such a method has now been discovered and its application in government vessels is commenced.

The process of Mr. de Lapparent, consists in directing, against the surface of wooden structures to be preserved, a jet of inflammable gas which burns the wood to the depth of about one fourth of a millimetre. The operation is performed in the interior as well as the exterior of casks after they are entirely set up and ready to be cased.

[The jet which is best adapted to this purpose is that known as Daniell's jet, the coal gas being in the exterior envelope, and the air from a smith's bellows being blown through the interior pipe. I have repeated Mr. Lapparent's process with satisfaction, and have advised its adoption in the American iron clad Navy.—S.]

In localities where illuminating gas is not available Lapparent recommends to use the "*water gas*," obtained by passing a current of vapor of water over incandescent charcoal, which burns by depriving the water of oxygen and gives off hydrogen and oxyd of carbon, which in the absence of a gasometer are conducted directly to the point where the charring of the wood is to be performed.

An idea may be obtained of the economy of this application from a consideration of the fact that war vessels require for repairs of water casks after five years' service $\frac{17}{24}$ of the cost of their construction.

The Orleans railroad company have already applied this process to the preservation of railroad-ties. 20 kilometers of such ties have already been laid down, and we shall soon learn the results. Finally, the government of Holland have made use of the same process for carbonizing timbers 5 or 6 metres in length, designed to be buried in the earth for strengthening the dykes, which in that country require continual repairs.

The Ceramic Arts of the London Exhibition.—For the following review we are indebted to Mr. Salvètat, director of the manufactory of Sèvres, and member of the Jury of the Exhibition. One general fact, he remarks, is presented by the Exhibition of 1862, and this fact is observed in the ceramic products as well as in very many others.

France, skillful in details, does not possess that happy talent for practical application which we observe in the Anglo-Saxon race, with their abundant resources, perfect workmanship, admirable fabrics, and industrial organization. But we find in England few of the novel ideas of which such a suggestive collection is crowded into the Ceramic Courts of the French.

In the French department, we find numerous exhibitors who, in different ways, are engaged in producing ornamental ceramic objects by the application of fine arts to manufactures, but they are deficient in certain practical notions of technology so fully developed by English manufacturers. Artistic taste has however increased in a surprising manner in England since the Exhibition of 1851. Messrs. Minton, Copeland and Wedgewood, have shown with what rapidity change is possible in that country which some have represented as entirely destitute of artistic tendency.

Some improvements which French industry has introduced into the ceramic art are worthy of mention.

To the Imperial manufactory at Sèvres is due the development of processes by the aid of which objects are formed of an entire piece in colored porcelain mass decorated at a high temperature without repeated bakings.

The number of metallic oxyds which it is possible to introduce into the mass has, as a consequence, considerably increased, and substances have been added capable of correcting the excess of fusibility of the clays thus colored. Again, it has been found that the action of the oxygen in flame and of the products of incomplete combustion modifies the shade of the clays, and produces with one and the same material very different colors. Thus, with the oxyd of chromium in a reducing atmosphere a blue shade is obtained, while with an oxydizing atmosphere a green color is produced, showing ruby red in the light. With the oxyd of uranium, in an oxydizing atmosphere, a pure yellow is brought out, and hues varying from reddish brown to black in the reducing atmosphere.

I would also call attention to the successful efforts made in the manufactory of Bordeaux to replace the old potter's wheel by mechanical means.

The art of brilliant gilding, whereby the cast leaves the mould with a metallic lustre without recourse to burnishing, has been largely developed at the hands of its discoverers, the Messrs. Dutertre. The discovery of other metallic lustres made by Messrs. Gillet and Brianchon; the application of chromo-lithography to the decoration of pottery; the employment of a vacuum, or of compressed air, to obtain perfect impressions in moulds, are equally interesting results, honorable to French industry.

"The employment of chromo-lithography appeared, it is true, in the exhibitions of Spain and of the Zollverein. But it should be stated that at Seville it was introduced under a license from a French patent, and that in Germany the specimens exhibited showed the application of the art to be in a rudimentary condition."

Mr. Salvètat remarks also that the English exhibitors have produced a new ceramic composition which is a perfect imitation of ivory. The process of its manufacture has not been made known.

Bibliography; Recent publications by HACHETTE & Co., Paris.

Leçons de Chimie et de Physique Professées en 1861 *à la Société Chimique de Paris.*—These lectures belong to the series which we noticed last year, and they have met with the same success, for the lecturers have treated only of subjects in which they have made extensive researches and important discoveries. The following are the subjects treated:

On the fusion of platinum and the production of high temperatures; by Mr. Debray (the associate of St. Claire Deville).

On the optical study of sound; by Mr. Lissajous.

On nitrification and uses of nitrates in vegetation; by Mr. Cloës.

On the luminous effects resulting from the action of light upon different bodies; by E. Becquerel.

On the organized corpuscles which exist in the atmosphere; being an examination of the doctrine of spontaneous generation; by Mr. Pasteur.

Entretiens Populaires à L'Association Polytechnique; 2nd series, 1862, in 12mo. This volume contains a series of lectures delivered by Babinet upon the physics of the globe.—Geoffroy St. Hilaire, upon acclimation.—Bouchardat, upon the abuse of fermented drinks.—Perdonnet, upon great inventions.—Homberg, upon the bleaching of linen.

Bréguet.—Manuel de Télégraphie Electrique, 4th edition, 1 vol. in 12mo, with figures, 1862. This volume is divided into four parts. The *first* contains the principles of Physics indispensable to the study of telegraphy. The *second*, the arrangement of the apparatus most frequently employed. *Third*, the study of telegraph lines, aerial, subterranean and submarine. *Fourth*, applications of electricity connected with electric telegraphy, such as electric clocks and domestic annunciators.

Mr. Bréguet, who is a member of the Bureau of Longitude, has under his direction all that relates to electric telegraphy, and to accurate apparatus in which electricity plays a part; his book has therefore an importance perfectly legitimate.

Mayer et Pierson.—La Photographie considérée comme art et comme Industrie. 1 vol. in 12mo. Mayer and Pierson are the photographers who by their beautiful works have recently caused it to be decided that *photography is an art*, and that therefore it has in its sphere the same claim as the painter at his canvass and the sculptor at his statue. Their book does not give all the details of the photograph business, but it gives definite directions in regard to the manner of placing objects in such a manner as to make them appear to advantage. They also give interesting details of the early history of photography and its relation to Daguerre and Niepce, and finally they close with the history of the grand civil suit which resulted in giving aid to photography and in causing photographs to be received in the exhibition of works of art.

Aug. Dupeyrat.—Canal Maratime de Junction de l'Ocean à la Mediterranie, a brochure in 8vo.—Here is the complete realization of an idea of the 17th century, to wit: to unite Bordeaux to the Mediterranean, so that ships of large tonnage may be relieved from the necessity of going around Spain by way of the Straits of Gibraltar. This idea is now important as following the cutting through of the isthmus of Suez, and will thus serve to bind together the West and the Orient.

Ach. Fillias.—Geographie Physique et Politique de l'Algerie. 1 volume in 12mo.—This work, which gives important details of statistics, closes with a geographical and historical dictionary of all the localities belonging to this French province.

Sédillot.—Histoire des Arabes, a volume 12mo with one plate. The subject of Algeria is ably treated in this book, in which the author proves that the Arab race was much better fitted for the pursuit of mathematics, geography and astronomy than the Hindoos or the Chinese; he has taken this nation at its origin, and has studied it with care in the different phases of its existence.

Ladevi-Roche—Unité des Races Humaines, a brochure in 8vo. The author decides in favor of this unity, after a profound examination of the moral nature of man in connection with an examination of physical facts which have been demonstrated by different observers.

Ch. Musset.—Hetérogénie ou Génération Spontanée, in 4to with plates. Mr. Musset is a great partisan of spontaneous generation, which he supports by observations which he has made with care in common with Joly of Toulouse.

By H. Bossange, Quai Voltaire, 25, Paris.

Achille Delesse.—Carte Agronomique des Environs de Paris, 1862.—For some time past they have undertaken, in France, to represent the vegetable world and its composition by special charts called *Cartes Agronomiques*. The chart which Delesse has made of the environs of Paris has a special interest because it makes known more completely the Parisian soil recently so deeply explored for the sake of the quarries of building stone which it contains. One peculiar feature of this soil is that the quarries are all in the valleys or upon the slopes of the hills, while the tops of the hills are sandy. The three elements of arable soil, the calcareous, the clayey, and the sandy, are largely represented in the soil of Paris, while the proportions vary considerably. These proportions are clearly shown in the chart of M. Delesse by the aid of well selected colors. [We acknowledge the reception of this brochure from the author.—*Eds.*].

Biguyer de Chancourtois.—Vis Tellurique.—This work consists of a natural classification of simple bodies as well as of organic radicals, effected by means of a system of 'helicoid' and numerical classification. This classification which depends especially upon the physical properties of bodies, conduces, very frequently, to results which accord with chemical observations. It was thus that the place of rubidium was marked upon the helix of M. de Chancourtois before that he knew the physical properties of this metal; so also the simple bodies which we have named semi-metals (*Journal de Pharmacie*, xl, p. 23) and which as we have seen form a class by themselves, appear in the table of M. de Chancourtois under the name of intermediate bodies, results to which M. de Chancourtois has been led from considerations totally different from our own. The same considerations led him to double certain equivalents, such as C, O, S, Se, Te, &c., just as has been done in the notation of Gerhardt. These parallel coincidences are certainly not accidental, they reveal a fundamental law of which the "*vis tellurique*" appears to give the key.

A. Scheurer-Kestner.—Principes Elémentaires de la Théorie Chimique des Types Appliquée aux Combinasions Organiques.—The leisure imposed by a political imprisonment has given to the author, a young chemist full of ardor, the idea of making for the chemical theory uppermost in his mind a sort of catechism for the use of persons who desire to become acquainted with this theory, deduced from the labors of Laurent and Gerhardt, of Dumas, Wurtz, Hoffman, Williamson, T. Sterry Hunt, &c. This theory is explained with great clearness and supported by numerous examples.

Boussingault.—Agronomie, Chimie Agricole et Physiologie, tome II.—This second volume is occupied for the most part with the great question of nitrification, and the assimilation of nitrogen by plants. All these questions are examined with the well known talent of Boussingault, and all lead invariably to this conclusion, that if plants derive nitrogen from the atmosphere it is not taken up in the form of nitrogen gas. Upon this subject the author cites numerous observations made by Messrs. Lawes, Gilbert, and Pugh.

H. Laurent.—Theorie des Séries.—The name of the author and the title of the work, lead one to suppose that he refers to the homologous series; this is an error. The work is devoted to mathematical analysis and the application of this theory to the calculus of transcendental expressions. It was at the polytechnic school, which he has left, that M. H. Laurent composed this valuable work. Our readers will learn with pleasure that this young mathematician is the son of Auguste Laurent, the great chemist, whose biography we have given in this Journal, ([2], xvi, p. 103).

J. Nicklès.—Theorie Physique des Odeurs et des Saveurs. A brochure in 8vo, 1862.—The author has taken the idea of this work from what has been previously stated, (this Journal, [2], xxviii, p. 427). This question, at once so interesting and so little studied, has in the new work been thoroughly examined upon theoretical considerations and also experimentally.

3. *Correspondence of* T. Sterry Hunt, F.R.S. (In a letter to the Editors, dated Montreal, February 1, 1863.)

Gentlemen,—You have given, on page 113 of this volume, an abstract of Schönbein's and Böttger's important observations upon the formation of a nitrite with ammonia, at the expense of water and atmospheric nitrogen. May I beg of you, as an important part of the history of this subject, and especially as an explanation of the theory of the reaction, to reproduce from the *L. E. and D. Philos. Magazine* for January, 1863, the following translation of a note *On the nature of Nitrogen, and the theory of Nitrification*, read by me before the French Academy of Sciences, on the 15th of last September, and published in the *Comptes Rendus* of that date (p. 460). My object is to claim for myself the new theory of nitrification, which Schönbein seeks to found upon his recent experiments, and which I published nearly two years since. It is in reality but a natural deduction from my view of the double nature of nitrogen, as the nitryl of nitrous acid, which I have maintained since 1848.

I am not aware whether my announcement of the production of ozone from permanganic acid, a discovery which is claimed both by Schönbein and Böttger, is anterior to that of the last named chemist. My own notice of it, which appeared in this Journal for July 1861, (vol. xxxii, p. 109) was dated and sent to you in Jan. 1861. (You are aware that the date of 1860, there assigned to it, is a printer's error.) The observation however has not the merit of great originality, for I was led to it by a remark in *Gmelin's Handbook* (Cavendish Soc. Ed., iv, p. 211) published in 1850, where Forchhammer's remark, that permanganic acid evolves "an electrical odor," is cited, with a suggestion that this may be due to ozone.

In two notes to my paper on petroleum (this vol., pp. 158 and 162), I have had occasion to call attention to my long since published views, on the equivalents of carbon, oxygen, etc., and on the constitution of gelatine and the albuminoids. These, after many years, are being resuscitated, and, like my theory of chemical types, are making progress in the scientific world. In this connection I may be permitted to express my satisfaction that the Kantian doctrine of the interpenetration of matter, which I set forward ten years since, as lying at the basis of a true chemical philosophy, is finding an exponent in Mr. Charles Peirce, whose paper on *The Chemical Theory of Interpenetration* appears in the last number of your Journal. See, on this subject, my paper *On the Theory of Chemical Changes*, which appeared in this Journal for March, 1853, (vol. xv, p. 226,) and was reproduced in the *L. E. and D. Philos. Magazine*, and in a German translation in the *Chem. Centralblatt.* See also my *Thoughts on Solution*, (vol. xix, p. 100), where, while still asserting interpenetration, I say that Kant's definition of chemical union "involves a mechanical conception, and is therefore inadequate. That of Hegel, in which chemical combination is said to be an identification of the different, is however completely adequate. His process involves an identification not only of volumes, (interpenetration, mechanically considered,) but of the specific characters of the combining bodies." See this doctrine taught by Stallo, *Philosophy of Nature*, p. 87. See also my objections to the Atomic hypothesis, in a note *On Atomic Volumes*, read before the

French Academy in 1855, (*Comptes Rendus*, xli, p. 77). The mechanical and material hypothesis, which belong to the infancy of the chemical and physical sciences, are gradually being repudiated, and these sciences themselves placed upon a philosophical basis. I shall be happy to believe that I have contributed to spread more just philosophical notions among modern chemists.

"In 1848 I suggested that free nitrogen is the nitryl of nitrous acid, NHO_4, $NH_3 - H_4O_4 = NN$, corresponding to the nitric nitryl, NNO_2, and to the phosphoric nitryl, PNO_2 (*American Journal of Science*, [2], v, 408; vi, 172; viii, 375). It might then be supposed that, like these two bodies, nitrogen should under favorable conditions fix H_4O_4, and regenerate nitrous acid and ammonia. In April 1861, I published a note in '*The Canadian Journal*' of Toronto, in which it was said that the spontaneous formation of these two bodies, by the combination of atmospheric nitrogen with water, would serve to explain the production of ammonia, so often remarked in the presence of air and reducing agents, and also the formation of nitrates in the experiments of Cloez, without the intervention of ammonia, and at the expense of air and water in presence of alkaline matters (*Comptes Rendus*, lxi, p. 135).

The simultaneous production of ozone and an acid of nitrogen by the electric spark, and during the slow oxydation of phosphorus, may be explained by the power of active oxygen to oxydize ammonia, thus setting free the acid of a small portion of regenerated nitrite of ammonia, and even, in accordance with the observations of Houzeau, carrying its oxydizing action so far as to acidify the nitrogen of the atom of ammonia. Certain of the reactions attributed to ozone would thus, as many chemists have already maintained, be due to a minute portion of nitrous acid, which is formed when active oxygen is brought in contact with moist atmospheric nitrogen. On the other hand, the hydrogen set free by reducing agents may, by destroying the acid of the regenerated nitrite of ammonia, set free the ammonia of the salt, and even form a second atom by the reduction of the acid (*The Canadian Journal*, March 1861). These views will also be found in a note written by me, and published in the *American Journal of Science* for July 1861 (page 109), and copied into the *Philosophical Magazine* for September 1861, and the '*Chemical News.*' I found that a current of air, which had passed through a solution of permanganate of potash acidulated with sulphuric acid, acquired the odor and the reaction of ozone. This disappeared when the air was passed through a solution of potash, which at the end of a certain time appeared to contain a nitrite. This reaction, which seems to indicate the formation of nitrous acid, not by an electric or a catalytic action accompanying the production of ozone, but by the action of nascent oxygen upon atmospheric nitrogen in the presence of water, supports the above views, and, as I have remarked in the note in question, furnishes the key to a new theory of nitrification.

The formation of nitrite of ammonia, by the combination of the nitryl NN with H_4O_4, must necessarily be limited to very minute quantities by the instability of this ammoniacal salt, which, as is well known, decomposes readily into nitrogen and water. In order therefore to produce any considerable quantity of a nitrite by this reaction, there is required the presence of active oxygen or of a fixed base to separate the ammonia.

The recent experiments of Schönbein have furnished new evidences of the direct formation of a nitrite at the expense of the nitrogen of the atmosphere. According to him, when sheets of paper moistened with a feeble solution of an alkali or an alkaline carbonate are exposed to the air, especially in the presence of watery vapor, and at a temperature of 50° or 60° C., the alkaline base soon fixes a sufficient quantity of nitrous acid to give the characteristic reactions. Appreciable traces of nitrite are, according to Schönbein, obtained in this way even without the intervention of an alkali. He moreover found that distilled water, mixed with a little potash or sulphuric acid, and evaporated slowly at a temperature of 50° C. in the open air, fixes in the one case a small portion of ammonia, and in the other a little nitrous acid. Traces of a nitrite are also formed in pure water under similar conditions. Schönbein explains all these results by the combination of nitrogen with the elements of water, producing at the same time ammonia and nitrous acid. As he has well remarked, this reaction serves to explain the absorption of nitrogen by vegetation, and, through the oxydation of nitrites, the formation of nitrates in nature. By these elegant experiments, he has confirmed in a remarkable manner my theory of nitrification, and of the double nature of free nitrogen. It is however evident that, since the publication of my note of March 1861, referred to above, we cannot say with Schönbein that the generation of nitrite of ammonia from nitrogen and water is "a most wonderful and wholly unexpected thing." (Letter from Schönbein to Faraday, *Philosophical Magazine*, June 1862, p. 467.) I cannot, however, admit with these gentlemen that the results of Schönbein are due to evaporation, except in so far as the coöperation of water and a slightly elevated temperature are necessary conditions of the reaction."

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY.

1. General Chemistry.

1. *Thallium*:—Dumas read before the French Academy, on the 15th of December, an elaborate report on the memoir of Mr. Lamy upon *Thallium*. This report, read, as Abbé Mogrio says, "*au milieu du plus profond silence*," is so important and interesting that we print it in full, from the translation in the *Chemical News* of Jan. 10th.

"*Report on a Memoir of Mr. Lamy relating to Thallium*; by Mr. Dumas.[1]—At the origin of human societies, the arts of procuring fire at will, of cultivating corn, of extracting metals, were considered benefits so great that the inventors of these arts were ranked among the gods.

At the present day, the metals are so numerous that the discovery of a new simple body of this class is less astonishing to ordinary men, although the scientific interest attaching to the discovery has not at all diminished. So far from that, in proportion as new metals are pointed out, the characters which appertain to them throw, by comparison, a strong light on the characters, similar or opposite, which are found in the older metals.

As soon as the bold and felicitous labors of Bunsen and Kirchhoff had shown, beyond doubt, that, in studying natural products by spectrum analysis, it was possible to discover traces of metals which ordinary analysis was powerless to recognize, rubidium and cæsium were considered by all chemists as only the two first terms of a long series of new elements. Every one understood that the residues of manufactures, in which, by the elimination of known and useful products, were concentrated the inappreciable traces of useless and unknown substances that the matter originally worked sometimes contained, offered a mine worth exploring.

It was, therefore, natural enough that Mr. Crookes in England, and Mr. Lamy in France, should submit to spectrum analysis the products of the combustion of iron pyrites, which for some years have played such an important part in replacing sulphur in the manufactare of sulphuric acid; and it is easy to understand, when one has seen it, that the beautiful green line, produced in the spectrum by the new body which forms the subject of this report, could not have escaped the observation of either the one or the other.

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[1] *Comptes Rendus*, lv, p. 866.

But, in our opinion, it is neither the process by which the new metal was recognized, nor the material which furnished it. that commends it to our notice. Spectrum analysis has completed its proofs, and manufacturing residues have long since been recognized as fruitful mines to explore. But thallium is destined to mark an epoch in the history of chemistry by the astonishing contrasts exhibited between its chemical characters and physical properties. It is no exaggeration to say, that, in regard to the classification generally accepted for the metals, thallium offers an assemblage of contradictory properties which entitles it to the name of a metallic paradox—the ornithorhynchus of metals.

We shall not detain the attention of the Academy on the history of its discovery. No one disputes that Mr. Crookes first saw, on the 30th of March, 1861, the green line characteristic of thallium in certain selenium residues; that he recognized it again in the products of a specimen of sulphur from Lipari, and in those of a pyrites from Spain; and that he described and named thallium as a new simple body.

Nor will any one dispute that Mr. Lamy was the first to isolate thallium, and establish, in the sequel, that it was not a metalloid analogous to selenium and tellurium, as Mr. Crookes, who had never obtained it free and pure, thought; but that it was, in fact, a true metal. Mr. Lamy announced his discovery to the Société Imperiale of Lille on the 16th of May, 1862, and on the 10th of June he submitted to the jury of chemists in London, in the presence of Mr. Crookes, a beautiful ingot of thallium. If the latter gentleman considered that he had any rights to preserve, he should at once, as is usual in such cases, have taken the members of the jury to his laboratory, and exhibited his notes and his products, instead of silently listening to the communication of Mr. Lamy, and depositing at the Royal Society, eight days afterwards, a note indicating that he had long been aware of the metallic nature of thallium, and was acquainted with the essential properties of the new body.

The historical point which engages us—for, in chemistry, the discovery of each new simple body has its legend or its history—is determined by two authentic dates; one of these is the 30th of March, 1861, on which day Mr. Crookes announces the existence of a new body which he believes to be non-metallic, characterized by the brilliant green line: the other is the 16th of May, 1862, the day on which Mr. Lamy makes known the metal as a metal, and who alone possesses it.

It was in the sulphuric acid manufactory of our learned *confrère*, Kuhlmann, among the sediment of the leaden chambers fed by Belgian pyrites, that Lamy discovered thallium in tolerably large quantity, and in a form which made it easy to extract; for, by a little manipulation, it could be brought to the state of sulphate or chlorid, from which combination the metal itself can be easily separated by means of zinc, which takes its place, and precipitates it in crystals, in the same manner as lead.

The Academy will permit us to draw attention to the importance which attaches, in cases of this kind, to positive characters, like those given by spectrum analysis. We shall see, as we proceed, that, beyond his certain conviction and natural penetration, a sure guide was necessary to Mr. Lamy, to prevent him from going astray in the first steps of the study. In fact, if the green line had not been there to prove incessantly that he was not dealing with lead or a plumbiferous alloy, how many chemical reasons were there for thinking that such was the fact! This metal, which is separated like lead from solutions of its salts, by means of zinc, presents the appearance of lead. It has nearly the same color as lead; is scratched and cut like it. It makes a streak on paper like that which lead produces; it has the same density, and and very nearly the same melting point. It possesses the same specific heat. Its solutions are precipitated black by sulphuretted hydrogen, yellow by iodids and chromates, and white by chlorids, just as those of lead are. We do not then hesitate to assert, that, without the aid of spectrum analysis, this curious and important metal must have remained unrecognized; that, even with this help, it was easy to be mistaken; and that Mr. Lamy has given proofs of great sagacity, when he places, without hesitation, a metal so much resembling lead in its essential properties beside the alkali metals, potassium and sodium, which it resembles so little.

Thallium is a perfect metal, endowed in the highest degree with a metallic lustre, as is seen on examining a freshly-cut surface, or on heating a bar strongly in hydrogen, and allowing it to cool in that gas. It is less blue than lead, less white than silver, and, in its color, more resembles tin or aluminium than any other metal. It softens at 100° C., and, if kept for some time at that temperature, a crystalline structure becomes apparent in the ingot: this is shown by the appearance of a beautiful watering (*moiré*), produced when the metal is moistened with water, which cleanses the surface like acids.

Before the blowpipe, thallium exhibits some characteristic phenomena. It melts rapidly, and oxydizes, giving off odorless fumes, of a whitish color, but mixed with reddish or violet tones. It continues to give off the fumes a long time after the heating has ceased. When the principal globule has cooled, it is found to be surrounded with small globules of the volatilized metal. In a closed tube, it melts in the flame of a spirit-lamp, oxydizes rapidly, giving an oxyd which, when hot, calls to mind the appearance of rubies (metallic sulphids), and when cold more resembles litharge: this is a compound of the protoxyd of thallium with the silica of the glass. A globule of the metal, heated over a spirit-lamp in a bulb tube open at both ends, and inclined to facilitate the passage of air, soon melts, forming a layer of the ordinary brown fused oxyd, but, at the same time, giving off abundant fumes, which condense, a short distance from the bulb, as a reddish or violet amorphous powder. When a globule of the metal is placed on a cupel heated to redness, and then plunged into oxygen, the metal burns brilliantly, and oxydizes, the fused oxyd sinking into the cupel. This oxyd is either the peroxyd of thallium, or a mixture of the proto- and peroxyd of thallium.

Mr. Lamy has discovered that thallium forms two oxyds: the protoxyd, a strongly alkaline base, like soda and potash; and the peroxyd, which gives up oxygen when heated with strong acids, and may be converted into a chlorid, which, when heated, gives up a part of its chlorine. Chemists, however, will notice that the protoxyd of thallium, which corresponds to potash, so far from having, like potash, a great affinity for water, loses its water readily when heated, or even when cold in a vacuum. There then remains the reddish anhydrous oxyd while the hydrated oxyd is yellowish white: the oxyd is hydrated or dehydrated with equal facility. It will be further remarked, that the peroxyd of thallium, in the experiments of Mr. Lamy, has given no sign of the formation of oxygenated water.

Thallium burns in dry chlorine. It forms three chlorids, one of which corresponds to common salt, another to sesquichlorid of iron, while the third is a bichlorid corresponding to corrosive sublimate. The protochlorid is white, fusible, slightly soluble, and, when prepared in the moist way, is precipitated in large dense flocculi like chlorid of silver. Thallium can also form higher chlorids than the bichlorid, but their composition is not definite.

Only the proto-iodid and proto-bromid have been studied; they resemble the corresponding compounds of lead. Cyanid of thallium is soluble; but a crystalline precipitate of this salt is formed when concentrated solutions of cyanid of potassium and of a salt of thallium are mixed.

The sulphid of thallium obtained by precipitation is brownish black; it resembles sulphid of lead. In whatever way obtained, it easily oxydizes in the air, and is converted into the soluble and colorless sulphate.

Thallium is very slowly attacked by hydrochloric acid even when concentrated and boiling. It is, on the contrary, rapidly attacked by nitric and sulphuric acids. The latter, concentrated and hot, dissolves it with a rapidity which contrasts with the slowness with which the same acid attacks lead.

In relation to the action of acids, thallium presents a complete opposition of characters to aluminium, the latter being quickly dissolved by hydrochloric acid, which does not attack the former, and resisting nitric acid, which easily dissolves thallium.

In the state of protoxyd, thallium forms soluble and crystallizable salts with carbonic, nitric, sulphuric, and phosphoric acids. The carbonate is a very characteristic salt.

The salts formed by the protoxyd of thallium with organic acids, which have been studied by Mr. Kuhlmann, Jun., are the oxalate, binoxalate, tartrate, paratartrate, malate, citrate, formiate, acetate, and some others of less importance. All these salts are soluble, and, according to Mr. La Prevostaye, some of them are isomorphous with the corresponding salts of potash.

Thallium, then, is a new metal well characterized. It is distinguished from all other reputed simple bodies by the beautiful green line it gives in the spectrum, and which corresponds to the line 1442 in the typical spectrum of Kirchhoff. From the examination of the solar spectrum, we may conclude that thallium does not exist in the solar atmosphere.

Thallium undoubtedly forms one of the family of alkaline metals, the number of which has been doubled by recent discoveries. At the beginning of this century, only two of these metals were known, potassium and sodium. Forty years ago lithium was added to the number; and within the last three years three others have been discovered, rubidium, cæsium, and thallium, all three by spectrum analysis.

From this we may be allowed to hope that the number of these metals, and of metals in general, is destined, by the application of this new method of analysis, to receive a rapid and considerable extension.

Among alkaline metals, thallium occupies the opposite extremity of a scale of which lithium forms the first term, and the equivalent weights mark the different degrees. The weights are, in fact, as follows:—

Lithium,	7
Sodium,	23
Potassium,	39
Rubidium,	85
Cæsium,	123
Thallium,	204

On this point it has been remarked,—

1. That the equivalent of sodium is exactly the mean of the equivalents of potassium and lithium: $\frac{39+7}{2}=23$;

2. That by adding double the weight of sodium to the weight of potassium, we obtain the weight of rubidium: $46+39=85$;

3. That by adding twice the weight of sodium to twice the weight of potassium, we get nearly the weight of cæsium: $46+78=124$;[2]

4. That by adding double the weight of sodium to four times that of potassium, we obtain nearly the equivalent of thallium: $47+156=202$.

These considerations are of a nature to attract the attention of chemists; and without attributing to them a value that the actual numbers would not justify, they show the interest which attaches to the careful comparison of the equivalents of bodies belonging to the same family.

The alkaline metals have this peculiarity, that to bring them under the law of Dulong and Petit—that is to say, to make their atomic heats equal the atomic heats of other metals,—it is necessary to halve their atomic weights. Thallium does not escape this rule. Its equivalent =204; but its specific

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[2] The new weight of *cæsium* (=133) obtained by Johnson and Allen (this vol., p. 94) does not support the combined numbers above given by Dumas. But if we add twice the weight of sodium to the weight of rubidium we have approximately the weight of cæsium: $46+85=131$.—Eds. A. J. S.

heat, as determined by M. Regnault (who appends a note on this subject to this report), being equal to 0·03355, it is necessary to reduce the atomic weight to 102. In the same way as potash has for its atomic formula K_2O, the protoxyd of thallium would have for its formula Tl_2O.[3]

The atomic volume of thallium will be equal to 8·5; and if we do not compare it with the volumes of sodium and potassium, it is because these present extraordinary anomalies which have not yet received sufficient attention from chemists.

In conclusion, we may remark that the series of alkaline metals actually known contains a body which possesses so light an equivalent that it may be placed near to hydrogen—that is to say, lithium; and also a body, thallium, which has so heavy an equivalent that it may be ranked by the side of bismuth, a metal which possesses the highest of equivalents.

We see that the discovery of new bodies extends the circle of our knowledge, not only by the facts with which they enrich practical science, but especially on account of the prospects revealed by the study of them, the laws they lead us to ascertain, and that freer and more general aspect under which we are taught to regard the properties of individual substances, their analogies, differences, and classification, and even their nature and essence.

For these reasons, and taking into consideration the difficulties overcome by the author, and the clearness and importance of his results, we have the honor to propose to the Academy that his memoir form part of the '*Recueil des Savants Etrangers.*'"

[In answer to the charges of a dishonorable character against Mr. Crookes contained in this Report, that gentleman replies as follows, giving also his grounds of priority.[4] Mr. Crookes' temperate and manly defense, under the peculiarly aggravating character of the assault made upon him, is worthy of all praise, and he certainly appears to free himself completely from the unworthy motives and practices attributed to him.—Eds.]

"*The discovery of the metal Thallium.*—In another part of this Number we print at length a translation of the report by Mr. Dumas on Mr. Lamy's latest observations on thallium. Our readers will hardly expect, interested as we are in this subject, that we should publish this report without comment. It will be seen that Mr. Dumas claims for Mr. Lamy the discovery of the *metal* thallium. Mr. Le Verrier had already made the same claim for Mr. Lamy in the journal *La France* for October 22, 1862; and, in reply to a letter of our own in answer to Mr. Le Verrier, published in the *Cosmos* for December 5, 1862, Mr. Lamy has since advanced the same claim for himself.

Now, as Mr. Lamy states (*Cosmos*, December 19, 1862, p. 681) that it is "priority of publication which constitutes priority of invention," we are induced to give a short *résumé* of dates in support of our own claim to the discovery—not only of the new element, but of its metallic character. Our readers will remember that it was in the CHEMICAL NEWS for March 30, 1861, we first announced "*The Existence of a New Element*, PROBABLY *of the Sulphur Group.*" The word *probably* is here of some importance, as showing the doubts we had at the time of the exact nature of the new body—doubts which were further indicated in

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[3] Mr. Dumas persists in using the symbol "Th," which we have already shown has been adopted for Thorinum.

[4] Chemical News, No. 162, p. 13, Jan. 10, 1863.

the title of our next paper—"*Further Remarks on the* SUPPOSED *new Metalloid*," in the CHEMICAL NEWS for May 18, 1861. Subsequent research soon proved to us that thallium was, in fact, a true metal, but the publication of this discovery was deferred.

Mr. Lamy's claim for priority of publication, and, consequently, priority of discovery, as advanced by himself, is founded on a communication made to the *Société Imperiale des Sciences, de l'Agriculture, et des Arts*, of Lille, on May 16, 1862. On May 1, 1862, however, the International Exhibition opened, and there, in a case, deposited some days before, and open to the inspection of the numerous scientific men of all countries who were present on the occasion, was displayed several grains of the new body, with the following label—'*Thallium, a New* METALLIC *Element, discovered by means of Spectrum Analysis.*' Besides this there was a card, on which was written '*Chemical Reactions of Thallium, by which it is distinguished from every other known element. It appears to have the character of* A HEAVY METAL, *forming compounds which are volatile below a red heat. It is reduced from its acid solution by zinc in the form of a dense black powder, difficultly soluble in hydrochloric acid, readily soluble in nitric acid.*' The above, we contend, was a publication in the widest sense of the word, and in this publication the metallic nature of thallium was distinctly asserted. The metal, it is true, was exhibited in powder, just as it was obtained by precipitation by means of zinc, but was none the less the pure metal. It was there for the jury of chemists to examine if they thought proper. It was not examined chemically by the jury; no one tested it; and yet Mr. Lamy, in his letter to the *Cosmos*, has the hardihood to assert, that Mr. Crookes 'contented himself with exhibiting to the public and the international jury of Class II, as thallium, some centigrammes of a black powder which was not thallium.' We shall make no remark on this assertion of Mr. Lamy; but, as some of our readers may be inclined to ask why the metal was not exhibited in the form of a button, we shall be excused for going into some detail.

The source from which we extracted the metal, and the compounds exhibited, was sulphur from the Spanish pyrites mentioned in our paper of May 18, 1861. This sulphur contained no more than *one or two* grains of thallium in *a pound*. The metal and compounds we exhibited represented in all about twenty grains of the metal, and the difficulty of extracting this quantity from upwards of fifteen pounds weight of sulphur will be fully appreciated by all chemical readers, when we inform them that the whole of the sulphur had first to be dissolved in nitric acid. We may contrast this, in passing, with the source from which Mr. Lamy derived his metal, as described by Mr. Dumas,—namely, the residues of a sulphuric acid manufactory, 'which contained thallium in tolerably large quantity, and in a form which made it easy to extract.'

Ignorant, at the time, of any richer source of thallium, and having in previous fusions of the precipitated metal discovered that it was rapidly volatilized and lost by oxydation, as described by Mr. Dumas, it was hardly likely that we should risk the loss of the whole of our small specimen for the sake of exhibiting it in a button; it was, therefore, placed in the Exhibition in the form of powder as precipitated. We might refer to our laboratory note-book, which is open to inspection, to prove that we had obtained the metal and fused it in September, 1861; but as a note in a private book does not constitute a publication, we found no claim on this. Nor do we on the fact that Mr. Williams saw the metal in our laboratory in January, 1862, as mentioned by him in the CHEMICAL NEWS, v, p. 350. But it may be evidence that we were 'aware of the metallic nature of thallium, and acquainted with the essential properties of the new body,' to state, that early in April, 1862, we had the following labels printed by Silverlock (as can be proved by a reference to the books of that firm) for the metal and the salts at that time we had prepared:—

Thallium (θαλλος)—*Oxyd of Thallium*—*Sulphid of Thallium*—*Basic Chlorid of Thallium*—*Iodid of Thallium*—*Sulphate of Thallium*—*Chlorid of Thallium*—*Nitrate of Thallium*—*Ferro-cyanid of Thallium*—*Cyanid of Thallium*—*Phosphate of Thallium*—*Carbonate of Thallium*—*Chromate of Thallium*—*Thallium, Sublimed*—*Oxalate of Thallium.*

It is sufficient for us, however, that the metal, labeled and described as a metal, was in the International Exhibition, at its opening, on the 1st of May, 1862, to prove priority of publication to Mr. Lamy's communication made at Lille, on the 16th of May, 1862.

The fact, that the metal was in the Exhibition, rendered it quite unnecessary for us to do what Mr. Dumas says we should have done after seeing Mr. Lamy's specimen. Our metal and two products, the peroxyd and sulphid, had been in the Exhibition some time, with the descriptive cards we have quoted; and with regard to Mr. Dumas's insinuation, that we borrowed from Mr. Lamy some, if not all, of the materials for the paper read before the Royal Society a few days after we met that gentleman, it may suffice to say, that, as Mr. Lamy only spoke French, a language we ourselves speak but imperfectly, it was not possible that either of us could have profited much by the interview.

We have no wish to detract in the least from the great merit of Mr. Lamy's researches. We estimate as highly as any one the skill and industry with which he has worked out the compounds of thallium. But it must not be supposed, as Mr. Lamy seems to suppose, that we ourselves remained idle during the fourteen months which had elapsed since we remarked the green line in the spectrum. With the limited means at our disposal, and amid other pressing occupations, we had, and have since, been continually engaged in investigating the properties and compounds of the new metal; and all we need say to Mr. Lamy is, that we heartily congratulate him on his successes, and envy him nothing but his opportunities."

2. ANALYTICAL CHEMISTRY.

2. *Alkalimetry.*—In the Sheffield Laboratory of Yale College the following method of conducting nice alkalimetrical analyses is employed, which combines several of the most recent improvements in a manner that unites great convenience with the highest accuracy. The requisites are, besides the usual graduated apparatus, a standard acid, a standard alkali, an indicator of the point of neutralization, and pure carbonate of soda.

The standard acid. The use of crystallized oxalic acid, as suggested by Mohr, has come into general favor, and nothing can be more satisfactory when the acid is *pure* and of *constant composition.* It is, however, difficult not only to procure a pure acid, but also to preserve it dry without loss of crystal-water. To dry the pulverized acid over oil-of-vitriol until it ceases to lose weight, as proposed by Erdmann, or to select uneffloresced crystals by help of a magnifier, is troublesome and likely to introduce error. We employ a dilute sulphuric acid, which may be made of convenient strength for ordinary use, by diluting ten cubic centimeters of oil-of-vitriol with water to the volume of a liter.

The standard alkali is made from commercial caustic potash: this is dissolved in water and diluted until a given volume e. g. 5 c. c. neutralizes 4 to 5 c. c. of the standard acid, as is determined by a few rough trials.

The alkali-solution thus obtained is heated to boiling in a flask, and a little freshly-slaked lime is added to decompose any carbonate of potash. The boiling is continued a few minutes and, finally, the ley is poured upon a filter, and the filtrate is collected in the bottle from which it is to be used. Care should be taken to bring upon the filter some of the excess of lime that is suspended in the liquid, so that the latter may acquire no carbonic acid from the air. The clear liquid thus obtained is a potash-lye containing lime in solution. If exposed to the air, the carbonic acid that is absorbed separates as carbonate of lime, leaving the liquid perfectly caustic.

It now remains to determine with the greatest accuracy, 1st, the volume of alkali which neutralizes a cubic centimeter of the acid and, 2d, the amount of SO_3 contained in a cubic centimeter of the latter.

As a means of recognizing the point of neutralization, tincture of cochineal possesses great advantages over solution of litmus. The knowledge of this fact is due to Luckow who has detailed its application in *Jour. für Prakt. Chem.*, lxxxiv, p. 424. Tincture of cochineal is prepared by digesting and frequently agitating three grams of pulverized cochineal in a mixture of 50 cubic centimeters of strong alcohol with 200 c. c. of distilled water at ordinary temperatures for a day or two. The solution is decanted, or filtered through Swedish paper.

The tincture thus prepared has a deep ruby-red color. On gradually diluting with pure water (free from ammonia), the color becomes orange and finally yellowish-orange. Alkalies and alkali-earths as well as their carbonates change the color to a carmine or violet-carmine. Solutions of strong acid and acid salts make it orange or yellowish-orange.

To determine the volumetric relation of the alkali and acid, a given volume of the latter, e. g. 20 c. c., is measured off into a wide mouthed flask, ten drops of cochineal-tincture and about 150 c. c. of water are added—the alkali is now allowed to flow in from a burette, until the yellowish liquid in the flask, suddenly, and by a single drop, acquires a violet-carmine tinge.

In nicer determinations, it is important to bring the liquid each time to a given volume, by adding water after the neutralization is nearly finished. For this purpose, two or more flasks of equal capacity are selected, and on the outside of each a strip of paper is gummed to indicate the level of the proper amount of liquid, e. g. 200 c. c. The same amount of coloring matter being thus always diffused in the same volume of the same water, the errors of varying dilution and varying amount of ammonia (which is rarely absent from distilled water) are avoided. The contents of one flask, in which the neutralization has been satisfactorily effected, may be kept as a standard of color for the succeeding trials, as the tint remains constant for hours, being unaffected by the absorption of carbonic acid. The greatest convenience and accuracy of measurement are attained by using burettes provided with Erdmann's swimmer (*Jour. Prakt. Chem.*, lxxi, p. 194).

When three or four accordant results have been obtained, the average is taken as expressing the relative strength of the acid and alkali.

To ascertain the absolute standard, weigh off in a small platinum crucible about 0·8 grm. of pure carbonate of soda, ignite to dull redness, cool and weigh accurately: bring the crucible with its contents into one of the wide mouthed flasks and let flow from the burette a slight excess, e. g. 50 c. c., of standard acid. The solution of the carbonate of soda is facilitated by warming, and, finally, the contents of the flask are gently boiled for several minutes to expel carbonic acid. The solution is now allowed to become *perfectly cold*, then add ten drops of cochineal and lastly the standard alkali to neutralization, diluting to the proper volume.

To illustrate the accuracy of the process and the calculations employed, the following actual data may be useful. The normal acid was made by diluting 50 c. c. of oil-of-vitriol to the volume of ten liters and had half the strength above recommended. The alkali was from a stock on hand and more dilute than necessary.

Relation of acid to alkali.

Exp. I, 20 c. c. SO_3 = 32·8 c. c. KO, or 1 : 1·64
Exp. II, 20 c. c. SO_3 = 32·8 c. c. KO, or 1 : 1·64
Exp. III, 40 c. c. SO_3 = 65·7 c. c. KO, or 1 : 1·6425

We have accordingly:

1 c. c. SO_3 = 1·64 c. c. KO and 1 c. c. KO = 0·60976 c. c. SO_3.

Absolute strength of acid and alkali.

Exp. I. 0·4177 grm. of carbonate of soda were treated with 44·2 c. c. of SO_3. To neutralize the excess of the acid were required 3·8 c. c. KO, which correspond to 2·32 c. c. SO_3 (3·8×0·60976). Deducting this from the total amount of acid (44·2 − 2·32) we have 41·88 c. c. of acid, equivalent to the carbonate of soda taken.

41·88 c. c. solution of SO_3 = 0·4197 grm. NaO CO_2.

Exp. II. 0·4126 grm. NaO Co_2 treated with 44 c. c. SO_3 required 4·28 c. c. KO. 4·28×0·60976 = 2·61 c. c. SO_3. 44 − 2·61 = 41·39 c. c. SO_3.

41·39 c. c. solution of SO_3 = 0·4126 grms. NaO CO_2.

It is convenient to calculate how much acid corresponds to 53 decigrammes of carbonate of soda, since the relation of any other substance to the acid is then obtained by substituting its equivalent number for 53 (the equivalent of NaO CO_2), thus:

$$\begin{array}{rccc} & \overbrace{\hphantom{0{\cdot}4177 : 0{\cdot}53}}^{\text{grms. NaO CO}_2} & & \overbrace{\hphantom{41{\cdot}88 : 53{\cdot}14}}^{\text{c. c. SO}_3} \\ \text{I.} & 0{\cdot}4177 : 0{\cdot}53 & :: & 41{\cdot}88 : 53{\cdot}14 \\ \text{II.} & 0{\cdot}4126 : 0{\cdot}53 & :: & 41{\cdot}39 : 53{\cdot}17 \end{array}$$

Accordingly 0·53 grm. $NaO\,CO_2$ neutralize 53·155 c. c. SO_3.

If the solutions are employed for nitrogen estimations, we learn how much nitrogen corresponds to 1 c. c. of acid, by the following proportion.

$$\overbrace{53{\cdot}155 : 1{\cdot}}^{\text{c. c. SO}_3} \quad :: \quad \overbrace{0{\cdot}140 : 0{\cdot}0026338}^{\text{grm. N.}}$$

We may then write on the label of the acid bottle the following data for calculation.

$$\begin{array}{lll} 1 \text{ c. c. KO} & = 0{\cdot}60976 & \text{c. c. SO}_3. \\ 1 \text{ c. c. SO}_3 & = 1{\cdot}64 & \text{c. c. KO.} \\ 1 \text{ c. c. SO}_3 & = 0{\cdot}0026338 & \text{grm. N.} \end{array}$$

As an example of the determination of nitrogen by help of these solutions, the following analysis of hippuric acid made by Mr. Peter Collier in this Laboratory, may be adduced.

0·3923 grms. hippuric acid were burned with soda-lime and the ammoniacal products were collected in 20 c. c. of the standard acid contained in the usually employed bulb tube. When the combustion was complete, the contents of the bulbs were rinsed out into a flask, brought to the volume of 150 c. c. and, after adding 10 drops of cochineal, the normal alkali was dropped in, until the change of color indicated neutralization; 13·7 c. c. of KO were required, $=$ 8·354 c. c. SO_3 ($13{\cdot}7 \times 0{\cdot}60976$) which deducted from 20 c. c. left 11·646 SO_3 as equivalent to the nitrogen of the hippuric acid. $11{\cdot}646 \times 0{\cdot}0026338 = 0{\cdot}0306732$ N. $\div\ 0{\cdot}3923 = 7{\cdot}818$ per cent. The calculated per centage is 7·82.

The advantages of cochineal over litmus as an indicator, are as follows: 1. It possesses far greater sensibility. Luckow asserts that water which is tinged faintly orange by it, becomes distinctly red by the addition of $\frac{1}{200{,}000}$th of ammonia or $\frac{1}{1{\cdot}430{,}000}$th of carbonate of lime.

When a little pulverized marble is covered with the diluted tincture and allowed to stand for some time, the lower stratum of liquid acquires a carmine tinge and by shaking, the whole solution becomes red. Luckow considers that in this case the carminic acid attacks the marble and forms a lime salt which causes the change of color. In this way the minutest traces of carbonates of alkali-earths may be detected in pulverized minerals, clays, &c. Alkali-salts must of course be removed by washing with distilled water free from ammonia.

This extreme delicacy allows of the use of much more dilute solutions than can be employed with litmus.

2. According to Luckow, cochineal is quite indifferent to carbonic and sulphydric acids, carminic acid being stronger than these. This is practically true for solutions of considerable strength. *Hence a normal alkali for technical analysis may be prepared by simply dissolving a weighed amount of carbonate of soda in a known volume of water*, and from this a standard acid may be easily made. In the neutralization it is not needful to expel carbonic acid by boiling. The influence of the latter is however at once seen when a caustic and carbonated alkali are operated with side

by side. In case of the former, the point of neutralization (or rather of supersaturation,) is shown by a prompt and decisive change from a tint in which orange predominates, to one in which this disappears and violet is most marked. In presence of carbonic acid the change is somewhat gradual, and though a red color is produced it is modified by an orange tint, even in presence of a large excess of alkali. Hence, it is to be recommended, especially in nice investigations, to employ a caustic alkali. A trifle less of it will be found needful to neutralize a given volume of acid, than is required of a carbonated solution, and no doubt will exist as to the point of saturation. Mr. Collier has made some experiments with a sulphuric acid containing 25 c. c. oil-of-vitriol to the liter and a solution of carbonate of soda and he found, when CO_2 was expelled by boiling, that 10 c. c. $SO_3 = 7{\cdot}66$ and 7·67 c. c. of NaO CO_2; when CO_2 was not expelled, 10 c. c. $SO_3 = 7{\cdot}68$ and 7·7. These results are as good as identical. In standarding the much weaker acid used for the nitrogen determination above mentioned, he obtained for it a value slightly too low when CO_2 was not removed. 0·53 grm. NaO Co_2 required in this case but 53·05 c. c. SO_3 instead of 53·155 as in the other instances. This is a very slight difference and not appreciable perhaps with ordinary burettes, but it is a constant and perceptible difference. What is of more importance is the uncertainty as to the point of neutralization.

This indifference towards carbonic acid is a great advantage in nice analyses, in that the time consumed for effecting neutralization is without influence on the result. When litmus is used and the point of neutralization is reached, a short exposure to the air suffices to redden the liquid again. If the operator is obliged to proceed slowly, he will require somewhat more alkali than when he operates rapidly; a portion of it being neutralized by atmospheric carbonic acid. With cochineal, the result is independent of the small amount of carbonic acid that can come from the air. The permanence of the color also allows several titritions to be compared directly together.

A third advantage of cochineal is, that its solution, prepared as above described, may be preserved indefinitely in closed vessels, without decolorization or alteration. S. W. J.

3. *On the solubility of Sulphate of Lime in chlorhydric acid.*—In this Laboratory it has long been the custom to bring into solution for analytical purposes gypsum, so-called super-phosphate of lime and other substances containing much sulphate of lime, by treatment with hot dilute chlorhydric acid. The action is rapid, and the analysis may be carried on with more convenience than when decomposition is effected by carbonate of soda. The sulphate of lime is not taken up by very concentrated chlorhydric acid to nearly the same extent as when the acid is dilute, and therefore a saturated solution of the salt in the latter is copiously precipitated by the addition of fuming chlorhydric acid as well as by that of water. S. W. J.

3. Technical Chemistry.

4. *Webster's process for producing Oxygen Gas.*—J. Webster of Birmingham (England), has taken out a patent for obtaining oxygen (and certain other products,) from nitrate of soda and oxyd of zinc, or peroxyd of iron, subjected to a low red heat in close retorts. The gaseous

products obtained are oxygen contaminated with variable quantities of nitrogen, and nitrous acid vapor, the latter of which is condensed by passing through water, while the residue in the retort consists of caustic soda and oxyd of zinc. Water completely separates these two, leaving the zinc-oxyd fit for a second operation. The soda solution serves for the manufacture of soap, while the mixed gases the process yields answer for the oxyhydrogen blowpipe and for various metallurgical purposes—or for increasing the brilliancy of coal gas, &c. Messrs. Pepper and Campbell have carefully examined and reported on Webster's process.[1] By the analysis of the former, the mixed gases consist of 59 vols. per cent of oxygen and 41 vols. per cent of nitrogen—while by Campbell's analysis the nitrogen was from 26·50 to 32·80 per cent of the whole. The process is conducted thus:—10 pounds of nitrate of soda (commercial) and 20 pounds of oxyd of zinc both previously dried, and warm, are roughly mixed and thrown into a red hot iron retort. The product, as soon as it will rekindle a taper, is conducted through a purifier—consisting of a 30 gallon stone-ware jar containing five pounds of water and eight moveable colander-like shelves, upon which are strown 48 pounds of residue, the product of previous operations, and consisting of zinc-oxyd, caustic soda and nitrate or nitrite of soda—this *caput mortum* stuff is moistened with five pounds of water and carefully strewn on the shelves (in the manner of the hydrate of lime, in the common, dry-lime purifier for coal gas). The purifier thus furnished is closed by a lid of stoneware dropping into a 'water joint'—and is also connected with a capacious sheet iron gasholder. The product of gas from this charge was 33·69 to 32·968 cubic feet and the loss of weight in the process 5·5 pounds in the charge; the time occupied for the first charge was 2h 5m, in second, 2h 25m, the second charge being added without cooling the retort—the caput mortum by the structure of the retort being removed while it is hot, as in a continous operation. Campbell found the yield from 20 pounds of oxyd of zinc and 30 pounds of nitrate of soda, in two operations, to be 157·85 and 159·03 cubic feet, and the time in working each charge of 50 pounds, 9½ hours. Campbell finds the proportion of nitrogen is diminished by using a moderate temperature and an increase of water in the purifier. This water becomes very acid from the NO_3 and NO_5 absorbed, these products resulting of course from the reaction of the materials.

The cost of oxygen by this process is less than from any other yet proposed as will appear from the following comparison, based on Deville's and Debray's well known statements.[2]

1 cubic meter (= 35·317 cubic feet),	*frs.*	*s.*	*d.*	English currency.
" " from chlorate potassa,	10 =	8	4	" "
" " Ox. manganese,	4·87 =	4	$0\frac{3}{4}$	" "
" " HO, SO_3 by heat,	1· =	0	10	" "
" " Webster's $NaONO_5 + ZnO$,			7½	" "
" " Do. rejecting all products,		1	$9\frac{7}{10}$	"

It is plain from this statement that, without considering its purity, Webster's process is cheaper than any other: but Deville's method gives

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[1] Chem. News, vi, pp. 218, 268. See also same Journal, vi, 287 and 299, vii, 34, for additional information.

[2] This Journal, [2], xxxi, 280, 427, and *Ann. de Chim. et Phy.*, [3], lxi, 97.

a pure gas. It is remarked however by Mr. Crookes[3] that the mixed gas of Webster's process is as pure as can be used in the arts unless in the metallurgy of the platinum metals. S.

5. *On the industrial applications of Cryolite.*—This interesting mineral, which a few years since was only looked upon as a mineralogical rarity, has now become an important article in commerce. Aside from its use as a source of aluminum as suggested by Percy and H. Rose, we learn from recent articles in *Dingler's Polytechnisches Journal,* that it is now extensively employed in chemical works at Copenhagen and Harburg for the production of caustic soda and salts of alumina.

J. Thomsen (*Ding. Jour.*, clxvi, 443) claims to have discovered in 1850 that cryolite could be decomposed by lime and lime salts, and after perfecting his process he commenced the manufacture of soda in 1857, and in 1858 erected large works at Copenhagen which now use 40,000 cwt. of cryolite annually. The exploration of the cryolite deposit in Greenland has become so extended that another large manufactory has been erected at Harburg, and others are being put up at Prague, Selicie and Mannheim. It is estimated that these manufactories will consume from 120,000 to 150,000 cwt. (6000 to 7500 tons) of cryolite annually.

The following method is used for converting the cryolite into soda ash and alumina salts: the cryolite is first ground to a fine powder and then mixed with chalk or ground limestone, in the proportion of 100 parts of cryolite ($3NaFl+Al_2Fl_3$) to 127 parts of carbonate of lime, equal to one equivalent of cryolite to six equivalents carbonate of lime. This when heated yields six equivalents of fluorid of calcium, aluminate of soda $2NaO+Al_2O_3$, and free carbonic acid. An excess of chalk in the mixture is found to be advantageous, as it renders the charge less fusible. The operation is conducted in a reverberatory furnace similar to those usually employed in alkali works. The compound of alumina and soda is dissolved in hot water and subsequently decomposed by carbonic acid, which last is obtained from the furnace in which the cryolite is decomposed. The carbonate of soda solution is separated from the precipitated alumina and either crystallized, or evaporated to dryness and calcined; it affords a remarkably pure soda ash, being, of course, free from chlorids and containing only traces of sulphites and sulphates, these last due to the small amount of sulphur contained in the coke. The greater portion of this soda solution is however converted into caustic soda by means of lime; the commercial article of caustic soda made at Harburg contains about 75 per cent of soda. The precipitated alumina, produced by the decomposition with carbonic acid, is washed with water and subsequently dissolved in sulphuric acid, yielding a sulphate of alumina entirely free from iron. (Schwarz, *Dingler's Journal,* clxvi, p. 283.) Cryolite is delivered at Harburg at two and a half Prussian thalers (about $2) a cwt. No mention is made of the economic application of the large amount of the fluorid of calcium produced in the above operation—aside from its use for making fluohydric acid, it unquestionably can be advantageously applied as a flux in many metallurgical operations. G. J. B.

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[3] Chem. News, vi, 221.

4. PHOTOGRAPHY.—

6. *The action of light upon a sensitive plate.*—At a recent session of the Photographic Society of Marseilles, one of the members stated his having failed to obtain a good development in some *tannin* plates which had been kept some twenty days after exposure in the camera, although some of the same lot of plates had developed good results, when the development took place within twenty-four hours of the exposure.—Mr. Vidal explains this phenomenon by a new theory of the action of the actinic rays upon a sensitized plate. He supposes that under the action of light a certain molecular change, of a transitory nature, takes place, but that, in accordance with a general physical law, there is a tendency to return to the anterior molecular condition, and that in the process of time a plate exposed in the camera would, by returning to its original molecular condition, lose all trace of its exposure, and be ready to receive an entirely new impression, the same as a plate which had not been exposed at all. Mr. Vidal concludes that the physical theory of the *absorption* of the actinic fluid by certain substances, such as the iodid of silver, is the one which best explains photographic reactions.

We have only to say, briefly, in regard to this theory, that we have no faith in it whatever; it is contrary to our photographic experience; which confirms the theory that the action of light upon the sensitized plate is a *chemical* and not a *physical* action. The loss of sensitiveness, or the lack of ability to develope well after keeping—can be readily and satisfactorily explained by referring it to causes familiar to all practical photographers. E.

II. METALLURGY.

1. *On Aluminum Bronze.*—Lieut.-Colonel STRANGE has communicated to the Royal Astronomical Society some interesting observations on the use of aluminum-bronze as a material for the construction of astronomical and other philosophical instruments. Col. Strange remarks that, "the qualities of most importance in instrument making are, (1) tensile-strength; (2) resistance to compression; (3) malleability; (4) transverse strength or rigidity; (5) expansive ratio; (6) founding qualities; (7) behavior under files, cutting tools, &c.; (8) resistance to atmospheric influences; (9) fitness to receive graduation; (10) elasticity; (11) fitness for being made into tubes; (12) specific gravity."

Tensile strength.—The mean of experiments made by Mr. Anderson at the Royal Gun Factory, Woolwich, shows that the average breaking tensile strength of aluminum bronze is 73,185 lbs. per square inch, while that of gun-metal is 35,040 lbs., the ratio being rather more than two to one in favor of the aluminum-bronze.

Resistance to compression.—Experiments made by Mr. Anderson show that no effect was perceptible until 9 tons 2 cwt. per square inch was applied, when the specimen gave ·006 of an inch; on removing the weight an elasticity of ·001 was observed, giving the first permanent compression as ·005 of an inch. The ultimate amount of compression applied was 59 tons 2 cwt. 1 qr. 4 lbs. (132,416 lbs.), under which the specimen became too much distorted to permit of more weight being applied with any true result.

Malleability.—Mr. Anderson states that, "the qualities of this metal for forging-purposes would appear to be excellent; with the exception of the part heated to a red-heat in the shade, all show that it is a good workable material under the hammer almost up to the melting point." Col. Strange adds, that there were specimens exhibited in the Industrial Exhibition at London which showed that the alloy could be drawn out under the hammer almost to a needle point.

Transverse strength, etc.—Messrs. Simms found by experiment that aluminum-bronze was 3 times more rigid than gun-metal, and upwards of 44 times more rigid than brass; and, in regard to its *expansive ratio,* they found this alloy less affected by change of temperature than either gun-metal or brass—a little less than gun-metal and much less than brass. Its *founding qualities* are such that it produces admirable castings of any size. It does not clog the file, and in the lathe and planing-machine the tool removes long elastic shavings, leaving a bright, smooth surface. It can be worked with much less difficulty than steel, and, notwithstanding its greater cost, the Messrs. Simms think that screws made of it would in the end prove less expensive than steel. It tarnishes less readily than any metal usually employed for astronomical instruments. It is remarkably well fitted to receive graduation, as it takes a fine division which is pure and equable, surpassing any other *cast* metal in this respect. Col. Strange remarks that in its elasticity it is said to surpass even steel, and it would therefore appear to be the most proper material for the suspension springs of clock pendulums. Regarding *its fitness for being made into tubes,* it can be soldered with either brass or silver solder; it can be rolled into sheet metal, and it can be hammered and drawn. Gun-metal does not admit of being rolled, so that hitherto the tubular portions of telescopes and other instruments have been made almost exclusively of yellow brass, an alloy very deficient in rigidity. The *specific gravity* of the alloy containing 90 copper and 10 aluminum is, according to Messrs. Bell, 7·689, very nearly that of wrought-iron.

Col. Strange adds, "it appears, from these experiments and from the concurrent testimony of those who have given it a fair trial, that the 10 per cent aluminum-bronze is far superior, not in one or some, but in every respect, to any metal hitherto used for the construction of philosophical apparatus, and that for such purposes it may be employed in the dimensions that would be proper in the case of cast steel. All parts which would otherwise be made of steel may with perfect safety, and even with advantage, be made of the new alloy, particularly such parts as bolts, and fixing, tangent, and micrometer screws. Its hardness and comparative inoxydizability point it out as peculiarly adapted for pivots, axes, and bearings. If employed for receiving the graduation of circles, the necessity for inlaying another metal will be obviated, by which two advantages will be gained: the hammering which forms part of the operation of inlaying, and which, more or less, must cause unequal density and tension in the circle subjected to such treatment, will be dispensed with; and the effect of inequality of expansion, in the circle and the inlaid strip, will no longer be a cause of apprehension. With respect to the due visibility of divisions cut on this metal, opinions will perhaps differ I can only say that I should be well content to observe with them."

This alloy has been selected by Col. Strange as the most appropriate metal for the construction of the large theodolite for the use of the Trigonometrical Survey of India. The horizontal circle of this theodolite is three feet in diameter, and the effect of using this alloy will be to keep the weight of the instrument within reasonable limits, notwithstanding its possession of means and appliances not hitherto bestowed on such instruments. In the manufacture of the alloy, Col. Strange says that extremely pure copper must be used; electrotype copper is best, and Lake Superior copper stands next, giving an alloy of excellent quality. The ordinary coppers of commerce generally fail, owing, it is said, to the presence of iron, which appears to be specially prejudicial. Further, the alloy must be melted two or three times, as that obtained from the first melting is excessively brittle. "Each successive melting, up to a certain point determined by the working, and particularly the forging properties of the metal, improves its tenacity and strength. It is probable that after several meltings there will remain in combination with the copper a somewhat smaller proportion of aluminum than 10 per cent. The present price of English-made 10 per cent aluminum-bronze is 6 shillings 6 pence per lb. This is four or five times that of gun-metal, but a much smaller quantity of the new alloy than of gun-metal will give the same strength; and when it is considered how small a ratio the cost of material bears to the cost of workmanship in refined apparatus, it will be found that even at the present price of the new alloy its cost is not prohibitory, whilst the advantages attending its use promise to outweigh the increased expenditure."—*L. E. and D. Phil. Mag.*, [2], xxiv, p. 508.

C. Tissier, Director of the Aluminum Works at Rouen, shows that one per cent of aluminum in copper makes the latter more fusible, giving it the property of filling the mould in casting, at the same time preventing it from rising in the mould. The action of chemical agents upon it is also weakened, and the copper gains in hardness and tenacity without losing its malleability, thus producing an alloy which has the malleability of brass, with the hardness of bronze.

In transverse strength, this alloy was found to be more than twice as rigid as either brass or copper. Tissier also finds that one part of aluminum, added to bronze consisting of 96 copper and 4 tin, gives an alloy of a fine color, of remarkable homogeneity, of great hardness and malleability. During casting, this alloy does not oxydize at all, and it is therefore free from the oxyd coating with which ordinary bronze castings are covered. The transverse strength of the castings of this alloy Tissier finds to be two and a half times that of the original bronze, and that of the hammered alloy is four times as great as that of bronze. Ordinary cannon-bronze, 89 parts copper and 11 tin, has the same transverse strength as castings of the new alloy. In reference to the hardness, tenacity and malleability, it is equal in these respects to aluminum-bronze, made of 90 parts copper and 10 parts aluminum, and, as it is considerably cheaper, it can with advantage be substituted for this more expensive alloy.—*Polytechnisches Journal*, clxvi, p. 430. G. J. B.

2. *Mineral and Metal products of Great Britain and Ireland.*—The following statistics are extracted from a paper on the Mines, Minerals and

Miners of the United Kingdom, read before the London Society of Arts by Mr. Robert Hunt, Keeper of the Mining Records.

Product for 1861.

Minerals.		Quantity.	Value.
Tin,	tons,	11,640	£ 725,560
Copper,	"	231,487	1,427,215
Lead,	"	90,696	1,136,249
Silver,	"	29	1,471
Zinc,	"	15,770	31,113
Pyrites,	"	125,135	79,715
Arsenic,	"	1,450	10,875
Nickel,	cwt.,	16	24
Wolfram,	tons,	8	29
Antimony,	"	15	45
Manganese,	"	925	2,925
Gossan, ochre, &c.,	"	3,016	3,016
Iron ore,	"	7,215,518	2,302,371
Coals (sold and used),	"	83,635,214	20,908,803
Other minerals,	"	2,222,602	880,114
Total value of Minerals produced in 1861,			£27,509,525

Metals produced from British Minerals.

		Quantity.	Value.
Gold,	oz.,	2,784	£ 10,816
Silver,	"	569,530	144,161
Tin,	tons,	7,450	910,762
Copper,	"	15,331	1,572,480
Lead,	"	65,643	1,445,255
Zinc,	"	4,415	79,101
Iron, Pig,	"	3,712,390	9,280,975
Total value,			£13,443,550
Estimated value of other metals,			250,500
Coals,			20,908,803
Total value of metals and coals,			34,602,853

There were worked, in 1861, 3052 collieries, 167 copper mines, 148 tin mines, 390 lead mines and 29 zinc mines—number of iron mines not given. The whole employed an aggregate of 336,000 persons actually engaged in mining operations, exclusive of quarries of all kinds. —*Journal of the Society of Arts*, xi, 94. G. J. B.

3. *The Mining and Smelting Magazine, a monthly review of Practical Mining, Quarrying and Metallurgy, and record of the Mining and Metal Markets;* edited by HENRY CURWEN SALMON, F.G.S., F.C.S. Vol. I and II. London, 1862.[1]—Besides the objects mentioned in the title, this monthly contains original articles of great value on mining and

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[1] Published monthly, at one shilling sterling per number. Agents, Baillière Brothers, 440 Broadway, New York.

metallurgical subjects. Among its contributors are Warrington W. Smyth, Robert Hunt, H. W. Bristow, James Napier, J. A. Phillips, Professor Ansted, and others who are well known to both scientific and practical men. It also contains translations of valuable memoirs from the *Annales des Mines* and other foreign journals. It is well illustrated with maps and plans of mines, furnaces, etc. We trust that this magazine will meet with the success it deserves, as it fills a want that has long been felt by miners and metallurgists.

III. PHYSIOLOGICAL AND AGRICULTURAL CHEMISTRY.

1. *On the Chemistry of Germination.*—Dr. MAX SCHULZ has published (*Jour. für Prakt. Chem.*, lxxxvii, p. 129) an extended investigation on this subject. He directs attention to the insufficiency of elementary analysis, as employed by earlier experimenters, for determining the chemical changes that occur in germination, and substitutes for it Bunsen's gasometric methods. Various seeds, viz: those of *Lepidium sativum*, *Lupinus albus*, *Vicia faba*, and *Iberis amara*, were made to germinate in pure water contained in sealed glass flasks. The chemical changes that took place were studied by analyzing the air of the flasks after a suitable interval. Schulz arrives at the following results, which he deems fully established in regard to what he terms the *first stage* of germination, or that period in which no cell-multiplication is observable, but during which the embryo merely bursts the integuments and extends itself with the radicle in a downward direction.

1. The first stage of germination is set up or made possible by the decomposition of albuminoid substances. 2. This decomposition is produced by the absorption of water and oxygen. 3. In its progress, *nitrogen* and carbonic acid and afterward *hydrogen* are set free. By several experiments made with crushed seeds, Schulz found that, in decay or putrefaction, nitrogen and carbonic acid were evolved, though less rapidly than in germination; but that *free hydrogen did not appear.*[1] Schulz hence concludes that the evolution of hydrogen, in his experiments, truly belonged to the germinative process, and was not a result of accompanying decay. From the circumstance that seeds will not develope in sealed vessels of suitable dimensions, beyond, or but little beyond, the first stage, owing to the accumulation of carbonic acid, Schulz was not able to investigate fully what happens in the later periods of germination. In the few trials that partially succeeded, he obtained the same results as were manifested in the first stage, though the liberation of free hydrogen appeared to be less copious, relatively to that of the nitrogen and carbonic acid.

S. W. J.

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[1] Dr. Pugh, President of the Ag. College of Penn., obtained *a large amount of free hydrogen and but traces of nitrogen* from decomposing vegetable matters (wheat, barley, beans and turnips) when they were placed in water over mercury, *atmospheric air being removed* by communicating the vessel containing them with the Torricellian vacuum. (*Lawes, Gilbert and Pugh on the Sources of the Nitrogen of Vegetation. Phil. Trans.* part II, 1861.)

It would thus appear to be experimentally established, that in the chemical process of decay, hydrogen is evolved only in the absence, and nitrogen only in the presence of an excess of free oxygen, whereas in the vital process of germination, hydrogen and nitrogen are both eliminated in presence of oxygen. Further, in the

2. *On the reduction of kinic acid to benzoic acid, and its conversion into hippuric acid in the animal organism.*—According to Lautemann (*Ann. Ch. u. Pharm.*, cxxv, p. 9), when kinic acid is heated with a saturated aqueous solution of iodhydric acid in a sealed tube for two to three hours, at 115 to 120° C, benzoic acid and iodine are obtained. The same conversion is effected by bringing into a retort two equivalents of iodine with one equivalent of phosphorus, and, after the two have united and the product is cold, adding to four equivalents of the crude iodid of phosphorus one equivalent of kinic acid dissolved in water to a syrupy solution. On warming gently, a vigorous reaction sets in, iodhydric acid escapes and water distils over. When the iodid of phosphorus has mostly disappeared, the contents of the retort on cooling solidify to a fat-like crystalline mass, from which ether extracts impure benzoic acid. The retort neck is also lined with crystals of this acid toward the close of the process.

$$\overset{\text{Kinic acid.}}{C_{14}H_{12}O_{12}} = \overset{\text{Benzoic acid.}}{C_{14}H_{6}O_{4}} + 6HO + 2O$$

The reaction may proceed according to either of the following equations.

$$1.\ C_{14}H_{12}O_{12} + 8HI = C_{14}H_{6}O_{4} + 8HO + 8I$$

$$2.\ C_{14}H_{12}O_{12} + 8I \ \ = C_{14}H_{6}O_{4} + 6HI + 2I$$

Since kinic acid is thus converted so easily into benzoic acid, it occurred to Lautemann to examine whether it would undergo the same change in the animal organism, and appear in the urine as hippuric acid. He found this to be actually the case, in trials upon himself and two other persons, 8 grms. of kinate of lime yielding in two experiments 2·2 and 2·7 grms. of hippuric acid, respectively. Kinic acid having been proved by Zwenger and Sievert to exist in considerable quantity in the whortleberry plant, it becomes probable that it may also occur in various grasses, and that it is the origin of the hippuric acid which is found in the urine of pastured animals. S. W. J.

3. *On the composition of the urine of oxen as related to their fodder.*—Henneberg, Stohmann and Rautenberg, (*Ann. Ch. u. Pharm.*, cxxiv, p. 200,) at the conclusion of an important paper chiefly occupied with an account of the method they employ for the determination of hippuric acid, urea and chlorid of sodium in urine, give the following *resumé* of results obtained with the urine of three oxen during seven months of 1860–61.

1. The urine had the maximum content of hippuric acid—2·1 to 2·7 per cent—when the cattle fed chiefly on *oat and wheat straw* with a small addition of crushed beans. When *leguminous forage* (clover hay and bean straw) was exclusively supplied, the hippuric acid fell to 0·4 per cent and less. With *meadow hay* the percentage was intermediate, viz: 1·2 to 1·4 per cent.

2. The addition of considerable quantities of easily digestible food, *e. g.* bean-meal, starch, sugar and oil, to the proper fodder, had the effect to diminish the amount of hippuric acid, and increase that of urea.

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vital process of "vegetable respiration" if not free hydrogen yet carburetted hydrogen and carbonic oxyd, but no free nitrogen, are given off in conjunction with oxygen, Boussingault (*this Journal*, xxxv, p. 122); while, as Pettenkofer and Voit have shown, (*Ann. Chem. u. Pharm.*, ii, Sup. vol. 66), both carburetted hydrogen and free hydrogen are found in the products of animal respiration. S. W. J.

3. The quantity of bicarbonates in the urine depends upon the amount of carbonates or salts of vegetable acids present in the food. The several materials used as rations in these experiments gave, by *incineration in the muffle*, ashes having the following quantities of carbonic acid to 100 of dry substance.

Clover-hay, - - - -	2·4	pts.	CO_2
Bean-straw, - - - -	1·6	"	"
Meadow-hay, - - - -	1·1	"	"
Oat-straw, - - - -	0·2	"	"
Wheat-straw, - - - -	0·0	"	"
Crushed beans, - - -	0·0	"	"

In the urine, the greatest amount of carbonic acid—1·6 to 1·8 per cent—was observed after feeding with clover-hay. In urine excreted after the ingestion of wheat-straw and crushed beans, carbonic acid was totally wanting. The urine from cattle fed on wheat-straw had an acid reaction notwithstanding it was destitute of carbonic acid, while in every other instance the reaction was alkaline. By adding to the day's ration of straw 75 grms. acetate of potash, the carbonic acid and the alkaline reaction reappeared. S. W. J.

4. *On some points in the composition of Soils.*—It has been assumed by chemists that hydrated oxyd of iron and hydrated alumina as well as hydrated silica are usual ingredients of soils, though no direct proof of their presence has been furnished. ALEXANDER MULLER (*Die landwirthschaftlichen Versuchs-Stationen*, iv, p. 227) has examined various soils for these substances by treating them with solution of a neutral or ammoniacal tartrate and with carbonate of soda. Müller finds that seignette salt when boiled with hydrated sesquioxyd of iron dissolves the latter, forming a dark-brown alkaline solution. The hydrated sesquioxyd does not lose its solubility by air-drying nor by drying at 212°, though, in the latter case, it dissolves with more difficulty. Hydrated alumina behaves similarly, but appears to go into solution with less rapidity. Silicates of these oxyds are insoluble in the ammoniacal solution of tartrates which easily take up the hydrates.

The only soils which yield to this reagent noticeable quantities of hydrated oxyd of iron (and hydrated manganeso-manganic oxyd) are those which possess a perceptible ocher-yellow color. Red soils, and also those having a light color, yield little iron to a tartrate, compared to that which is removed from them by hydrochloric acid. The yellow soils thus contain hydrated sesquioxyd, the red, anhydrous sesquioxyd, and the light-colored soils appear to contain a silicate of iron.

Hydrated alumina Müller scarcely found at all. He supposes that alumina exists in nearly all cases as a silicate.

By digesting the clayey soils of the vicinity of Stockholm directly with solution of carbonate of soda, or by treatment with chlorohydric acid, but very little silica is taken up. On the other hand, the residue that remains after acting on them with chlorohydric acid yields much silica; in some cases, even 15 per cent. It hence appears that in the soil the silica exists for the most part in a state of combination.

Note.—There can be little doubt that the hydrous silicates of the various bases occurring in the soil—or its zeolitic constituents as they may be termed, enact a series of most important functions. The researches of Daubrée on Metamorphism, *Ann. des Mines*, [5], xvi, also *Smithsonian Report*, 1861, have elucidated, in the most clear and striking manner, the conditions and results of the action of warm water on the anhydrous silicates, and have shown that crystallized zeolites may be produced from them by its influence. Way and Eichhorn (*this Jour.*, xxvii, 71–85) have made it in the highest degree probable, that the absorbent power of soils for the alkalies is due to the action of amorphous zeolitic compounds; and it is hardly to be questioned, that the good (or bad) results of tillage and many of the hitherto inexplicable effects of manures, will be found to bear close relations to the processes of soil-metamorphism, in which silicates, water and carbonic acid play the chief parts. S. W. J.

IV. MINERALOGY AND GEOLOGY.

1. *Manuel de Minéralogie* par A. DesCloizeaux, Maitre de conférence à l'Ecole Normale supérieure, etc. Tome premier, 572 pp., 8vo. Paris, 1862.—This Manual of Mineralogy embodies the results of a very large amount of original research by the author. DesCloizeaux has for many years been engaged in studying the optical and crystallographic characters of mineral species, and by these means, especially the former, has thrown new light on doubtful species, distinguished many that have been confounded together, and referred others, supposed to be distinct, to their true places. Many of these results have already been mentioned briefly in former numbers of this Journal,[1] and it is hardly necessary to enter into details in this place. Suffice it to say that the work is a source of original information on minerals, indispensable to all who are interested in having an accurate knowledge of species.

2. *Report on the Geological and Mineralogical specimens collected by* Mr. C. F. Hall *in Frobisher Bay.*[2]

To the New York Lyceum of Natural History:—

One of your committee, appointed to examine the collection of minerals and fossils made by Mr. Chas. F. Hall in his late Arctic Exploring Expedition, begs leave to report, that he found the collection of fossils small in number of individual specimens, and limited in the range of its species, but possessing great interest to the student of Arctic geology.

The specimens are as follows:—

Maclurea magna (Lesueur).	No. of	specimens	7
Casts of lower surface.	"	"	3
Endoceras proteiforme? (Hall).	"	"	1
Orthoceras (badly worn specimens).	"	"	3
Heliolites (new species).	"	"	2
Heliopora " "	"	"	1
Halysites catenulata (Fischer).	"	"	1
Receptaculites (new species).	"	"	1

This collection was made at the head of Frobisher Bay, lat. 63° 45′ N.,

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[1] [2], xx. 270, xxv, 396, xxix, 363, xxxi, 356, xxxiv, 203.

[2] Communicated to this Journal by the Lyceum.

and long. 70° W. from Greenwich, at a point which, Mr. Hall says, is 'a mountain of fossils,' similar to the limestone bluff at Cincinnati, with which he is familiar. This limestone rests upon mica schist, specimens of which he also brought from the same locality. Whether the limestone was conformable to the schist or not, Mr. Hall did not determine. It is much to be regretted that this interesting point was not examined by him, as it is doubtful whether this locality may ever be visited by any future explorer.

The fossils, without doubt, are all Lower Silurian. The *Maclurea magna* would place the limestone containing it on the horizon of the Chazy limestone of New York. The *Halysites catenulata* has been found in Canada in the Trenton beds, but in New York not lower than the Niagara Limestone. The *Endoceras proteiforme* belongs to the Trenton limestone. The *Receptaculites* is unlike the several species of the Galena limestone of the West, or the *R. occidentalis* of Canada. Mr. Salter speaks of one found in the northern part of the American continent. This may be that species, or it may be a new one; which it was, we have no means of determining. The *Orthocerata* were but fragments, and so badly water-worn that the species could not be identified.

The specimens of corals were very perfect and beautiful, and unlike any figured by Prof. Hall in the Palæontology of New York. The *Heliolites* and *Heliopora* belong to the Niagara group, in New York, but in Canada they have been found in the Lower Silurian. For the identification of strata, corals are not always reliable. Whether these species are similar or identical with any in the Canadian collection, it was out of my power to determine. They are unlike any figured by Mr. I. W. Salter. R. P. STEVENS.

One of the committee, appointed to examine the mineral specimens brought from Frobisher Bay by Mr. Hall, reports that the specimens though quite numerous were mostly of the same general character. The rocks were nearly all mica schist; some of the specimens were taken from boulders, some from the ruins of houses, and had the mortar still attached, and some were from the rock in its natural position. There was nothing peculiar in the rock, it presenting the usual variations in composition. The other specimens were an argillaceous limestone determined by its fossils to be Lower Silurian; a single specimen of quartz, crystallized and presenting besides the usual six-sided termination another pyramid whose angle was much more obtuse; magnetic iron, some of which was found *in situ* and other specimens which were evidently boulders and had undergone for some time the action of salt water; a few pieces of iron pyrites, bituminous coal and nodules of flint or jasper. * * * *

[The part of this Report omitted gives reasons for believing the coal and siliceous nodules to have been brought from England by Frobisher, who, it is well known, took out large supplies and many miners, expecting to mine and smelt ores; some "blooms" of iron which Mr. Hall found may have been the result of their operations with the magnetic iron.—EDS.]

* * * This theory is supported by the traditions of the natives, who say that the coal was brought there by foreigners,[1] as well as by the

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[1] Everything that seems to them peculiar they refer to this source.

entire absence of any indications of geological strata so high up in the series as the Carboniferous formation. The siliceous pebbles seem to have served as gravel for the mortar used in building the houses for carrying on the various objects for which the expedition was sent out. No trace of any mineral containing silver existed in the collections. The sands supposed by Mr. Hall to be those in which Frobisher found gold have not yet been assayed. A small bead detached from an ornament worn by the natives was found to be lead. THOS. EGLESTON.

But little attention was paid to zoology, Mr. Hall not having the means at hand for the preservation of specimens. A single specimen of a mollusk, in a dried state, was sent to Wm. Stimpson, Esq., for examination. He writes as follows: "I find the specimen to be *Cynthia pyriformis* Rathke, an Ascidian mollusk, originally found on the coast of Norway." Only two species of birds were brought, viz: *Colymbus torquatus* Brunwich, and *Plectrophanes nivalis* Linn.

Of mammals, he obtained two Lemmings which were referred for determination to Prof. S. F. Baird of the Smithsonian Institution. He informs me that they agree best with *Georychus helvolus* Audubon, and he should so consider them for the present. GEO. N. LAWRENCE.

3. *Note on a fossil Echinoderm from the Blue Limestone (Lower Silurian) of Cincinnati, Ohio;* by J. D. DANA.—In vol. i, (1846) page 44 of the second series of this Journal, there is a paper on a fossil Echinoderm from the Blue Limestone of Cincinnati, by G. GRAHAM, J. G. ANTHONY and U. P. JAMES, illustrated by a figure from a drawing by the last-mentioned. In a recent letter from Mr. James, the writer learns that the specimen was discovered by him in March, 1846, and that it still remains in his possession and is the only one yet found. The species is referred in the article to the genus *Asterias.* In the writer's Manual of Geology, the figure is reproduced on page 221, and the provisional name annexed of *Asterias Anthonii.* From an examination of the drawing, Mr. E. Billings of Montreal, well versed in Silurian Echinoderms, concludes that it comes nearest to the genus *Palasterina* and may belong to it. Deriving the name from the true discoverer, the species will then be the *Palasterina* (?) *Jamesii.*

4. *On a new Crustacean from the Potsdam Sandstone;* by Prof. JAMES HALL, (*Canadian Naturalist and Geologist,* Dec. 1862, vii, p. 443.)—The Crustacean fossils here described and figured are the cephalic shields of a species supposed by Prof. Hall to approach in character the modern Limulus. They are from the Potsdam sandstone of Wisconsin. The shield is three times as broad as long, has a strong thickened border, rounded lateral angles, and small but quite prominent eyes. Other fragments have been obtained in the region of the Upper Mississippi, and one is a straight spine, which may have been, Prof. Hall observes, the caudal spine of this species. It is suggested that the tracks, called *Protichnites,* found in the Potsdam sandstone of Canada by Logan, may have been made by this species; and this is urged as the more probable, since, in 1857, similar tracks were observed by E. Daniels, of the Geological Survey of Wisconsin, in the Potsdam sandstone of Black River.

5. *Proceedings of the Portland Society of Natural History,* vol. i, part 1.—This volume of 100 octavo pages is the first publication, in

form, of the Portland Society of Natural History. It contains many papers of interest, a plate of coal plants of the Carboniferous age, and a valuable geological map of the northern portions of the state of Maine. If the future numbers of the Proceedings are equal to the first, their publications will contribute much to the progress of science.

Most of the papers in Part 1 appear to have been communicated by members of the Scientific Survey of Maine: and we understand that the first set of specimens collected by the authority of the state government will be deposited in the rooms of the society. The following are the titles of the most important papers in Part 1. A catalogue of the Flowering Plants of Maine, by G. L. Goodale, Botanist to the Maine Scientific Survey:—Catalogue of the Mammals and Birds of Maine, compiled by C. H. Hitchcock, State Geologist:—Notes upon the Geology of Maine, by C. H. Hitchcock:—Catalogue of the Reptiles and Amphibians of Maine, by B. F. Fogg, M.D.:—Fossils of the Potsdam Group of North America, by C. H. Hitchcock:—Grooved Boulders in Bethel, Maine, by N. T. True, M.D.:—Description of a new species of Carpolithes from the Miocene Tertiary of Vermont, by C. H. Hitchcock.

6. *On the present condition of the Crater of Kilauea on the island of Hawaii*; by Rev. TITUS COAN.—The following facts on the present condition of the crater of Kilauea are taken from a letter addressed to Prof. C. S. Lyman by Rev. T. Coan, dated Hilo, Hawaii, Nov. 13, 1862.

"Very great changes have taken place in Kilauea since your visit in 1846.[1] The great dome, some two miles in circuit, which was raised over Haluemauma [the lake of lava situated in the south extremity of the crater of Kilauea,] has subsided, leaving a corresponding depression or crater. It is as if a great cauldron had been turned right side up and set for boiling. Near the center of this depression, there is an active lake about 600 feet in diameter. Sometimes this lake is sluggish, and again it boils and rages, tossing its fiery masses and throwing up its jets of melted lavas 20 to 50 feet high. Occasionally it overflows, or rends its rocky sides, and sends off streams to harden in other parts of the crater. Within the aforesaid basin or crater, and one-fourth of a mile from the active lake, a great mound has been recently raised, and on its summit a huge mass of lava is piled up, rising into pinnacles and turrets, of such form as to resemble, in the distance, a cathedral. This is called Pelé's Temple.

All the central portion of the crater of Kilauea has been elevated by upheaving forces, and the circuit, once the "Black Ledge," has been raised by superincumbent deposits or overflowings proceeding from the southern portion of the crater. I think the central area is not more than 600 feet below the highest point in the outer wall of Kilauea. Near this central portion of the crater rests an irregular and broken ridge of immense masses of very compact basalt filled with grains of olivine or chrysolite."

7. *Arsenids of Copper from Lake Superior.*—SCHEERER gives in the *Berg- und Hüttenmännisches Zeitung*, xx, p. 152, an account of a specimen of a metallic mineral found as a boulder on the banks of the St. Louis River, near Superior City, Wisconsin. He found it to contain 86 pr. ct. of copper and 14 pr. ct. arsenic. On the weathered surfaces it was black, while on the fresh fracture it was yellow, tarnishing and becoming black on exposure to the air. It was considered by several members of the

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[1] See this Journal, [2], xxii, 75.

"Miners' Union" at Freiberg to be a furnace product, perhaps made by the Indians. Dr. Kenngott very properly classes this substance with whitneyite (*Uebersicht*, 1861, p. 114), and the mass is unquestionably a mixture of whitneyite and algodonite similar to that described by Dr. Genth (*this Journal*, [2], xxxiii, p. 191). A further notice of this boulder has been sent to Prof. Silliman, Jr., by Col. Chas. Whittlesey of Cleaveland, from which we extract the following facts. It was found on the bank of the St. Louis river at Rice's Point, one and a half miles from the west end of Lake Superior. It was about one foot in length, and weighed from 95 to 100 lbs.; on the fracture it was crystalline and contained small pieces of calc-spar. The fragment analyzed by Scheerer was sent to him by Col. Whittlesey through Mr. Boole, who was then a student in Freiberg. Col. Whittlesey considers that this boulder was transported to the St. Louis River, from some vein, by the northern drift. It had the usual worn aspect of the copper boulders of the Lake Superior region.

The writer is informed by Mr. C. F. Eschweiler, Superintendent of the Isle Royale Mine, that a *vein* of arsenids has recently been discovered on the property of the Columbia Mining Company at Houghton. The whitneyite is there found associated with native copper and domeykite.

G. J. B.

8. *Catalog einer Sammlung vom 675 Modellen in Ahornholz, zur Erläuterung der Krystallformen der Mineralien, ausgegeben vom Rheinischen Mineralien-Comptoir des* Dr. A. Krantz in Bonn. pp. 50, 8vo. Bonn, 1862.—This catalogue is a description of the collection of crystal models now made by Dr. Krantz. The models 1 to 78 illustrate the monometric system, 79 to 151 the dimetric system, 152 to 343 the hexagonal system, 344 to 506 the trimetric system, 507 to 645 the monoclinic system, and 646 to 675 the triclinic system. Among these are 81 models of twin crystals, illustrating twinning in 44 species. The whole represent 222 mineral species. The catalogue contains under each number the name of the form or species, the crystallographic symbols of the planes, according to both Naumann and Miller's notations, and references to the figure corresponding to the model in Naumann, Miller, Rose, Dana, Dufrénoy and other prominent treatises of Mineralogy. The models are made with the greatest accuracy; many of them are copies from models furnished to Dr. Krantz by G. Rose and Hessenberg. They are made of maple, and have an average diameter of 5 centimetres (about 2 inches). They are sold in Bonn for 120 Prussian thalers.

G. J. B.

V. ZOOLOGY.

1. *Contributions to Conchology*, vol. ii.—*A Monograph of the Order Pholadacea and other papers;* by George W. Tryon, Jr. Dec. 31, 1862.—This volume of 127 pages is composed of articles printed originally in this Journal, and in the Proceedings of the Academy of Natural Sciences of Philadelphia. The first volume, containing a bibliography of American Conchology, was published independently in 1861. The seven articles in the present volume are, "*On the Mollusca of Harper's Ferry, Virginia,*" (pp. 9–11), "*A sketch of the history of Conchology in the United States,*" (13–32),[1] "*Synopsis of the Recent Species of Gastro-*

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[1] See this Journal, [2], vol. xxiii, March, 1862.

chænidæ, a Family of Acephalous Mollusca," (33–62), "*On the Classification and Synonymy of the recent species of Pholadidæ,*" (63–93), "*Notes on American fresh water Shells,*" (95–96), "*Monograph of the family Teredonidæ,*" (97–126), and "*Description of a new Genus and Species of Pholadidæ,*" (126–127).

The *Pholadacea*, as will be seen from the above list, are divided into three families, first severally distinguished by Mr. Carpenter. These families may be natural, the *Teredonidæ* being most justly separated from the *Pholadidæ*, with which they had been confounded until distinguished by Carpenter; but, to the number admitted by Mr. Tryon, would perhaps be properly added another, the *Aspergillidæ* of Gray; the presence of fringes or tentacles at the front of the mantle, and the consequent development of tubuli radiating from the edge of the anterior disk of the tube, conjoined with the modification of the other part, appear fully to justify that distinction. There would then be four allied families, *Pholadidæ*, *Teredonidæ*, *Gastrochænidæ* and *Aspergillidæ* or *Brechitidæ.* The propriety of the erection of this group of families into an "order," as has been proposed by some and adopted by Tryon, is extremely questionable.

The genera of the *Pholadacea* accepted by Mr. Tryon are numerous, but apparently not more so than are natural. A number, it is true, have been refused by many conchologists, chiefly on account of the burthen on the memory caused by the multiplication of generic names; but, as it is not quite evident what relation the powers of memory have to the existence of natural groups, scientific men will doubtless prefer to express in a scientific nomenclature the structural modifications that nature indicates.

The "description of a new genus and species of *Pholadidæ*" forms an Appendix to the monograph, and makes known an interesting addition to our Fauna, the *Diplothyra Smithii* of Tryon, from New York Bay; the genus indicated belongs to the subfamily *Jouannetiinæ* of Tryon, distinguished by the development of a callous plate closing the anterior ventral gap of the adult shell, and also, it might have been added, by the perfect union of the siphonal and anal tubes, and the fringed border of the common tube in the known animals. The bibliography of the monograph is exhaustive, almost every reference to any genus or species having been given. The author proposes to publish an illustrated descriptive monograph of the same *Pholadacea* at a future time, if furnished with requisite material—for which he appeals to collectors.

In the "Notes on American fresh water Shells," the subdivision of the genus *Vivipara* Montfort (properly *Viviparus*), into four subgenera, *Vivipara*, *Tulotoma* Hald., *Melantho* Bowd, and *Haldemania* Tryon, is proposed. This view will doubtless be accepted, although the distinguishing characters of *Melantho* are not given. The latter includes the ordinary *Paludinæ* of the Eastern States, and is distinguished by the form of the shell, the sigmoidally sinuous outer lip, &c. A family *Amnicolidæ* is also proposed for the reception of *Amnicola*, but is unaccompanied by a diagnosis. The distinction of that genus from the *Viviparidæ* as well as *Littorinidæ* and *Rissoidæ*, is justifiable; it is indeed more nearly related to the Melanians but has no lateral jaws. The characters of the family, as well as of the *Viviparidæ*, and the subdivisions of each, will be given in another place by the reviewer. The genus *Amnicola* is proposed to admit the new subgenus *Pomatiopsis*, based on *A. lapidaria* and other elongated species. The correctness of this distinction at least remains to be verified on the animal.[2] Two more distinct types exist in the *A. Cincinattensis* G. & H., and the globular *A. depressa* Tryon. The former, on account of its reflected circular lip, has been named by the reviewer *Chilocyclus*, while the latter, distinguished by its large, globose body-whorl, is called *Somatogyrus*.

The memoirs, brought together in this volume, are valuable contributions to science, and will doubtless obtain for the author the merited thanks of the scientific world. It were to be wished that more conchologists would imitate him in precision and knowledge of bibliography.

T. GILL.

2. *Analytical Synopsis of the order of Squali, and Revision of the Nomenclature of the Genera;* by THEODORE GILL. pp. 42(–47). (Reprinted from *Annals of New York Lyceum*, vol. viii.) *On the Classification of the Families and Genera of the Squali of California;* by THEODORE GILL. (*Proc. Acad. Nat. Sci. Phila.*, Oct., 1862).—The two articles cited are devoted to the systematic revision of the families and genera of Sharks, which the author regards as constituting an order of Elasmobranchiate Fishes, distinct from the Rays; the ordinal name of *Squali*, previously used in a subordinal sense, has been retained. The "analytical synopsis" is divided into three chapters,—1st, "*On the history of the order*," in which a review of the principal classifications of the sharks is given, and their respective merits discussed; 2d, "*On the relations of the order*," in which the isolation of the *Rhinæ* (*Squatinæ* Dum.) as a distinct suborder, is urged, and the nearer affinity of that group to the order of Rays is contended for; the relation of the families sought to be ascertained, and the most striking peculiarities of the geographical distribution of the several types pointed out; and 3d, "*Systematic Arrangement.*" In this portion of the synopsis, two analytical tables are first given, illustrating the principal or most apparent distinctions of the different families, sixteen of which are admitted; these are followed by similar analytical tables for the respective families, the dichotomous method being applied to facilitate the identification of the various genera. After the "synopsis" of each family, an enumeration of the subfamilies and genera is presented, in which the authorities, typical species, and synonyms of the generic names are given. As a sequel to the whole, the latin diagnoses of fifteen new genera are offered; this, added to the number adopted from others, gives a total of fifty-eight represented in our present seas; to that number, six others are superadded in the supplementary article on the Californian sharks.

The classification adopted in the synopsis is said to be a "modification of that of Müller and Henle. The principal differences consist in the arrangement of the *Scyllioids* at another point in the series, and their distribution among three families, and in the union of the Müllerian families of the *Carchariæ*, *Triænodontes*, *Galei*, *Scylliodontes* and *Mus-*

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[2] The *A. lapidaria* itself perhaps belongs to the *Aciculidæ*, and consequently to a different family from the other species.

teli in one, but after the exclusion, from the first, of the hammer-headed sharks, which appear to constitute a distinct family, *Cestraciontoidæ*, (the *Zygænæ* of former American authors and not the *Cestraciontes* of Agassiz) recognized as such by most of the recent systematists." The terminology of the family names is also different from that adopted by the German naturalists, the terminal syllables *oidæ* being employed; and the subdivision into subfamilies is likewise original. The principal changes in the nomenclature result from the revival of names proposed by Klein and Rafinesque. A still further modification is proposed in the article on Californian sharks, where the proposition is made to distinguish the genus *Oxynotus* of the synopsis (*Centrina* Cuv.) as the type of a special family, and the arrangement of the genera left in the *Spinacoidæ* is considerably altered. In the same article, the family of *Heterodontoids* of the author (*Cestraciontes* Ag.) is made to include three genera, the Californian species (*Cest. Francisci* Grd.) being fully described as the type of one (*Gyropleurodus*), and a species illustrated in the *Zoology of the Venus* being proposed as that of another named *Tropidodus.* The author is inclined to exclude many of the genera referred by Prof. Agassiz to the Cestraciontes, from that family, and has restricted it with reference chiefly to the living forms. One of the chief characters noticed, as distinguishing the family from all other existing types, is the form of the head, and the rapid declension of profile from the interorbital region.

In accordance with the classification proposed in the Synopsis, there are eight families of *Squali* represented along the eastern coast of the United States;—(Squali) *Lamnoidæ*, *Odontaspidoidæ*, *Alopecoidæ*, *Cestraciontoidæ* (*Zygænæ*), *Galeorhinoidæ* (*Carchariæ*), *Spinacoidæ*, *Scymnoidæ*, and (Rhinæ) *Rhinoidæ*, (*Squatinæ*). Along the western coast, only five are yet known to be represented; the *Galeorhinoidæ*, *Heterodontoidæ*, *Notidanoidæ*, *Spinacoidæ*, and *Rhinoidæ*. A.

3. *On the mode of development of the marginal tentacles of the free Medusæ of some Hydroids;* by A. Agassiz. 14 pp., 8vo. (From the *Proc. Bost. Soc. Nat. Hist.*, vol. ix, August.) *On Alternate Generation in Annelids, and the Embryology of Autolytus cornutus;* by A. Agassiz. 26 pp., 8vo, with 3 plates. (From the *Journ. Bost. Soc. N. H.*, vii, 392, 1862.)—These papers by A. Agassiz (son of Professor Agassiz) contain the results of careful research, bearing on facts of great zoological interest. The first relates to the order of succession in the development of the marginal tentacles of Medusæ. Designating each new intermediate series by t and a number, added as an index expressing the order in time of the several series, he makes out a formula for the order of arrangement, and also for the number of tentacles. Thus, in a young *Tiaropsis*, the formula for the number of tentacles is

$$\Sigma t = 4T_1 + 4t_2 + 16t_3 = 24t,$$

or in other words, the sum of the number of tentacles equals 4 of the series first in the order of time, +4 of the second (or those next developed), +16 of the third. In two older stages of the *Tiaropsis*, the formulas are

$$\Sigma t = 4T_1 + 4t_2 + 16t_3 + 8t_4 + 8t_5 = 40t,$$

and $$\Sigma t = 4T_1 + 4t_2 + 16t_3 + 8t_4 + 8t_5 + 16t_6 = 56t.$$

We refer to the paper for other examples of these important results.

In the second paper above mentioned, the author has illustrated, by many excellent figures, the reproduction by fission of some Annelids, and further has sustained the view, which has heretofore been questioned, that there is actual alternate generation in these species; showing that the individuals proceeding from the egg reproduce *only* by fission; and that from fission come males and females; and, from these males and females thus originating, reproduction by eggs again commences. A new American species of *Autolytus* also is described, and its development from the egg described and illustrated.

VI. ASTRONOMY.

1. *On the double star μ Herculis*, (in a note to the Editors of this Journal, dated Cambridgeport, Feb. 20, 1863.)—In the summer of 1856, I discovered that the companion of μ Herculis was a double star, but having no suitably mounted instrument for executing measures of either position or distance, I reported the case to Mr. Bond at Cambridge, and also to Mr. Dawes of England.

The latter has published the following measures, made soon after its discovery, in the Monthly Notices of the Royal Astronomical Society of London, vol. xvii, No. 9. $P = 58°\cdot97$; $D = 1''\cdot85 \pm$.

In July, 1862, I found $P = 70°$; the distance remaining about the same, or certainly not increased. Mr. Dawes calls them $10\frac{1}{2}$ and 11 magnitudes. Considering the large distance and minuteness of the components, this change in the angle of position is very remarkable.

Another interesting object, at this time, is ζ Herculis; so nearly in conjunction, the past summer, that it could not be divided with a fine eight inch glass, in the best atmosphere, with a power of 1000. A notable epoch in its history! ALVAN CLARK.

2. ALVAN CLARK *receives the LaLande Prize.*—The LaLande Prize of a gold medal, value 500 francs, has been awarded by the French Academy of Sciences in January last to Alvan Clark of Cambridgeport, for his discovery of the companion of Sirius (*this Journal*, xxxiii, p. 286). It will be noticed that the great $18\frac{1}{2}$ inch objective with which Mr. Clark made this remarkable observation, has been purchased by the Chicago Astronomical Association.

3. *The Astronomical Association of Chicago.*—This new association have purchased the great $18\frac{1}{2}$ inch object glass made by ALVAN CLARK of Cambridgeport, Mass., for the University of Mississippi under the order of President Barnard. The price paid was $11,187, the same sum Mississippi was to have paid for it. It will cost about an equal sum to mount it properly.

We congratulate the prosperous city of Illinois on the possession of this remarkable objective, which already, while mounted only in a rude tube of wood, has won for its talented maker the LaLande medal.

The possession of such an instrument implies a well organized Observatory, with all its appointments, for the endowment of which Chicago lacks neither the spirit nor the means.

4. *Shooting Stars of Dec.* 10*th*–13*th*, 1862.—Mr. BENJAMIN V. MARSH writes from Philadelphia, that on the evening of the 10th of December, between $10\frac{1}{2}^{h}$ and 11^{h}, he noticed about half a dozen brilliant meteors. They radiated from the vicinity of Castor and Pollux. The next morning, during the half hour, 4^{h} to $4\frac{1}{2}^{h}$, they were not remarkable for number or brilliancy, but all radiated from the same vicinity.

On the morning of the 12th, Prof. Gummere and Mr. Battey saw at Haverford, Pa., 28 in $1\frac{1}{4}$ hours, nearly all of which radiated from a point about midway between Castor and Pollux.

Mr. Marsh adds, "the report which Mr. George Wood made on the 11th Dec., 1861, (*this Journal*, xxxiii, p. 149,) would agree very well with this radiant, so that I think there is strong reason to conclude that from the 10th to the 12th of December the meteors mostly belong to *one* group radiating from the vicinity of Castor and Pollux. Is it not probable that on most occasions the great body of those seen belong to a regular group reappearing annually, and that such groups, variously scattered through the year, and sometimes perhaps over-lapping, make up the mass of the meteors seen?"

VII. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Scientific application of the Metric System of Weights and Measures.*—The establishment of the International Decimal Association in the year 1855, has at length resulted in the appointment of a Committee of inquiry by the British House of Commons, which after examining numerous witnesses of great eminence, has presented to Parliament a report recommending the adoption, throughout the British Empire and for all purposes, of the Weights and Measures of the Metric System. This report, having been published by the House of Commons, with the evidence of 39 witnesses and an analytical index, forms a "blue book" of nearly 300 pages. Besides matters of the utmost importance in regard to the improvement of education, the progress of domestic trade and of foreign commerce, and the advance of the general interests of humanity, it merits the attention of all who are engaged in scientific pursuits on account of its statements in regard to the progress of the Metric System among chemists, physiologists, and other philosophers. The witnesses, whose testimony relates to this subject, are, Thomas Graham, F.R.S., Master of the Mint; Professor Miller, of Cambridge, one of the Commissioners appointed by the British Government to restore the lost standards of weights and measures; T. L. Donaldson, Professor of Architecture in University College, London, and a Juror of the International Exhibition; Dr. Bolley, Director of the Polytechnic School and Professor of Applied Chemistry at Zurich. The testimony of these gentlemen is to the following effect:—

Within the last ten years the Metric System has made great progress in the British Islands so that it is used almost exclusively in chemical pursuits. It now forms a sort of common scientific language understood everywhere. Papers published in England with the national weights and measures are neglected on the continent, being so far unintelligible. Scientific men generally look forward to the universal adoption of this system, being of opinion that no other can prevail. It begins to find a place in elementary English books. It is used in papers read before the Royal Society. On the other hand, the English weights and measures are so complicated that it is impossible to use them, and some of them, such as the scruple and the drachm, are little known even by name. The grain has been decimally divided for more than 30 years, and Mr. Oertling of London now makes delicate balances with grain weights, which are commonly used by chemists and at the colleges. As far as scientific investigations are concerned, the old English method is entirely useless. In our scientific journals, weights are almost universally given in grams, and lengths in millimetres. In Switzerland, as well as in other continental nations, the Metric System is the only one in use for scientific purposes: without its adoption they cannot write on chemical or physical matters. In Alexandria the builders all use the metric form employed by the French and Italians, extreme difficulty and confusion being produced in architecture and engineering by the diversity of weights and measures. At the late International Exhibition in London the foreign jurors abandoned in despair the task of drawing parallels between the values of British and foreign goods.

The claims of science, to have the benefit of the Metric System, have likewise been represented at an interview, on the 18th of November, with the Rt. Honorable Milner Gibson, M.P., President of the Board of Trade. On this occasion, Professor Owen of the British Museum showed the value of the system in the study of natural history. The majority of the facts in this science include the elements of weight and measure. But, besides the confinement to Britain of its own national weights and measures, which constitute a wall of separation between British and foreign science, innumerable mistakes arise from their variety, their intricacy, and their want of system. Uncertainty arises between avoirdupois and troy, and between divisions of the inch into tenths and twelfths, both of which are called "lines."

In the United States and the South American States, the employment of the Metrical System for scientific purposes is all but universal, and, in those institutions of learning where this system is employed by teachers, the results are always most satisfactory.

2. *Pasteur* has been chosen and confirmed a member of the French Academy, in the section of Mineralogy, in place of De Sénarmont, deceased. Des Cloizeaux was his competitor (*ex æquo*), in the second rank Delesse, and in the third Hébert. The vote stood thus: 60 votes, 31 requisite for a majority, the first ballot gave Pasteur 36, Des Cloizeaux 21, and Delesse 3.—*Session of Dec.* 8, 1862.

VIII. BOOK NOTICES.

1. *Storer's Dictionary of Solubilities of Chemical Substances.*[1]—Mr. Storer here presents us the first installment of a work on which he has been long engaged with well known assiduity, and which is destined to connect his name inseparably with chemical literature. This part of the *First Outlines* takes us nearly to the close of the letter C, probably a near approach to one third the bulk of the entire work. The term

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[1] First Outlines of a Dictionary of the Solubilities of Chemical Substances. By Frank H. Storer. One volume in three parts. Part I, 8vo, pp. 232. Cambridge: Sever & Francis, 1863. B. Westermann & Co., New York.

solubility is used by Mr. Storer in its most comprehensive sense, thus grouping by this character a wider range of phenomena than might at first appear germane to this single constant. Thus the plan includes, not only "the comportment of a substance towards water, alcohol, wood spirit, ether, oil of turpentine, benzine and analogous hydrocarbons, and the other neutral solvents;" but also in many cases observations on the action of acids and alkalies, as well as the influence of one salt on the solubility of another.

The alphabetical arrangement makes the work one of extreme convenience for reference, as it proceeds on no principle of selection, but gives the names of all substances, each in its proper place, with formulas of constitution, and in all important—we might almost say in all possible—cases, with references to original memoirs or authorities. The arrangement of substances is by the acids rather than by the bases. Thus the acetates, chlorhydrates, chlorids, carbonates, &c., are made to embrace all the salts of these electronegative substances. It of course falls into the plan of this work to present full tables of solubilities of all the important substances of common use in the laboratory, as ammonia, chlorhydric acid, various chlorids, carbonic acid, carbonates, alcohol, acetic acid, the acetates, &c. &c. The qualities of accuracy, fullness, convenience of reference and quotation of authorities will secure the use of this Dictionary of Solubilities, not only by all investigators, but no analytical student who has well mastered his Fresenius can afford to be without it, while manufacturers and pharmaceutists will find it the most convenient *vade mecum* at their command.

Mr. Storer tells us in his preface that he was driven, after some six years of labor, to the expedient of printing, in order to facilitate the completion of the projected work, owing to the great bulk and increasing complexity of the manuscript, with its innumerable interpolations. The present work is therefore, as its title indicates, in many points only a general outline requiring innumerable details to fill up each special feature. But taken as it stands it is a monument of amazing labor, erudition, and skillful authorship. Such "compilations" can be made only by the hand of a master. Mr. Storer has for some time been recognized as one of our most encyclopedic chemical scholars. The readers of this Journal need no other reference than to the very numerous contributions which have lately appeared from his pen in our pages, on a great variety of subjects. The article on coal oils, published in the modest form of a review of Dr. Antisell's book, has been very widely reproduced, and is highly complimented by Wagner in the *Jahresbericht*, while his papers on the alloys of copper and zinc and on the impurities of zinc (the latter in company with Eliot) have become the authority on those subjects at home and abroad, being quoted by Kerl, Otto, Percy and others. Storer has from the commencement of the *Repertoire de Chemie* been selected as the American Editor of that well known Journal.

We are assured of the early completion of the *First Outlines*, and we cannot wish any author a longer life or more sustained and useful labor than is implied in the completion of the work in all its details according to the original plan.

2. *New American Cyclopedia*, vols. XV and XVI.—This work, which has been nearly six years in hand, is completed. Some of the articles in

vol. xv which are of most scientific interest are Steam and Steam engine, Steel, Sugar, Symbols, Telegraph, Telescope, Thermometer, Tides, Tobacco, &c. The most elaborate article in this volume is very naturally *United States*, which fills 122 pages, and contains a vast amount of valuable matter in a compact form.

In volume xvi we notice the following titles of scientific interest: Volcano, Warming and Ventilation, Weights and Measures, Walrus, Whale, Wheat fly and Moth, Winds, Zeuglodon, Zinc, Zoology, and many more. A list of contributors, with the titles of their articles, is given in vol. xvi. Among them we find very many of our best authors in all departments. A mere enumeration of the principal ones would exceed our present limits. One of the daily journals gives some statistics of this great literary enterprise, from which we borrow a few items:[1]

The present work of Messrs. G. Ripley and C. A. Dana is the first original general Cyclopedia completed in this country. Dr. Lieber's valuable translation of the German *Conversations-Lexicon*, made many years ago by that industrious and erudite scholar, with the assistance of a staff of writers, was long a standard work, but the rapid march of modern events has left it behind; and no attempt was ever made, we believe, (beyond the issue of one supplementary volume, the xivth,) to bring up arrears in monthly supplements like those printed by Messrs. Brockhaus in Germany, as continuations of the last edition of the *Conversations-Lexicon*.

Since 1857, besides the two editors already named, a staff of twenty-five writers has been occupied upon the American Cyclopedia in a large office provided with an ample reference library in various languages, aided also by the Astor Library. Numerous gentlemen outside the regular corps have also contributed articles on subjects upon which they were specially conversant.

The labor of revising the articles as written, and again revising the proof sheets, employed not only the two editors, but in addition five or six other gentlemen, especially competent for this work, who verified dates and other figures, and so far as is possible to human handiwork, made each page perfect. Besides this, proofs of all the more important articles were sent to the authors, or to experts, for verification and correction. The cost of the revision alone amounts to considerably over twenty thousand dollars.

The number of titles or subjects treated is about twenty-seven thousand in 13,804 pages, of 52 million "ems" printers measure, requiring, for 10,000 copies printed, over 12,600 reams of white paper. Before the rebellion, over 17,000 subscribers to the work were registered, of which about 5000 were in disloyal states.

Messrs. Appleton, the enterprising publishers, have invested over four hundred and fifteen thousand dollars in this great literary venture, of which $143,700 went to contributors and for making the stereotype plates. The whole number of volumes printed is 227,550.

Of the literary execution of the work we can speak with satisfaction. Its scientific articles are in general far from possessing the completeness and finish which are to be found in the elaborate treatises (for such they in reality are) which are to be found in the Encyc. Britannica; but for the

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[1] New York Evening Post.

purpose intended in their compilation, as a general and popular reference, they are quite sufficient in most cases, and often perfectly satisfactory. The work as a whole is full of information, accurate, and well arranged for reference. In any condition of affairs it would be a creditable production, but continued to a successful end amidst a great civil strife, it is peculiarly creditable to all concerned.

We understand that the design is to issue a supplementary volume which will bring the work up to the present times, to be followed hereafter by the issue of an annual volume, entitled

The American Annual Cyclopedia and Register of Progress and Events, the 1st volume of which, for 1861, has been on our table for some months, and that for 1862 will be soon issued in a style identical with the American Cyclopedia.

OBITUARY.

We have to record the death of several men of science since our last.

1. **James Renwick**, long Professor of Physics in Columbia College, New York, died in that city about the close of January, aged 78 years. Prof. Renwick's "treatise on the Steam Engine" was long an authority for engineers, and his Outlines of Natural Philosophy (2 vols. 8vo, Philadelphia, 1832) was the earliest extended treatise on physics by an American. For many years Prof. Renwick had retired from active service, enjoying with dignity an ample fortune.

2. **Melins C. Leavenworth.**—Dr. Leavenworth died near New Orleans, La., in December, while acting as Surgeon to the 12th Connecticut regiment. He was among the oldest of American botanists, his first paper, "on four new plants from Alabama," having appeared in vol. vii, of the first series of this Journal, in 1824. Dr. Leavenworth has resided, since his retirement from the medical service of the United States army, in Waterbury, Conn., until at the call for volunteers, well advanced in years and by no means firm in health, he went cheerfully to offer his life a sacrifice for his country.

3. Dr. **Asahel Clapp**, a botanist and naturalist, died at an advanced age, Dec. 17, 1862, at his residence, New Albany, Indiana. He was well known to collectors in botany and geology. His chief publication is a Report to the American Medical Association on the plants of the United States useful in medicine.

IX. WORKS RECEIVED.

Mathematics and Physics.—

Report of the Thirty-First Meeting of the British Association for the Advancement of Science; held at Manchester in September, 1861. London: J. Murray. 1862. 8vo, pp. 340 and 320.

An Elementary Treatise on Plane and Spherical Trigonometry, with their application to Navigation, Surveying, Heights and Distances, Spherical Astronomy, etc.; by **Benjamin Peirce**, LL D., &c. Revised edition. Boston and Cambridge: James Munroe & Co. 1861. 8vo, pp. 327.

De la Théorie Mathématique de la Musique; par **Alexandre-P. Prevost**. Genève, 1862.

On the Density of Steam; by **W. J. Macquorn Rankine**, C.E., LL.D., F.R.SS. Lond. and Edin., &c. From the Trans. Roy. Soc. Edinburgh, 1852. 4to.

Vis Inertiæ Victa, or Fallacies affecting Science: an Essay to increasing our knowledge of some physical laws, and a Review of certain Mathematical Principles of Natural Philosophy; by **James Reddie**. London, 1862.

On Certain Forms of Interpolation; by **W. P. G. Bartlett**, A.M. Cambridge, 1862. Mem. Amer. Acad.

Astronomy and Meteorology.—

Smithsonian Contributions to Knowledge.—Discussion of the Magnetic and Meteorological Observations made at the Girard College Observatory, Philadelphia, in 1841—1845. Part II. Investigation of the Solar Diurnal Variation in the Magnetic Declination, and its Annual Inequality; by A. D. Bache, LL.D. Washington, June, 1862.

The same. Part III. Investigation of the Influence of the Moon on the Magnetic Declination; by A. D. Bache, LL.D. Washington, June, 1862.

On Meteorology; by Prof. Joseph Lovering, of Harvard University. Continued from the American Almanac for 1862.

Contributions to Meteorology for the year 1861, from observations taken at Isle Jesus, Canada East; by Charles Smallwood, M.D , LL.D., Professor of Meteorology in the University of McGill College, Montreal.

Intorno alla Corrispondenza che passa tra i Fenomeni Meteorologici e le variazioni d'intensita' del Magnetismo Terrestre; memoria del P. Angelo Secchi.

Sul Recenti Progressi della Meteorologia. Discorso letto alla Pontificia Accademia Tibernia; dal P. Angelo Secchi, d. C. d. G., Direttore dell'Osservatorio del Collegio Romano; il giorno 8 Aprile 1861. Roma, 1861.

Report of the Regents of the University of the State of New York, on the longitudes of the Dudley Observatory, the Hamilton College Observatory, the City of Buffalo, the City of Syracuse. Albany, 1862.

Further researches on the Auroræ Boreales, and the phenomena which attend them; by A. de la Rive. From the Phil. Mag. (Suppl.) for June 1862.

On the Lunar-Diurnal Variation of the Magnetic Declination, obtained from the Kew Photograms in the years 1858, 1859, and 1860; By Major-general Edward Sabine, R A , Treas. and V.P.R S. From Proc. Roy. Soc., January 1861.

Standard Mean Right-ascensions and Circumpolar and Time Stars, prepared for the use of the U. S. Coast Survey; A. D. Bache, Supt. Washington, 1862.

On the Physical Constitution of Comets; by Olinthus Gregory Downes, F.R.A.S. London, 1860.

Considerations on the phenomena attending the Fall of Meteorites on the Earth; by W. Haidinger, For. Mem. R.S.L. & E., &c. From the Philosophical Magazine for November and December, 1861.

Das Meteoreisen von Sarepta; von dem w. M. W. Haidinger. Mit 2 Tafeln. Akad. der Wissenschaften vorgelegt in der Sitzung am 24 Juli 1862.

An attempt to account for the physical condition and the fall of Meteorites upon our Planet; by W. Haidinger, &c. From Brit. Assoc. Report, 1861.

Chemistry and Agriculture.—

A Manual of Chemistry, Descriptive and Theoretical; by William Odling, M.B., F.R.S , &c. Part I. 8vo, pp. 380. London: Longman, Green, Longman & Roberts. 1861.

On Mauve and Magenta: a Lecture delivered in the theatre of the Royal Institution of Great Britain; by A. W. Hofmann, Ph.D., LL.D., F.R.S., President of the Chemical Society. London: W. Clowes & Sons. 1862.

Preliminary Researches on Thallium; by William Crookes, Esq., F.C.S. 1862.

Remarks upon the Recent Determinations of the Atomic Weight of Antimony: by William P. Dexter. From the Proceed. Am. Acad. of Arts and Sciences for January 14, 1862. Cambridge, 1862.

Medico-legal contributions on Arsenic: containing Reports of a number of cases of Arsenical Poisoning, together with an account of the methods employed in their Chemical Examination; by Charles H. Porter, M.D., Professor of Chemistry and Medical Jurisprudence, Albany Medical College, Albany, N. Y. Albany, 1862.

Experimental Researches into a New Excretory Function of the Liver; consisting in the removal of Cholesterine from the Blood, and its discharge from the body in the form of Stercorine (the Seroline of Boudet); by Austin Flint, Jr., M.D., Professor of Physiology and Microscopy in Bellevue Medical College, N. Y. Illustrated by three plates. From the American Journal of the Medical Sciences for October, 1862.

Sur les Relations d'Isomorphisme qui existent entre les Métaux du groupe de l'Azote; par M. J. Nicklès, Professeur, etc. Nancy, 1862.

Report on the Chemical Analysis of Grapes, submitted to Hon. Isaac Newton, Commissioner of Agriculture; by Charles M. Wetherill, Ph.D., M.D., Chemist of the Department. Washington, 1862.

First and Second Reports of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland. Annapolis, 1860, 1862.

Salt manufacture of the Saginaw Valley, Michigan; A. Winchell.

The Salt Company of Onondaga. Syracuse, 1862.

Report on the Brines of Onondaga; by C. A. Goessmann, Dr. Ph. Made to the Salt Company of Onondaga, December, 1862.

Contributions to the knowledge of the nature of the Chinese Sugar cane (Sorghum saccharatum, W.). Albany, 1862. From Transactions N. Y. State Agricultural Society, 1861.

Circular from the Commissioner of Agriculture of the United States, on the Agricultural, Mineral, and Manufacturing Condition and Resources of the United States. Washington, 1862.

Geology and Mineralogy.—

Ideal Views of the Primitive World, in its Geological and Palæontological phases; by Dr. F. Unger, of Vienna. Edited by Samuel Highley, F.G.S., F.C.S., &c. Illustrated by 17 photographic plates. London. 4to.

On the Mode of Formation of some of the River-valleys in the south of Ireland; by J. Beete Jukes, Esq., &c. From the Quart. Journ. Geol. Soc. for Nov., 1862.

Geological Survey of Canada.—Descriptive Catalogue of a collection of the Economic Minerals of Canada, and of its Crystalline Rocks, sent to the London International Exhibition for 1862. Montreal: John Lovell.

Notice of some new and imperfectly known Fossils from the Primordial Zone (Potsdam Sandstone and Calciferous Sand Group) of Wisconsin and Missouri; by B. F. Shumard, M.D. May, 1862. From the Trans. St. Louis Acad. Sci.

Description of new species of Fossils from the Devonian and Carboniferous Rocks of the Mississippi Valley; by Charles A. White, of Burlington, Iowa. From the Proc. Boston Soc. Nat. Hist., Feb. 1862.

Descriptions of Fossils from the Marshall and Huron Groups of Michigan; by Alexander Winchell. From the Proc. Philad. Acad. Nat. Sci., Sept., 1862.

Notes on the Surface Geology of the Basin of the Great Lakes; by Dr. J. S. Newberry. From the Proc. Bost. Soc. Nat. Hist., May, 1862.

Ueber eine neue kreisförmige Verwachsung des Rutils; von Gustav Rose.

Défense des Colonies. I. Groupe Probatoire, comprenant la Colonie Haidinger, la Colonie Krejci et la Coulée Krejci. Par Joachim Barrande. Paris, 1861.

The same. II. Incompatibilité entre le Système des Plis et la Réalité des faits Matériels. Par Joachim Barrande. 1862.

Observations upon some of the Brachiopoda, with reference to the genera Cryptonella, Centronella, Meristella, and allied forms; by James Hall. From the Trans. Albany Institute, Feb., 1863. pp. 23.

Zoology, Natural History and Medicine.—

Annual Report of the Trustees of the Museum of Comparative Zoology, together with the Report of the Director. Boston, 1862.

Materials for a Monograph of the North American Orthoptera; by Samuel H. Scudder. From Boston Jour. Nat. Hist., Vol. vii, No. 3. Cambridge, 1862.

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[SECOND SERIES.]

ART. XXX.—*On American Devonian;* (in a letter to the Editors from J. W. DAWSON, Principal of McGill University).

Gentlemen:—In a communication from Professor Winchell, in your January number, I observe that some American geologists are inclined to refer certain rocks, hitherto regarded as Upper Devonian, to the Carboniferous period. Will you permit me to state some facts, derived from the study of fossil plants, which seem to me to militate against this view, at least in so far as Eastern America is concerned.

In my investigations of the Devonian flora of Eastern America, carried on for several years past, and the latest results of which are published in the number of the Journal of the Geological Society of London for November, 1862, I have described or identified sixty-nine species of land plants from Devonian beds; and of these only 10 or 12 are even probably Carboniferous species. Of thirteen species from the Chemung group of New York,[1] kindly communicated to me by Prof. Hall, not one is known as Carboniferous. All are of Devonian forms, and the most abundant species are also found in the undoubtedly Devonian Gaspé sandstones, as well as at Perry in Maine, in both of which localities the flora is quite distinct from that of even the lowest Carboniferous beds, ("Sub-Carboniferous" of some authors). At St. John, New Brunswick, where, in beds which I believe to belong to the Upper Devonian, there is a more abundant flora than at the other places mentioned, a larger number,

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[1] Including the beds formerly incorrectly referred to the Catskill group.

but still only a small proportion of the species, are probably Carboniferous. In Pennsylvania, in so far as I can judge from the statements of Mr. Lesquereux and the figures given by Prof. Rogers, the flora of the "Vergent" and "Ponent" series appears to be of similar character with that of the Chemung of New York.

In Europe the observed facts are not dissimilar from those above stated. Gœppert enumerates fifty-five species as known to him in the Upper Devonian, and of these only six seem to be Lower Carboniferous. Of forty-six species from the Cypridina Shales of Thuringia, described by Unger, only four are Carboniferous. The scanty flora of the Devonian of Scotland and Ireland, described by several British authors, appears to be equally distinct from that of the Carboniferous rocks, while it closely resembles that of our American Upper Devonian. It is also to be observed that several generic and sub-generic forms of the Devonian are wanting in the richer flora of the overlying system.

In the Carboniferous system, while it is true that there are somewhat different assemblages of plants in the Lower, Middle, and Upper members; and that, within these, there are minor differences, arising probably from local causes affecting the distribution of species, and also from the greater or less amount of driftage, and the greater or less coarseness of the sediments, there is a grand unity of the fossil flora throughout. Even in the lowest Carboniferous beds, at least in Eastern America, the genera and most of the species are identical with those of the middle Coal Measures, separated from these lower beds by the Marine Limestones and the Millstone Grit. On the other hand so soon as we descend to the Devonian, we find some new genera and a distinct assemblage of species.

The only apparently exceptional case known to me, and this may have some connection with the facts stated by Prof. Winchell, is that of certain beds at Akron and Richfield, Ohio, which have, I believe, been regarded as equivalent to the Upper Devonian of New York. In a small collection from these places, shown to me by Prof. Hall, I observed two species which I regard as identical with Lower Carboniferous forms, while the other species present, though some of them have a Devonian aspect, are not certainly identical with any of the New York or Gaspé species.

It may very probably be the case that, in the Palæozoic period, the range in time of marine forms exceeded that of terrestrial plant life; but it would surely be an anomaly to have a system of rocks including one flora and a part of another almost entirely distinct, and characteristic of another period. I do not however suppose that there is everywhere so great a gap between the floras of the Devonian and Carboniferous periods as that which appears in Eastern America. Such gaps are usually local and bridged over somewhere. In the West there may be a transition, as would indeed seem probable from the Ohio plants mentioned above, in connection with the peculiarities of the physical geology; but in this case I should not suppose these beds of passage to be precisely equivalent in age to the Chemung group, but rather to be newer, and possibly wanting or represented by barren deposits in New York.

If such intermediate or passage beds exist in the West, and if their plants have not been already collected and studied by Dr. Newberry or Mr. Lesquereux, it would be very important that attention should be devoted to them, and that they should be carefully compared with the species of the two floras which they may be supposed to connect. I may add that, for this purpose, the most unpromising fragments, especially if capable of showing structure under the microscope, would be of some service; as the characters of the Devonian species have often to be gathered from remains which would scarcely be deemed worthy of the attention of collectors in the rich beds of the Coal Measures.

McGill University, Montreal, Feb. 24, 1863.

ART. XXXI.—*On the Flora of the Devonian Period in Northeastern America;* by J. W. DAWSON, LL.D., F.R.S., Principal of McGill University, Montreal.[1]

[This paper by Prof. Dawson is the one alluded to in his previous communication. The 2d part containing descriptions of species is omitted.]

The existence of several species of land-plants in the Devonian rocks of New York and Pennsylvania was ascertained many years ago by the Geological Surveys of those States, and several of these plants have been described and figured in their Reports.[2] In Canada, Sir W. E. Logan had ascertained, as early as 1843, the presence of an abundant, though apparently monotonous and simple, flora in the Devonian strata of Gaspé; but it was not until 1859 that these plants were described by the author in the 'Proceedings' of this Society.[3] More recently Messrs. Matthew and Hartt, two young geologists of St. John, New Brunswick, have found a rich and interesting flora in the semi-metamorphic beds in the vicinity of that city, in which a few fossil plants had previously been observed by Dr. Gesner, Dr.

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[1] Copied from the *Quarterly Journal of the Geological Society,* Nov., 1861.

[2] Hall and Vanuxem, Reports on the Geology of New York; Rogers, Report on Pennsylvania.

[3] *Quart. Jour. Geol. Soc. Lond.,* xv, 477.

Robb, and Mr. Bennett of St. John; but they had not been figured or described. These plants were described in the *Canadian Naturalist*,[4] together with some additional species, of the same age, found at Perry, in the State of Maine, and preserved in the collection of the Natural History Society of Portland. The whole of the plants thus described, I summed up in the paper last mentioned as consisting of 21 species, belonging to 16 genera, exclusive of genera like *Sternbergia* and *Lepidostrobus*, which represent parts of plants only.

In the past summer I visited St. John; and, in company with Messrs. Matthew and Hartt, explored the localities of the plants previously discovered, and examined the large collections which had been formed by those gentlemen since the publication of my previous paper. The material thus obtained proving unexpectedly copious and interesting, I was desirous of having opportunities of fuller comparison with the Devonian Flora of New York State; and, on application to Prof. Hall, that gentleman, with consent of the Regents of the University of New York, kindly placed in my hands the whole of his collections, embracing many new and remarkable forms. Prof. C. H. Hitchcock, State geologist of Maine, had in the meantime further explored the deposits at Perry, and has communicated to me three new species discovered by him. The whole of these collections, amounting in all to more than sixty species, constitute an addition to the Devonian Flora equal in importance to all the plants previously obtained from rocks of this age, and establish for some of the species a very extensive distribution both geologically and geographically; they allow, also, more satisfactory comparisons than were heretofore practicable to be instituted between the Devonian Flora and that of the Carboniferous period.

I shall first shortly notice the geological character of the localities, with lists of the fossils found in each, and shall then proceed to describe the new species.

I. NOTICES OF THE LOCALITIES OF THE DEVONIAN PLANTS.

1. *State of New York.*—The geology of this State has been so fully illustrated by Prof. Hall and his colleagues, and the parallelism of its formations with those of Europe has been so extensively made known by Murchison and others, that it is only necessary for me to state that the fossils entrusted to me by Prof. Hall range from the Marcellus Shale to the Catskill group inclusive, and thus belong to the Middle and Upper Devonian of British geologists. The plants are distributed in the subdivisions of these groups as follows:—

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[4] Vol. vii, May, 1861.

Upper Devonian.

Catskill Group.[5]

Aporoxylon.
Sigillaria Simplicitas *Vanuxem.*
Lepidodendron Gaspianum *Dawson.*
Psilophyton princeps *Dawson.*
Cyclopteris Jacksonii *Dawson.*
Rhachiopteris punctata, sp. nov.
—— cyclopteroides, sp. nov.

Chemung Group.

Sigillaria Vanuxemii *Gœppert.*
Syringodendron gracile, sp. nov.
Stigmaria exigua, sp. nov.
Lepidodendron Chemungense *Hall.*
—— corrugatum *Dawson.*
Lycopodites Vanuxemi, sp. nov.
Cyclopteris Halliana *Gœppert.*
Psilophyton princeps *Dawson.*
Acanthophyton spinosum, sp. nov.
Rhachiopteris striata, sp. nov.

Middle Devonian.

Hamilton Group.

Syringoxylon mirabile, sp. nov.
Dadoxylon Hallii, sp. nov.
Aporoxylon.
Sigillaria.
Didymophyllum reniforme, sp. nov.
Calamites Transitionis (?) *Gœppert.*
—— inornatus, sp. nov.
Lepidodendron Gaspianum *Dawson.*
—— corrugatum *Dawson.*
Psilophyton princeps *Dawson.*
Cordaites Robbii (?) *Dawson.*
——, sp. nov.
—— angustifolia *Dawson.*
Cyclopteris incerta, sp. nov.
Rhachiopteris striata, sp. nov.
—— tenuistriata, sp. nov.
—— pinnata, sp. nov.

2. *Maine.*—The only locality in this State that has hitherto afforded fossil plants is Perry, near Eastport, in the eastern part of the State. The plant-bearing rocks are grey sandstones, resembling those of Gaspé, and associated with red conglomerate and trappean or tufaceous rocks, which, according to the recent observations of Prof. C. H. Hitchcock,[6] rest unconformably on shales or slates holding Upper Silurian fossils.[7] I have little doubt that these beds at Perry are a continuation of part of the series observed at St. John, New Brunswick; and it is probable that they are Upper Devonian. The following species occur at this place:[8]—

Lepidodendron Gaspianum *Dawson.*
Lepidostrobus Richardsonii *Dawson.*
—— globosus *Dawson.*
Psilophyton princeps *Dawson.*
Leptophlœum rhombicum, sp. nov.
Megaphyton?
Aporoxylon?
Cyclopteris Jacksoni *Dawson.*
—— Brownii, sp. nov.
Sphenopteris Hitchcockiana, sp. nov.

3. *Canada.*—Devonian beds holding fossil plants occur in Eastern Canada, in Gaspé, and in Western Canada, at Kettle Point, Lake Huron. At the former place there is an extensive series of sandstones and shales, regarded by Sir W. E. Logan as representing the whole of the Devonian series, and containing

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[5] Now included in the Chemung.
[6] Report on the Geological Survey of Maine, now in the press.
[7] See also notices by Dr. Jackson and Prof. Rogers in the *Proceedings of the Boston Society of Natural History.*
[8] A few additional species discovered last summer will shortly be described.

plants throughout, but more abundantly in its central portion.[9] At the latter a few plants have been found in shales of Upper Devonian age. The plants found at Gaspé were described in my former paper, and are—

Prototaxites Logani *Dawson.*
Lepidodendron Gaspianum *Dawson.*
Psilophyton princeps *Dawson.*
Psilophyton robustius *Dawson.*
Selaginites formosus *Dawson.*
Cordaites angustifolia *Dawson.*

The plants from Kettle Point, noticed with doubt in my former paper, I may now refer to the following species:—

Sagenaria Veltheimiana *Gœppert.*
Calamites inornatus, sp. nov.

4. *New Brunswick.*—The rocks in the vicinity of the city of St. John, constituting a part of the coast metamorphic series of New Brunswick, have been described in the official reports of Dr. Gesner and Dr. Robb;[10] and additional facts respecting their stratigraphical relations, ascertained by Mr. Matthew, were stated in my paper in the *Canadian Naturalist*, already referred to. The new interest attached to these beds, in consequence of the discovery of their copious fossil flora, induced me to re-examine all the sections, in company with Mr. Matthew, during my late visit; and that gentleman has recently extended the limits of our observations eastward in the direction of Mispec. The results of these observations I shall state in some detail, as the precise age of the St. John series has not until now been determined.

The oldest rocks seen in the vicinity of St. John are the so-called syenites and altered slates in the ridges between the city and the Kennebeckasis River. These rocks are in great part gneissose, and are no doubt altered sediments. They are usually of greenish colors; and in places they contain bands of dark slate and reddish felsite, as well as of gray quartzite. In their upper part they alternate with white and graphitic crystalline limestone, which overlies them in thick beds at M'Closkeney's and Drury's Coves on the Kennebeckasis, and again on the St. John side of an anticlinal formed by the syenitic or gneissose rocks, at the suburb of Portland. These limestones are also well seen in a railway-cutting five miles to the eastward of St. John,[11] and at Lily Lake. Near the Kennebeckasis, they are unconformably overlain by the Lower Carboniferous conglomerate, which is coarse and of a red color, and contains numerous fragments of the limestone.

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[9] Reports of the Geological Survey of Canada; paper on the Devonian plants of Gaspé, *Quart. Journ. Geol. Soc. Lond.*, xv.

[10] Gesner's Second and Third Reports on the Geological Survey of New Brunswick; Robb, in Johnston's Report on the Agriculture of New Brunswick.

[11] At this place the limestone is penetrated by a thick vein of graphic granite, holding black tourmaline; and at Drury's cove, not far distant, it contains dykes of dark colored trap.

At Portland, the crystalline limestone appears in a very thick bed, and constitutes the ridge on which stands Fort Howe. Its colors are white and grey, with dark graphitic laminæ; and it contains occasional bands of olive-colored shale. It dips at a very high angle to the southeast. Three beds of impure graphite appear in its upper portion. The highest is about a foot in thickness, and rests on a sort of underclay. The middle bed is thinner and less perfectly exposed. The lower bed, in which a shaft has been sunk, seems to be three or four feet in thickness. It is very earthy and pyritous. The great bed of limestone is seen to rest on flinty slate and syenitic gneiss, beneath which, however, there appears a minor bed of limestone. Above the great limestone are beds of a hard grey metamorphic rock, apparently an indurated volcanic ash, associated with some sandstone; and this is succeeded by the great series of gray, olive, and black shales and flags which underlie the city of St. John. These rocks are well exposed on both sides of Courtney Bay, in the city of St. John, and in Carlton. Though somewhat contorted, they have a general dip to the southeast, at angles of 50° to 70°. In some of the beds there are great numbers of *Lingulæ*, which have not as yet been identified with any described species. There are also trails of worms, and scratches which may have been produced by the feet of Crustaceans or the fins of fishes.

The comparatively coarse shales above described are succeeded by a thick band of black papyraceous shale, much contorted, and with a few thin seams of calcareous matter arranged in the concretionary forms known as 'cone-in-cone.' No fossils were found in them, but two thin seams of anthracitic coaly matter are stated to have been seen on their line of strike eastward of Courtney Bay.[12]

Overlying these beds, is a group of very different character. It consists of purplish-red and green grit and shale, with beds of red conglomerate and red sandstone. Interstratified with these are massive beds of a greenish rock, consisting of trappean and feldspathic fragments, imbedded in a shining reddish paste, or sometimes presenting the appearance of a compact trap or amygdaloid. This rock usually presents an appearance of greater alteration than the neighboring beds, and contains veins of epidote, quartz, and calc-spar. Its hard and massive character causes it to resist denudation, and to project above the surface in irregular masses. It has usually been regarded as a trap; I am disposed however, to consider it as more probably a tufaceous or volcanic ash rock, except in a few places, where it is either an amygdaloid trap or a mass of fragments of such material too

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[12] Gesner's Second Report.

intimately connected to be separated from each other. It is evidently a stratified member of the series, though its beds are very unequal in hardness and texture, and probably also in thickness. This portion of the series is well exposed on the east side of Courtney Bay, in the southern part of the city of St. John, and in the direction of Carlton, where its tufaceous or trappean members constitute prominent elevations. It seems also to be this member of the series which, turning to the south, constitutes Cape Meogenes.

Reposing on the rocks last described, is the most interesting member of the series, consisting of hard buff and gray sandstones, with black and dark-gray shales. The sandstones contain numerous Coniferous trunks; and the shales, which are sometimes highly graphitic, abound in delicate vegetable remains, often in a very perfect state of preservation. These rocks appear on the east side of Courtney Bay, near Little River, at the extremity of the point of land on which the city of St. John stands, and in the ledges and cliffs on the shore westward of Carlton. In all these places they are quite conformable with the underlying rocks, though the dip gradually diminishes in ascending.

No rocks newer than the above are seen at Carlton or in the city of St. John; but near Little River a few beds of red shale and coarse sandstone seem to indicate the commencement of a new member of the series, the coast-section failing at this point. Mr. Matthew has, however, succeeded in finding a continuation of the section further inland, exhibiting first, in ascending order, gray sandstone and grit, with dark shale holding fossil plants, among which is *Calamites Transitionis.* This may perhaps be regarded as the top of the group last mentioned. Above it, and passing into it at their base, are reddish sandstones, grits, and conglomerates, alternating with green, greenish-gray, and red shale. Resting on these, is a thick-bedded, coarse, angular conglomerate, succeeded by evenly bedded shales, shaly sandstones. and grits, of dark-red and purplish colors. These are the highest beds seen, as beyond this place they are bent in a synclinal, and reappear with reversed dips.

Another most important observation of Mr. Matthew is that near Red Head the member of the St. John series last described is overlain unconformably by a conglomerate similar to that of the Kennebeckasis, and probably the Lower Carboniferous conglomerate. It dips to the northwest, or in the opposite direction from that of the underlying beds, at an angle of 30°; but Mr. Matthew regards the dip as due in part to false bedding.

The whole of the deposits above described may be summed up as follows, the thicknesses stated being from measurements and estimates made by Mr. Matthew, and to be regarded as merely approximate.[13]

	Feet.
Carboniferous System.	
Coarse red conglomerate, with pebbles of the underlying rocks, and constituting in this vicinity the base of the Carboniferous System.	
Devonian System (or perhaps, in part, Upper Silurian).	
1. Dark-red and greenish shales; flaggy sandstones and grits; coarse angular conglomerate, - - - - - - -	1850
2. Reddish conglomerate, with quartz pebbles; reddish, purple; and grey sandstones and grits; deep-red, gray, and pale-green shales. A few fossil plants, - - - - - - - -	2350
3. Blackish and gray hard shale and arenaceous shale; buff and gray sandstone and flags. Many fossil plants; Crustaceans and *Spirorbis*, - - - - - - - - - - -	2000
4. Reddish conglomerate, with slaty paste and rounded pebbles; trappean or tufaceous rock; red, purplish, and green sandstones and shales. Thickness variable, - - - - - -	1000
5. Black papyraceous shale, with layers of cone-in-cone concretions, - - - - - - - - - - - - -	400
6. Hard, generally coarse and micaceous, gray shales and flags, of various shades of color, and with some reddish shale and tufaceous or trappean matter at the bottom. *Lingulæ*, burrows, and trails of animals, - - - - - -	3000 feet or more.
7. White and gray crystalline limestone, with bands of shale and beds of graphite, - - - - - - -	600 feet or more.
8. Gneissose and other metamorphic beds, with bands of quartz-rock and slate. Thickness unknown.	

The Devonian age of the upper members of this great series of beds I regard as established by their fossils,[14] taken in connection with the unconformable superposition of the Lower Carboniferous conglomerate. The age of the lower members is less certain. They may either represent the Middle and Lower Devonian, or may be in part of Silurian age. Their only determinable fossil, the *Lingula* of the St. John shales, affords no decisive

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[13] In my paper in the *Canadian Naturalist*, I gave a sectional view of the general arrangement, as observed on a line of section from the Kennebeckasis River to the extremity of the peninsula on which St. John stands. The sections referred to in the text represent the same series, as seen on the east side of Courtney Bay, immediately to the east of St. John, with the continuation ascertained by Mr. Matthew towards the Mispec River.

[14] The scanty animal remains of the plant-beds No. 3 accord very well with the evidence of the fossil plants. They are a small Trilobite, apparently a *Phillipsia*, and three other Crustaceans, one of which is probably a *Stylonurus*, another a *Eurypterus*, and the third a Decapod not apparently referable to any described genus. These Crustaceans are now in the hands of Mr. Salter. (See his paper on these fossils, read before the Geological Society, May 21, 1862.) There is also a shell, apparently a *Loxonema*, and a *Spirorbis*.

solution of this question, and the evidence of mineral character is not to be relied on in the case of beds so remote from those regions in which the Devonian rocks of America have been most minutely studied.

In mineral character, Nos. 1 and 2 of the above sectional list might very well represent the Old Red Sandstone, or Catskill group, of the New York geologists. Nos. 3 and 4 might be regarded as the analogues of the Chemung and Portage groups. No. 5 would represent the Genesee Slate; No. 6 the remainder of the Hamilton group; No. 7 the Corniferous Limestone; and No. 8 might be regarded as a metamorphosed equivalent of the Oriskany and Schoharie Sandstones. The entire want of the rich marine fauna of these formations is, however, a serious objection to this parallelism. If, on the other hand, we employ as our scale of comparison the development of the Devonian system in Gaspé, Nos. 1 and 2 will correspond very well with the upper member of the Gaspé series, and No. 3 with the rich plant-bearing beds of the middle of that series; but no mineral equivalent of the St. John shales and limestones occurs at Gaspé, unless we seek for it in the Upper Silurian.

The rocks of the St. John group extend along the coast as far as the frontier of Maine, and there can scarcely be any doubt that the plant-bearing beds at Perry represent some portion of the St. John series, most probably Nos. 2 and 3 of our sectional list. At Perry, the plant-beds rest on a trappean bed, which may be the equivalent of our No. 4, a member of the series much more constant in its occurrence than would be anticipated from its composition. According to Prof. Hitchcock, this last bed at Perry, rests unconformably on shales containing a *Lingula*, apparently not identical with that of St. John, and also other fossils of distinct Upper Silurian forms. The analogy of Perry, therefore, as well as of Gaspé, would point to an Upper Silurian age for the lower members of the St. John series, though at St. John they appear to be conformable with the overlying beds. On the other hand, the unconformability at Perry renders it possible that the lower members of the St. John series may be wanting there; and to assign a Silurian date to the lower beds at St. John would imply the entire absence of the copious and characteristic Lower Devonian marine fauna observed at Gaspé and in Nova Scotia, as well as in Maine, though not in immediate connection with the Perry beds; while, if the whole series of St. John be Devonian, the absence of this fauna would be accounted for by the metamorphism of the lower beds.

In the present state of the evidence, it would be premature to decide this question, which may be settled either by the discovery of portions of the lower beds in a less altered state, or by tracing the St. John series into connection with the similar deposits in Maine. In the meantime, therefore, we may be content to regard the upper members of the series as belonging to the later part of the Devonian Period, leaving the lower members to be regarded as Lower Devonian or possibly Upper Silurian.

The fossiliferous portion of the St. John series presents the richest local flora of the Devonian Period ever discovered. It far excels, in number of genera and species, the Lower Carboniferous flora as it exists in British America, and is comparable with that of the Middle Coal-measures, from which, however, it differs very remarkably in the relative development of different genera, as well as in the species representing those genera.

It is only just to observe, that the completeness of the following list is due to the industrious labors of an association of young gentlemen of St. John, who, under the guidance of Messrs. Matthew and Hartt, have diligently explored every accessible spot within some distance of the city, and have liberally placed their collections at my disposal for the purposes of this paper.

Dadoxylon Ouangondianum *Dawson.*
Sigillaria palpebra, sp. nov.
Stigmaria ficoides (var.) *Brongn.*
Calamites Transitionis *Gœppert.*
—— cannæformis *Brongn.*
Asterophyllites acicularis, sp. nov.
—— latifolia, sp. nov.
—— scutigera, sp. nov.
—— longifolia *Brongn.*
—— parvula *Dawson.*
Annularia acuminata, sp. nov.
Sphenophyllum antiquum *Dawson.*
Pinnularia dispalans, sp. nov.
Lepidodendron Gaspianum *Dawson.*
Lycopodites Matthewi *Dawson.*
Psilophyton elegans, sp. nov.
—— glabrum, sp. nov.
Cordaites Robbii *Dawson.*
—— angustifolia *Dawson.*
Cyclopteris Jacksoni *Dawson.*
Cyclopteris obtusa *Gœppert.*
—— varia, sp. nov.
—— valida, sp. nov.
Neuropteris serrulata, sp. nov.
—— polymorpha, sp. nov.
Sphenopteris Hœninghausi *Brongn.*
—— marginata, sp. nov.
—— Harttii, sp. nov.
—— Hitchcockiana, sp. nov.
Hymenophyllites Gersdorffii *Gœppert.*
—— obtusilobus *Gœppert.*
—— curtilobus, sp. nov.
Pecopteris (Alethopteris) discrepans, sp. nov.
—— (——) ingens, sp. nov.
—— (——) obscura (?) *Lesquereux.*
Trichomanites, sp. nov.
Cardiocarpum cornutum, sp. nov.
—— obliquum, sp. nov.
Trigonocarpum racemosum, sp. nov.

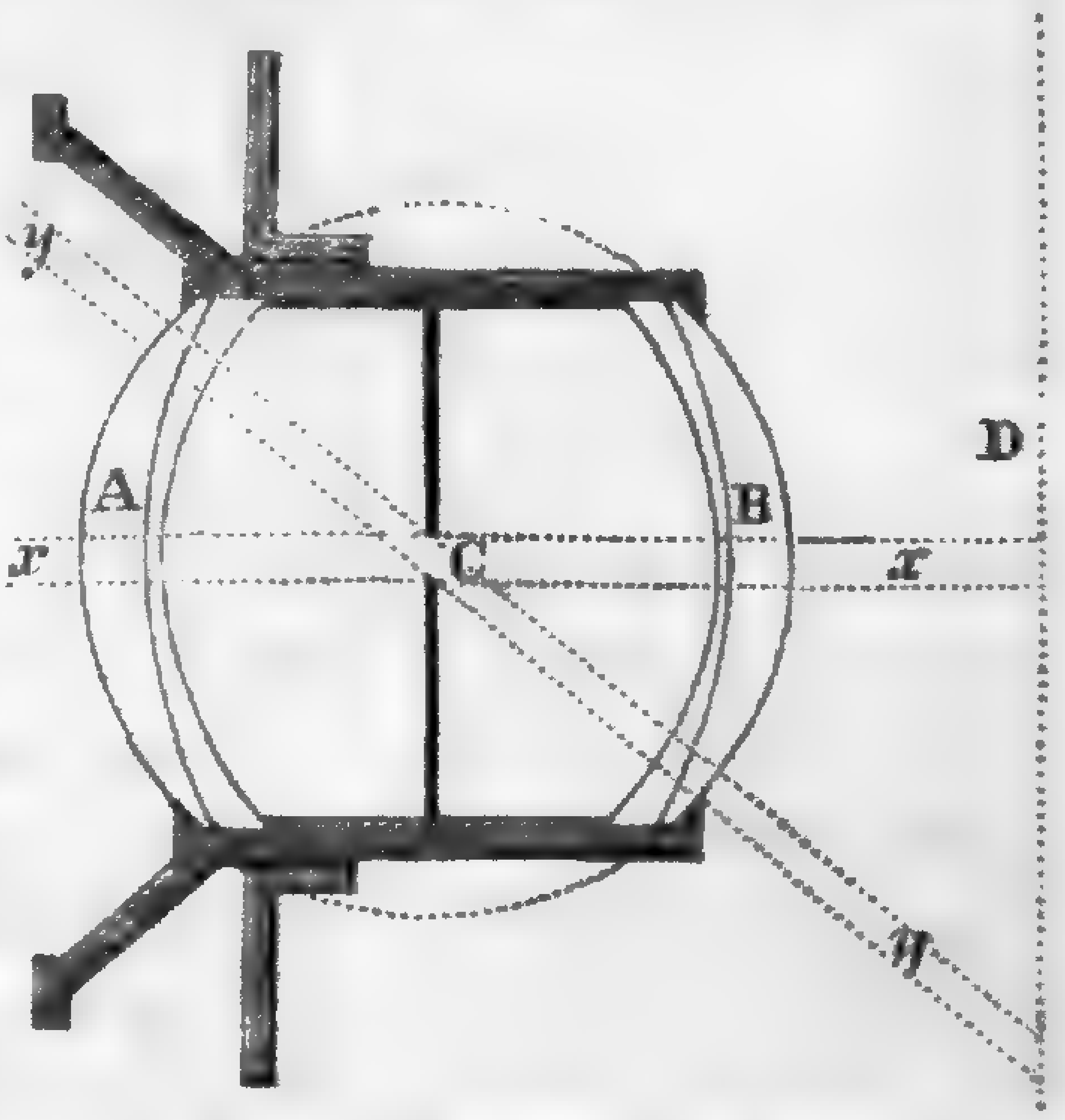
(To be continued).

Art. XXXII.—*On the nature and advantages of the Globe Lens for the Photographic Camera;* by Coleman Sellers.

The Globe Lens for photographic cameras, patented by Messrs. Harrison and Schnitzer of New York, is now attracting so much attention and is the subject of such contradictory statements, that a brief notice of it by one who has tried it may not be uninteresting to the readers of this Journal. Photography, with the discovery of the use of collodion, seemed to leap into its present high position at one bound, at least so far as the chemistry of the art is concerned. The negatives of to-day look like the negatives of the first experimenters, and the chemical process of their production is essentially the same. But with the optics of photography the case is different—here there has been a steady improvement. The wants of the portraitists have been met by the construction of new objectives suited to the style of pictures to be produced. In these instruments depth of field with free admission of a large volume of light was what was most sought for. Theory could not dictate what shape or combination of lenses would best produce this result, and patient experiments were resorted to. The requirements of landscape photography are quite different from those of portraiture. A portrait tube may be used to take views if it be provided with a stop or small opening to limit the amount of rays passing through it and thus to deepen the field, or increase the 'reach' of the instrument as it is technically called. This involves loss of light, and consequently diminishes the quickness of its working. We hear continually of rapid or instantaneous photography, and are often led to believe that the rapidity is to be ascribed to some wonderful sensibility of the chemicals used, but this is only partially true, and to the optician is due the most of the merit of instantaneous pictures. A portrait tube with its full opening will, in a sky-light room, produce a picture in perhaps ten or fifteen seconds. This same instrument, with the same opening and same chemicals, exposed to an extended view in bright sun light, could not be opened and shut quick enough; the immense volume of light reflected from so large an area of space being concentrated on the same sized plate as in the first case, would be too violent in its action, and from the nature of the instrument near and distant objects could not be brought into focus at the same time.

The human eye, when the head is at rest, takes in an angle of view of at least 70° or 80°, the whole of which is not seen clearly at once but can be examined in detail by the almost unconscious rolling motion of the eye in its socket—the actual included angle of clear vision at any one instant being only 1° or 2°. Hence a picture of a landscape, for instance, to fill the eye and seem a true representation of nature, should include an angle of at least 60°. Ordinary instruments, such as have heretofore been used, do not include an angle of more than one-half this amount and hence has originated the complaint that photographic views represent mere patches of scenery and not pictures. I remember once standing on a bridge—camera in hand—and looking up the romantic Wissahicon. The picture presented to my eye was very beautiful—the centre a waterfall framed in on both sides by wild and rugged rocks and spanned above by the arch of a railroad bridge crossing at the tops of the cliffs. The foreground was made up of a stony bed, where danced and foamed the rapid current. I planted the camera and hoped soon to peel off from this charming view a cuticle (as Dr. Holmes says) which like plates of mica could be split and re-split for the collections of my friends. But on the ground glass I found nought but the tumbling water. No rocks, no bridge, no stony river bed—the poor camera in its empty head was incapable of taking in the whole of the charming picture. One of the dreams of the photographer has been of an instrument which should embrace a large angle and thus satisfy the wants of the eye; but, with the majority of the attempts in this direction came other evils, the greatest of which was distortion of the marginal lines. The aplanatic lens of Grubble is said to comprise an angle of 70°, but in a view before me of Trinity College, Dublin, taken with this lens, there is a curvature of the straight lines of the roof of more than one-eighth of an inch in its length. Mr. Sutton's panoramic lens, a sphere of glass filled with water, includes a very large angle, over 100°, on the base line, but the pictures are produced on curved plates, which require curved holders, baths, and printing frames, and, in the case of architectural pictures, the right lines are distorted, unless the picture be bent to the curvature of the plate upon which it was taken, and thus viewed near the centre of the curvature.

The Harrison and Schnitzer globe lens consists of two achromatic meniscus lenses placed with their concave sides together, and so made that their outer curved surfaces form part of a perfect sphere and the light is admitted through an aperture placed midway between the two lenses, i. e., in the exact centre of the external sphere. The annexed figure represents one of these instruments, A and B being the meniscus lenses, and C the centre opening through which the rays of light pass. The focus of such a lens one and three-quarter inches in diameter is two and one-half inches for distant objects, measuring from the surface of the back lens to the ground glass D. The circle of light produced is five inches in diameter, and from this may be cut the ordinary 3″ square of a stereoscopic picture. The included angle of light in the five inch circle is 75°, and in a three inch square picture cut from it is contained just four times the area of any instrument I have ever tried, suited to similar work. The remarkable property of this lens consists in its absolute correctness of reproduction. If it is used for copying purposes, the marginal lines are copied as straight as the originals, and, if



a copy be made the same size as the original, the photographic copy will, if laid upon the original, match it in every line. I have said that the globe of $2\frac{1}{2}''$ focus will make a circle of light of $5''$ diameter. This is when a distant landscape is in focus. If it is used for copying, the circle of light increases in diameter as the object approaches the front lens and the ground glass recedes to focus, so that an instrument which will cover a given size plate for views will cover one of twice the size, when reproducing the size of the original. As the lenses increase in size and length of focus, the plates covered increase in size, and the amount of glass in the lenses bear a larger proportion to the brass work in which they are mounted, and hence the included angle of vision is increased, so that while in the $2\frac{1}{2}$ inch globe the included angle is 75°, in a 12 inch globe (that is, one of $12''$ focus) the included angle is over 90°. It has been said that the light, being admitted through a round hole in a plane plate in the centre of the instrument, must be much more intense at the centre of the field than at the margin, and some writers have stated this fault to be one of great magnitude. Practice however does not show the evil to be so great as they represent, if it exists at all. By reference to the cut, it will be seen, that the dotted lines *x x* representing a pencil of light of the diameter of the centre opening passing through the axis of the instrument, and *y y* representing a pencil of light passing through the same opening obliquely, doubtless the area of the centre one will be the largest, but as it passes through much thicker glass than the rays *y y*, may not the ultimate effect of each be equalized? I do not pretend to any knowledge of the theory of optics, and must confine myself to facts. In the trial of many of these lenses, of different sizes, I have never found the evil to exist, and all the pictures I have made with the globe lens are remarkable for the even illumination of the field. At the last two meetings of the Photographic Society of Philadelphia, (February, 1863,) the merits of these lenses have been discussed—full credit for correctness of reproduction was accorded to them by all; but the quickness of working was questioned by one gentleman, who stated that in broad sunlight he had exposed an engraving for several minutes and had obtained an under-exposed negative, while all others present who had tried them were unhesitating in their assertions that they were remarkably quick workers when the size of aperture was taken into consideration. A few days ago I placed in bright sunlight an engraving from the London Art Journal, and copied it on a $6\frac{1}{2}\times 8\frac{1}{2}$ plate with the same size instrument as was used by the gentleman who questioned its quickness. An exposure of 25 seconds gave an impression which flashed up instantly under the developer, assuming great intensity in the light and showing unmistakable symptoms of over exposure, so that I can see no reason why the same law should not hold good with these lenses as with others, viz.: that, with the same area of opening to admit light, the shorter the focus the quicker they will work. For interiors, the short focus and large angle of vision possessed by these instruments render them invaluable, and as they are provided with a revolving diaphragm plate in the centre (not shown in the cut) various sizes of aperture can be brought into position, just as the stops under the table of some compound microscopes are arranged, and thus the largest amount of light, consistent with sharpness, admitted.

In the English journals, when the accounts of this instrument were first published, it was denounced in no measured terms, as being constructed on erroneous principles, and the assertion has even been made that its very shape must give fearful distortion to marginal lines, but since it has been proved to be no failure, and its success is no longer an experiment, comes the unwilling acknowledgment: "The principle of its construction must insure correct marginal lines," and last of all comes the declaration that it is "old, very old." Everybody had been making them for years and there is no merit of invention due to the patentees! Granting that lenses may have been made with an external spherical focus, as is the Sutton case, it will be difficult to produce a lens, made previous to the invention of this now described, composed of two achromatic meniscus lenses combined as these are and producing a like result. The theory of operation and mode of construction of the globe lenses admit of their being readily made of various focal lengths, and thus, by the use of a series of instruments, the whole included angle can be made available on any size plate that may be desired; the six inch focus covering a 6½″×8½″ plate and the 12″ focus lens covering 14″×18″ each including the same angle. One great advantage of short-focus lenses, when there is no spherical distortion, is in the appearance of perspective produced. If, for instance, we would view a machine or statue to the best advantage, we stand at such a distance from it as will admit of our viewing the whole of it in the eye at once, and can then best judge of its proportion. If now a picture be made by an instrument of long focus, it will be so far away from the object to be depicted as to make, as it were, too nearly a plane or flat view of it, deficient in perspective effect. With the very shortest focus of this new lens (the 2½″ focus), this perspective effect may be too much exaggerated, but with all the other sizes it is not, and with the globe lens and with this only have been produced pictures which seem to me to convey a just idea of size and proportion. Some year or so ago, Messrs. E. and H. T. Anthony published a series of stereographs of Niagara, which seemed to me when I first saw them to bring to my mind all the wonders of the stupendous cataract, and all to whom I have shown them seemed similarly impressed: it was not until recently that I learned that they were taken with the Harrison globe lens, thus furnishing another convincing argument in my mind of the value of the instrument. I cannot too strongly urge their adoption by photographers, and am proud of them as originating in America. The shortness of their focus adds much to their portability, as the camera is made smaller than usual, and amateur field photography with the globe lens and dry plates is a pleasure in place of a labor. Its advantages may be summed up in a few words. Short focus, clear definition, wide angle of included vision, absolute correctness of copy on a plane surface, and tolerably quick work. It takes the place entirely of the orthoscopic lens, giving absolute correctness to marginal lines, while the orthoscopic was only approximately correct. It fills all the requirements of a lens for landscape and architectural work, and is wanting only in the one thing of absolute instantaneity of action.

Philadelphia, March 10, 1863.

[We may add to Mr. Seller's notice of the 'Globe Lens' that this instrument has been found to reproduce military and other maps and plans with a minute fidelity heretofore unattained; and by their use our Army and Navy are furnished with photographic copies of manuscript maps and Coast-Survey plans, in which, as appears from the statements of the officers in charge, there is no sensible distortion of the right lines, even on very large plates.—Eds.]

Art. XXXIII.—*On the Glacial origin of certain Lakes in Switzerland, the Black Forest, Great Britain, Sweden, North America, and elsewhere;* by A. C. Ramsay, F.R.S., President of the Geological Society, &c. (Communicated by the Author.)[1]

Erroneous theories of the transport of Alpine Blocks.—In the year 1859, in a series of papers by the members of the Alpine Club, I published a memoir in which I compared the old glaciers of North Wales with those of Switzerland; and in it, among other matters, I explained the glacial origin of certain rock-basins now holding lakes, on the watersheds and in the old glacier-valleys of both those countries; and in a later edition of the same memoir, published as a separate book, with additions,[2] I extended these generalizations to many of the lakes in Sutherlandshire.

In the same work I also expressed an opinion that the blocks

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[1] From the Quarterly Journal of the Geological Society for August, 1862.

[2] 'The Old Glaciers of North Wales.' Longman & Co.

of Monthey, in the valley of the Rhone, and the great erratic boulders that strew the southern flank of the Jura had been transported by icebergs derived from glaciers which descended in the Alpine valleys to the sea-level, during a period of submergence in which the low country that lies between the Jura and the Oberland was covered with erratic drift.

There was nothing new in this latter opinion, for it had previously been held by several distinguished geologists, both English and continental.

Since then I have twice revisited Switzerland, and have seen good reason to change my opinion respecting the cause of the transport of erratic blocks to Monthey and the Jura, and of *débris* not remodelled by rivers, &c., that lies scattered over the lowlands of Switzerland, or that borders, or lies in great mounds well out, in the plain of Piedmont and Lombardy. I am now convinced, for example, that the vast circling moraine of Ivrea, noticed by Studer in 1844, was shed from a glacier, 105 miles in length, that filled the valley of Aosta to a height of more than 2000 feet, and protruded far into the plain; while on the north a still greater glacier, long ago described by Charpentier, flowed from the valley of the Rhone right across the low country until its end abutted on the Jura. As there are still many persons in England who doubt these conclusions, it may not be beside the question to state the considerations that led me to reject the old theory.

Reasons for abandoning the older theories.—I first began to doubt the correctness of my earlier opinions in the summer of 1860, while examining the country near Bonn, the banks of the Moselle, and the Eifel. Neither in the valleys nor on the wide table-lands on both sides of the Rhine and the Moselle is there any sign of glacial drift. Excepting alluvial *débris* in the valleys, the native rock is generally quite bare of transported detritus; and the only marks of glaciation lie low on the sides of the Moselle, where the floating down of the river-ice has frequently rounded, polished, and striated the rocky banks in the direction of the flow. Boulders, transported from further up the stream, also sometimes lie on the shores. But, in the absence of true drift, I considered that, had Switzerland been depressed at least 3000 feet, until its mountains were washed by a sea that floated transported blocks to the higher Jura, the table-lands of Rhenish Prussia and Westphalia would also possibly have been submerged, and more or less covered with glacial detritus. Further up the Rhine and in the Black Forest the same absence of marine drift prevails. There, looking eastward towards the Rhine, the mountains, chiefly of gneiss, are wonderfully scarred, telling the observer of the wasting effects of frost, ice, rain, and rivers, probably ever since the close of the Miocene period. In the valley of Oberweiler, between Mullheim and the watershed, I observed occasional heaps of moraine-like detritus, in which by diligent searching I found a few stones marked with the familiar glacial scratchings.

In the interior towards Schonau and the Belchen, the rocks being generally soft and schistose, no very decided signs of old glaciers occur, and no part of the country shows symptoms of the presence of drift. Altogether, the country looks as if it had stood in the air for so great a period that, even if glaciers were once present, they had disappeared so long ago that all the more prominent signs of degradation are now due to rain and running water. But further in the interior it is altogether different; for the signs of old glacier-ice are plentiful enough, and for miles round the Feldberg, which rises 4982 Baden feet above the sea, the sides of the valleys to the very summits of the mountains are often strikingly *moutonnées*, though the rounded forms are generally roughened and frequently half ruined with age. On these, striations, though rare, may occasionally be discovered (running in the direction of the valleys), although the rapid rate at which the rock weathers is much against their preservation. Moraines also are not uncommon. At the foot of the Feldberg, on the east, there is a beautiful circular lake, called the Feldsee, surrounded by tall cliffs of gneiss and granite in the shape known in Scotland as a corrie—a form eminently characteristic of all glacier-countries past or present. The outer side of the lake is dammed up by a perfectly symmetrical moraine, curving across the valley, and formed of sand, gravel, and of granite and gneiss, often in large boulders. It is now covered with pine-trees. The lake is deep, and the moraine rises from 25 to 40 feet above the water. Outside the moraine lies a flat marsh, still retaining traces of having been a lake, once also dammed by a second and outer moraine, formed chiefly of large angular blocks of gneiss, piled irregularly on each other like the old moraine of Cwm Bochlwyd, above Llyn Ogwen in Caernarvonshire. Quantities of moraine-matter strew the valley for two or three miles further down to the little marshy lake at Waldbauer, which is also dammed up by moraine-rubbish, in one place rudely stratified, like some of the old moraine-heaps on the Jura and parts of the great moraine of Ivrea; or like the heaps of glacier-*débris* that often border the lakes, marshes, and flat peat-mosses, once lakes, that diversify the lowlands of Switzerland. At the upper end of the Alb Thal also, at the entrance of Menzenschwanden Alb, I saw four moraines curving across the valley, arranged concentrically one within another, like those at the end of the glacier of the Rhone; and for many miles in the Alb Valley, both above and below St. Blasien, *roches moutonnées* stand like islands through the alluvium, while it is also plain that the sides of the mountains above have been to a great height smoothed by ice. Nowhere, however, down to Allbruck, where the river joins the Rhine,[3] did I see any "drift;" and this village lying close on the north side of the Jura, it seemed impossible that the higher ground on the south side of that range, between the Lakes of Constance and Geneva, should have been submerged during any part of the Glacial period, while the country on the Rhine above Basel remained above the sea. I therefore saw that the theory that the *Pierre à bot* and its companion blocks had been floated from the Alps by marine icebergs was untenable; and a later examination of a portion of the Jura, partly under the able guidance of Professor Desor, fully convinced me that the ice that descended the great valley of the Rhone had covered much of the low country and abutted on the south-eastern flank of the Jura.

Old distribution of the Great Alpine Glaciers.—At that period, then, of extreme cold, when the glaciers of the Alps flowed right across the Miocene basin of Switzerland, a glacier of vast thickness, running from end to end of the upper valley of the Rhone, debouched upon the lowlands at what is now the eastern end of the Lake of Geneva, and, spreading in a great fan-shaped mass, extended to the south-west several miles down the Rhone below its present outflow from the lake, and north-east to the banks of the Aar, about half-way between Solothurn and Aarau. The length of this fan-shaped end of the glacier, from north-east to southwest, was about 130 miles, and its extreme breadth about 25 miles. Another great glacier descended in a direction opposite to the higher part of the Rhone glacier, through the upper valleys of the Rhine, and debouched upon a wide area that extends from Kaiserstuhl on the Rhine, far to the north-east. In the center of this area lies the lake of Constance. Between these, which were the largest glaciers on the north watershed of the Swiss Alps, several smaller, but still enormous, glaciers flowed in a north-westerly direction from the mountains,—one down the Linth, through the area now occupied by the Lake of Zurich, another down the Upper Reuss, across the area in which lie the Lakes of Lucerne, Zug, and others, and a third down the valley of the Aar to Berne, through the country that now contains the Lakes of Brienz and Thun. According to this view (the result of the researches of the best Swiss geologists), the greater part of the Swiss Miocene area lay deep under ice, and I am inclined to think that the country between the great old glaciers of the Reuss, Aar, and Rhone was much more covered with ice than any map shows, the whole helping to

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[3] Between Basel and the confluence of the Aar and the Rhine.

swell the prodigious glacier of the Rhone that abutted on the Jura.

Connection between Tarns and Glaciers.—In *The Old Glaciers of North Wales* I have shown that in all glacier-countries, whether whether past or present, there is an intimate connexion between tarns and glaciers. Some of these are dammed by old moraines,[4] but the greater number lie in *rock-basins*, formed by the grinding of glacier-ice as it passed across the country, whether in valleys, on rough table-lands, or on the watersheds of passes. These lakes and pools are of all sizes, from a few yards in width, lying amid the mammillations of the *roches moutonnées*, to several miles in diameter. Sometimes in the convolutions of the strata (conjoined with preglacial denudation subsequent to the contortion of the beds), softer parts of the country may have been scooped out, leaving a hollow surrounded by a frame-work of harder rock; but perhaps more generally they were formed by the greater thickness and weight, and consequently proportionally greater grinding pressure, of glacier-ice on particular areas, due to accidents to which it is now often difficult or impossible to find the clue. Trifling as this phenomenon at first sight may seem, I yet believe the manner of the formation of these lakes is of much importance to the right understanding of the glacial theory, whether taken in connection with the great extension of extinct glaciers in recognized glacier-regions, or, further, when viewed on a general continental scale; for *the theory of the glacial origin of many rock-basins* must, I feel convinced, be extended much beyond such mountain-districts as Switzerland, Wales, and the Highlands of Scotland, where they first attracted my attention.[5]

Origin of the Great Alpine Lakes, subject stated.—From the consideration of the origin of mountain-lakes and tarns, the question easily arises,—What are the causes that have operated in the formation of the great lakes of Switzerland, such as those of Geneva, Zurich, and Constance, and, south of the Alps, of Maggiore, Lugano, Como, and others? To answer this with precision, it will be necessary, first, to examine several other hypotheses that by some may be thought sufficient to account for them.

It is well known that after the close of the Miocene epoch the rocks of the Alps were much disturbed,—a circumstance

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[4] Quart. Journ. Geol. Soc. Lond. 1851, viii, 371; and The Old Glaciers of North Wales.

[5] It is not to be supposed that I attribute the origin of all rock-basins to glacial action. Many lie in the craters of extinct volcanos, some, no doubt, in areas of special subsidence, and others may be due to causes of which I know nothing. I now confine my remarks to certain lakes common in all highly glaciated regions such as I know.

proved by the contortion of the Miocene strata, as for instance in the neighborhood of Lucerne, where, on the Rigi (and in other conglomeratic mountains on the same strike), the strata are considered by the best Swiss geologists to be repeatedly folded and fairly inverted, so that the basement-beds form the top of the mountain, instead of its bottom, thus, by reversal of dip, plunging under the Eocene and Cretaceous strata of the mountains further south. The whole, as shown by the rapid truncated folding and the escarpments of the hills, has since been much denuded, the denudation being of a kind and amount that, to effect it, proves the lapse of a long period of time. Witness the outliers of Miocene strata in the upland valleys of the Jura. Among these disturbed and denuded strata of Miocene and of older dates, the Lakes of Geneva, Thun, Brienz, Lucerne, Zurich, Constance, the Wallen See, and the great lakes of north Italy lie. A knowledge of the stratigraphical structure of the Alps, in my opinion, proves that these lakes do not lie among the strata in basins merely produced by disturbance of the rocks, but in hollows due to denuding agencies that operated long after the complicated foldings of the Miocene and other strata were produced.

First, none of these lakes lie in simple synclinal troughs. It is the rarest thing in nature to find an anticlinal or a synclinal curve from which some of the upper strata have not been removed by denudation. I never yet saw a synclinal curve of which it can be proved that the uppermost stratum in the basin is the highest layer of the formation that was originally deposited over the area before the curving and denudation of the country took place. The only approach to this may possibly be in the upper valleys of the Jura, where a part of the Miocene beds lie in basins separated by secondary anticlinally curved strata, the tops of the anticlinal bends having been removed by denudation; but these cases are surrounded with difficulties. The lake-hollows in the Alps are, however, encircled by rocks, the strikes, dips, and contortions of which often exhibit denudation on an immense scale; and in no case is it possible to affirm, here we have a synclinal hollow of which the original uppermost beds remain. If these beds have disappeared to a great extent, then it is evident that denudation has followed disturbance. The fragmentary state of the uppermost Miocene strata of the lowlands of Switzerland proves this denudation. Again, if it be argued that in the lake-areas these denudations have been produced by the waters of the lakes, it is replied that, though waves may form cliffs, neither running nor still water can scoop out deep trough-shaped hollows.

Secondly, the same kind of argument applies to areas of mere watery erosion by rivers. Running water may scoop out a sloping valley or gorge, but (excepting little swallow-holes) it cannot form and deepen a profound hollow, so as to leave a rocky barrier all round: though it may fill with sediment one that had previously been formed.

Thirdly, neither do most of the Swiss lakes lie in lines of dislocation. For many reasons, I do not believe that any one of them among the high Alps or on their flanks can be proved to lie in lines of mere gaping fracture. Let us consider the nature of such fractures.

In any country where the strata are comparatively little disturbed and lie nearly horizontally, if it be faulted, there is no reason why the fractures should be open. In the Oolites, for example, in the south of England, where faults are numerous, and in the New Red Sandstone of the central counties, there is generally a simple displacement of the strata up or down, on one side or the other; or, if the disturbance go beyond this, it is that along the sloping line of fracture the beds on the downthrow side are turned up, and those on the opposite side bent down, by pressure and slipping combined. In more disturbed districts, like the Welsh Coal-measures, the same phenomena are observable: witness, for instance, the numerous sections from accurate observation, drawn on a true scale, by Sir Henry De la Beche, Sir William Logan, and others. Experience, both above ground and in mines, proves the same. Most lodes are in fractures, and many lie in lines of fault. In metamorphic, excessively contorted, and greatly fractured districts, like those of Devon, Cornwall, and Wales, the cracks, whether bearing metals or not, vary from mere threads to a few fathoms in width. They are always filled with quartz or other foreign substances, frequently harder than the surrounding matrix. I have often traced lodes on the surface, in Wales, by the hard matter filling the crack standing in relief above the surface of the softer enclosing rock. In limestone rocks the cracks are usually partly filled with crystallized carbonate of lime. Lines of fracture are not, therefore, for purposes of denudation, necessarily lines of weakness, unless it happen that on opposite sides of the fault hard and soft rocks come together, when of course the softer rocks will wear away more rapidly, and generally originate a straight valley.

Again, in an excessively contorted country, such as the Alps, it is, I believe, impossible, *in consequence of that contortion*, that there should be gaping fractures now exposed to view. Assuming for the sake of argument the sudden violent contortion of the strata of any great tract of country, we shall see that the contorted rocks *now exposed at the surface*, even if broken, would be most unlikely to gape.

The expression "elevation of mountains" conveys to the minds of many persons the idea that the elevation has been produced by some force acting from below, along a line in the case of a chain, and on a point of greater or less extent when the mountains lie in a cluster, as a whole, more or less dome-shaped. Such forces would stretch the strata; and, when they could no longer stand the tension, cracks would ensue, and many lines of valley are assumed to lie in such fractures. But in Wales, the Highlands of Scotland, and more notably in the Alps, the strata now visible have been compressed and crumpled, not stretched, and they occupy a smaller horizontal space than they did previous to the formation of the chain.

Let us suppose a set of strata of (say) 14,000 to 20,000 feet in thickness, like the rocks of North Wales, and let these be spread out horizontally over thousands of square miles. Let these strata, from any cause, be compressed from the right and left so as to be contorted, and occupy a smaller horizontal area than they did before disturbance. Then, at a great depth, where the superincumbent strata pressed heavily on the lower beds, the latter would be crumpled up, cleavage would often supervene, and gaping fractures would be impossible; for, where mere fractures occurred, the walls of the cracks would be pressed more closely together. But nearer the surface, where there was less weight, and at it, where there was none, the beds would extend into larger curves than they did lower down; and where the limits of extensibility were passed, shattering might take place, and yawning chasms might ensue. In all violently contorted countries, however, as in the cleaved rocks of North Wales, for instance, the present surface shows those originally deep-seated contortions that since disturbance have been exposed by denudation; otherwise the rocks would not be cleaved. I therefore do not believe that in any country I have seen, such as Wales or Switzerland, there are any lakes now occupying yawning fractures, consequent in Switzerland on Post-eocene or Post-miocene disturbances. On the contrary, they lie in hollows of denudation, shortly to be explained, of later date than these disturbances.

Fourthly, again, it may be supposed that the great lakes lie each in an area of special subsidence; but, in reply to this, it is evident that among the unnumbered lakes of Switzerland and Italian Alps it would be easy to show a gradation in size, from the smallest tarn that lies in a rock-basin to the Lakes of Geneva and Constance. Neither do I see any reason why mere size should be considered the test of subsidence. Disallowing that test, we should require a great number of special subsidences, each in the form of a rock-basin, in contiguous areas. Between the Seidelhorn and Thun, for example, we should require one for the Todten See, several on the plateau on the north immediately under the Seidelhorn, one for the lake at the Grimsel, another for the drained lake at the Kirchet,[6] and another for the lakes of Brienz and Thun. In Sutherlandshire these areas of special subsidence would be required by the hundred, and in North America by the thousand.

Signor Gastaldi, in a masterly memoir on the composition of the Miocene conglomerates of Piedmont,[7] considers with reason that the large angular blocks of these strata, many of them far-transported, and some of them foreign to the Alps and Apennines, have been deposited from ice-rafts; and thence he infers the existence of glaciers during a part of the Miocene epoch. But, admitting this, it is evident that the distribution of the Post-pliocene glaciers of the Alps must, in all details, have been quite different from those of Miocene age, in consequence of the great disturbance that the Alpine rocks underwent after the close of the Miocene epoch, and the subsequent formation of numerous new valleys of denudation. Traces of the long lapse of time between the Miocene and the later Glacial epoch are in other countries but imperfectly preserved in the subdivisions of the Crag, and of other minor formations of still later date. Of the finer gradations that unite these subdivisions, few traces have been described. For long before, and during all these Crag epochs and the ages between them, of which we have little trace, and during all the time that elapsed from the close of the Crag until the period of extreme cold came into action, the Alps stood above the sea, and suffering subaerial denudation, valleys were being formed and deepened. It is possible that, while the mild climates of the Lower Crag epochs endured, there may still have been glaciers in the higher Alps; but at whatever period the later glaciers commenced, those who allow the extreme slowness of geological change will admit that the period was immense that elapsed during the gradual increase of the glaciers, until, in an epoch of intensest cold, the ice abutted on the Jura in one direction, in another spread far beyond the present area of the Lake of Constance, and on the south invaded the plains of Lombardy and Piedmont. During all that time, weather and running water were at work modifying the form of the ground under review. But, as I have already explained, these two agents were incapable of scooping out deep hollows surrounded on *all* sides by rocks, and it therefore follows that the lakes first appeared after the decline of the glaciers left the surface of the country exposed approximately as we now see it,—unless we admit, what seems to me impossible, that fractures, formed at the close of the Miocene epoch, remained filled with water until

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[6] See the "Old Glaciers of Switzerland and North Wales."

[7] "Sugli elementi che compongono i conglomerati Mioceni del Piemonte," Turin, 1861.

the great glaciers filled them with ice; or believe, with De Mortillet, that the valleys and lake-hollows were charged with water-borne alluvial or diluvial *débris* before the glaciers ploughed it out.[8]

Allowing the hypothesis of De Mortillet, the rock-basins must have been twice filled with water; but, according to my hypothesis, they did not exist as lakes till after the disappearance of the glaciers.

But the glacier map of ancient Switzerland shows that the areas now occupied by the great lakes, both north and south of the Alps, have all been covered with glaciers. No Tertiary deposit, of an age between the close of the Miocene and the commencement of the Glacial epoch, lies between the Alps and the Jura; and, had the hollows of the lakes existed prior to the great Glacial epoch, we ought, but for some powerful wasting agent, probably in these hollows, still to find some traces of fresh water deposits, perhaps of the age of part of the Crag. No such relics exist.

The Great Lakes. Lake of Geneva.—The Lake of Geneva is about 45 miles in length by about 12 in breadth, and its delta, once part of the lake, between Villeneuve and Bex, is 12 miles long. The latter and a small part of the banks of the lake beyond the mouth of the river lie in the great Rhone valley, formed of older Tertiary and Secondary rocks. All the rest of the lake is surrounded by the low country formed of the various subdivisions of the Molasse and Nagelfluh. The lake is 1230 feet above the level of the sea, and 984 feet deep towards the eastern end, according to the sounding of De la Beche.[9]

Geneva itself stands on superficial *débris;* but the solid rock first appears in the river-bed below Geneva, at Vernier, at the level of 1197 feet above the sea—only 33 feet below the surface of the lake, or 951 feet above the deepest part of its bottom. Any one acquainted with the remainder of the physical geography of the country will therefore see that the water of the lake lies in a true rock-basin. The question thus arises, How was this basin formed?

1st. It does not lie in a simple synclinal basin; for, though the Lake of Geneva lies in the great synclinal hollow of the Miocene strata between the Alps and the Jura, it is evident by an inspection of the country that the flexures of that formation are of far greater antiquity than the lake. These flexures have

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[8] See an admirable memoir by G. de Mortillet, "Des Anciens Glaciers du Versant Italien des Alpes." Milan, 1860. Though I had seen his map, I had not seen this memoir when I read my paper; and the passages in which it is mentioned have been added as these pages pass through the press. His theory leaves the difficulty of the first formations of the basins untouched, unless we believe (which I do not) that the Alpine valleys are lines of fracture.

[9] Edinburgh Philosophical Journal, 1820, ii, 107, and plate 2.

been denuded, and the lake runs in a great degree across their strike.

2nd. For reasons already stated, it is, I believe, impossible to prove that the lake lies in an area of special subsidence, all the probabilities being against this hypothesis.

3rd. It is almost needless to say that the Lake of Geneva is too wide to lie in a mere line of fracture; and I know of no reason why the valley of the Rhone, where occupied by the delta, should be esteemed a line of fault or gaping fissure, any more than many other valleys in Switzerland, which many geologists will consider with me chiefly the result of the old and long-continued subaerial denudation of highly disturbed strata. I could enter on details to prove this point, but they belong rather to the rock-geology of Switzerland than to the matter in hand.

4th. Those who do not believe in the existence and excavating power of great and sudden cataclysmal floods will at once see that the area of the lake cannot be one of mere watery erosion; for not ordinary running water, and far less the still water of a deep lake, can scoop out a hollow nearly 1000 feet in depth.

Now, if the lake of Geneva do not lie in a synclinal trough, in an area of subsidence, in a line of fracture, or in an area of mere aqueous erosion, we have only one other great moulding agency left by which to modify the form of the ground, namely, that of ice.

When at its largest, the great glacier of the Rhone debouched upon the Miocene beds where the eastern end of the Lake of Geneva now lies. The boulders on the Jura, near Neuchâtel, prove that this glacier was about 2200 feet thick where it abutted on the mountains; and, where it first flowed out upon the plain at the mouth of the valley of the Rhone, the ice, according to Charpentier, must have been at least 2780 feet thick.[10] Add to this the depth of the lake, 984 feet, and the total thickness of the ice must have been about 3764 feet at what is now the eastern part of the lake. I conceive, then, that this enormous mass of ice, pushing first northwest and then partly west, scooped out the hollow of the Lake of Geneva most deeply in its eastern part opposite Lausanne, where the thickness and weight of ice, and consequently its grinding power, were greatest. This weight, decreasing as it flowed towards the west, from the natural diminution of the glacier, possessed a diminishing eroding power, so that less matter was planed out in that direction, and thus a long rock-basin was formed, into which the waters of the Rhone and other streams flowed when the climate ameliorated and the glacier retired.

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[10] The Lake of Geneva is 197 feet lower than the Lake of Neuchâtel. The glacier first surmounted the hills between Lausanne and Vevay, and then flowed down the general slope northwards to the Jura.

Lake of Neuchâtel.—The basins of the lakes of Neuchâtel, Bienne, and Morat were, I consider, hollowed out in a similar manner, differing in points of detail. Near the Lake of Neuchâtel, on the flank of the Jura, the fan-shaped end of the Rhone glacier attained its greatest height, swelled in size and pressed on as it was by others that descended from the north snowshed of the mountains between the Oldenhorn and the great snow-field above Grindelwald. According to estimates based on the highest ice-stranded boulders, the ice rose 2203 feet above the present surface of the lake. The lake is now 1427 feet above the sea, and 480 feet deep; and the Lake of Bienne is 1425 feet above the sea, and 231 feet in depth. The bottom of the Lake of Neuchâtel is thus 947 feet above the sea. Unless the gravel, therefore, on the banks of the Aar, immediately east of the latter, be over 480 feet deep, the hollow of the lake near its immediate bounds is a true rock-basin; for on the north, south, and west it is surrounded by solid Secondary and Miocene rocks. Even if the rock does not rise close to the surface in the river near the lake, still, at Solothurn, strata in place come close to the river-bank on both sides, the river being 1414 feet above the sea. Under any circumstances there must therefore be a long, deep trough between Solothurn and the rocks a little southwest of the Lake of Neuchâtel. How was this basin formed? When the glacier, debouching from the valley of the Rhone, spread out like a fan and pressed forward till it abutted on the Jura, its onward progress was stopped by that mountain; and direct further advance being hindered, the ice spread northeast and southwest, to the right and left, and being as a whole thickest and heaviest above the area where the lake now lies, a greater quantity of the Miocene strata on which it rested must have been ploughed out there than further on towards the northeast and southwest ends of the glacier, towards which the ice, gradually declining in thickness, exercised less grinding power. In this manner I believe the troughs were formed in which lie the three lakes near Neuchâtel; and when the ice finally retreated, the ordinary drainage of the country filled them with water, the cliffs on the southeastern side of the Lake of Neuchâtel and other changes of the form of the ground having since been produced or modified by watery erosion and the local deposition of silt and alluvial gravel.

The Lake of Thun.—The Lake of Thun is 1825 feet above the sea, and 776 feet deep. Its bottom is therefore 1049 feet above the sea. It is about 10 miles in length, 1½ broad, and its length chiefly cuts across the strike of rocks of Secondary and Miocene age. The Lake of Brienz (about the same size) is more remarkable; for, while its level is 1850 feet above the sea, its depth is more than 2000 feet; so that its bottom is at least between 100 and 200 feet below the level of the sea. Before the formation of the alluvial plain between, these two lakes were probably united; and whether or not this was the case, it is evident, from its great depth, that the Lake of Brienz lies in a true rock-basin. Even if below Thun the rocks do not crop nearer than Solothurn, the Lake of Thun still lies in a rocky hollow more than 600 feet deep, both hollows having, I believe, been deepened by the great old glacier of the Aar, the ice of which was so thick, that above Brienz it overflowed into the valley of Sarnen by the Brunig, about 1460 feet above the Aar below Meyringen, and sent off a branch which scooped out the hollows of the Lakes of Lungern and of Sarnen on its course towards Alpnach on the Lake of Lucerne.

The Lake of Zug.—The Lake of Zug is about 9 miles long, from 1 to 2½ wide, 1361 feet above the sea, and 1279 feet deep; and its bottom is therefore only 82 feet above the sea. The whole is surrounded by Miocene strata, the strike of which the lake cuts across, and its great depth clearly shows that it lies in a rock-basin.

The Lake of Lucerne.—The Lake of the Four Cantons (Lucerne) ramifies among the mountains and extends its arms in various directions. In its lower part, the branches that run N.E. to Kussnach and S.W. towards Gestad lie partly in the strike of the Miocene and older strata; but for the most part it runs across the average strike of the Eocene and Secondary rocks, between banks, sometimes precipitous, that rise in noble cliffs sometimes more than 2000 feet above the water. Its height is 1428 feet above the sea, and its recorded depth 853 feet; but the shape of the banks and the round number of 800 French feet make it likely that it may contain deeper gulfs than have yet been plumbed. If not, then its bottom is 575 feet above the sea; and those acquainted with the shape of the ground by Lucerne will easily be convinced that the lake lies in an actual rock-basin. The steepness of the walls of this lake more resembles the sides of a rent than those of any of the basins yet described, and the re-entering angles of rock opposite curving bays have been cited as evidences of fracture, one side being supposed to fit into the other. But in most cliffy valleys of aqueous erosion there are necessarily such re-entering angles, from the common action of running water; and, in Switzerland, ere these valleys were filled with ice, they existed in some shape, and were drained by rivers that deepened them and gave them a general form preparatory to the flow of the ice that largely modified their outlines. I should no more consider the re-entering angles a sign of gaping fracture in these valleys than I would the bends of the Welsh valleys or of the tortuous Moselle. But even if at first sight one were inclined to believe the space between the opposite cliffs between Brunnen and Flühlen to be an open fracture, if we take a moderate average slope for each side, say of 65°, and produce it below the water, we get a depth, ere the lines meet, of between 7000 and 8000 feet—a very improbable depth for the original hollow of the lake. But it may be said that the fracture has been much widened by degradation, the line of the break merely giving a line of weakness, along which the surface-drainage might widen the valley. If, however, we only take an angle for the sides of the lake giving a moderate depth, the necessity for a fracture does not exist, and we recur to some process of mere erosion for the scooping of the hollow in which the water lies, that process having, I consider, been the long-continued grinding of the ice of the great glacier.

The Lake of Zurich.—The Lake of Zurich runs from N.W. to S.E., across the average strike of the Miocene strata, which are much disturbed towards its eastern end. It is bounded by high hills, much scarred by the weather, on which the different Miocene strata often stand out in successive horizontal steps. The Linth Canal and the Wallen See lie in an eastern prolongation of this valley, which is still further extended to the valley of the Upper Rhine at Sargans. The lake is about 25 English miles in length, by 2¼ wide in its broadest part. A great moraine partly dams it up at its outflow at Zurich; and a second forms the shallow at Rapperswyl, where the lake is crossed by a long wooden bridge. The general level of the water is 1341 feet above the sea, and only about 639 deep; and the bottom of the lake is therefore 702 feet above the sea. The limestone rocks at Baden, on the Limat, are 1226 feet above the sea; and the lake therefore lies in a true rock-basin, though it is probable that the old moraine at Zurich accounts for the retention of the water of the lake at its precise level. The long hollow was in old times entirely filled by the great glacier which descended from the mountains between the Todi and the Trinserhorn, through the valley of the Linth, to Baden.

The Wallen See.—The Wallen See lies in a deep valley, whose cliffy slopes of Secondary rocks rise from 2000 to 3000 feet, and in the Leistkamm 4500 feet above the surface of the lake. The lake itself is 1391 feet above the sea; and from the great steepness of its banks it may be inferred that it is exceedingly deep, but none of the authorities I have consulted give its soundings. A large branch from the great Rhine glacier joined that at the valley of Glarus and Zurich through this wide gorge, and ground out the hollow of the Wallen See.

The Lake of Constance.—The Lake of Constance, the largest sheet of water in Switzerland, is about 50 miles in length, by about 15 in breadth at its broadest part. It is entirely surrounded by Miocene strata, often considerably disturbed, and forming great hills towards the S.E., which in a remarkable manner evince all the signs of long-continued erosion by running water, conveying the impression that chiefly by that means all the deep valleys of the district have been worn since the close of the Miocene epoch. This lake lies 1298 feet above the sea; and, its depth being 912 feet, its bottom is only 386 feet above the sea. The falls of the Rhine are 1247 feet above the sea; and the lake therefore lies in an unmistakable rock-basin, the whole of which was once overflowed by the deep and broad-spreading glacier of the Upper Rhine valleys which stretched far northward beyond the lake into Baden and Wurtemberg. Being of greatest thickness where it entered the region of the lake, by its enormous weight and grinding power it scooped out, in the soft rocks below, the wide hollow now filled with water.

The Italian Lakes.—If we now turn to the Italian side of the Alps, we shall find the same phenomena prevailing in the Lakes of Maggiore, Lugano, and Como, the only important lakes I have yet had an opportunity of seeing, south of the great chain. To each of these the same reasoning applies, modified only in detail; and I shall therefore briefly pass them over.

The most westerly, the Lago Maggiore, lies in a winding valley, 40 miles long, excavated in gneissic and Jurassic rocks, which rise on either side in lofty mountains. The surface of the lake is 685 feet above the level of the sea, and near the Borromean Islands it has the enormous depth of 2625 feet; so that its bottom is 1940 feet lower than the sea-level. It must, therefore, be enclosed all round by rocks, unless we suppose the narrow passage at Arona, near its outlet, to be as deep as its deepest part, or that the alluvial deposits of the Ticino and the Po are more than 1940 feet deep—an assumption no one is likely to make.

Of all the Alpine lakes, that of Lugano is the most irregular in form,—in the language of Mr. Desor, stretching its arms like a great polyp among the mountains in all directions.[11] Its surface is 938 feet above the level of the sea, and its depth 515 feet. Its bottom is therefore only 410 feet above the sea-level, and the shape of the surrounding ground renders it impossible to believe that it is not entirely surrounded by rocks.

The Lake of Como, the hollow of which has been scooped out generally in the same set of rocks as the other two lakes, is 700

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[11] See memoirs "De la Physionomie des Lacs Suisses" (extrait de la 'Revue Suisse,' 1860) and "Quelques Considérations sur la Classification des Lacs, à propos des bassins du revers méridional des Alpes," by E. Desor. The opinions of Mr. Desor and my own do not agree on the question of the origin of the lake-basins on the Alps. His views are well expounded in the above-named memoirs. It was in conversation with my friend, in 1860, that I first proposed what I consider the true solution of the question, and to this conversation I presume he alludes in the latter memoir, p. 13.—"On a prétendu que les lacs étaient l'effet de l'affouillement des glaciers qui auraient labouré le sol sur lequel ils s'avançaient," &c.

feet above the sea, and 1929 feet deep; and its bottom is therefore 1229 feet below the level of the sea. On the borders of these lakes the rounded rocks and the well known glacier-stranded boulders, high on the mountain-sides, attest that these deep valleys were filled to the brim by a vast system of glaciers that flowed southerly from the snow-shed that runs from the eastern side of Monte Rosa, by the Rheinwald-horn, to the top of the valley of the Adda,—a system of glaciers so large that, like that of Aosta and Ivrea, further west, they protruded their ends and deposited their moraines far south on the plains of Piedmont and Lombardy.

The glacier of Ivrea, when it escaped from the valley of the Doire, deposited a moraine at its side, east of the town of Ivrea, rising in mere *débris* 1500 feet above the plain, and spreading out eastward in a succession of fan-shaped ridges miles in width. The vastness of this mass gives a fair idea of the huge size of the glacier, and of the great length of time it must have endured; and just as this glacier hollowed out the little rock-basins in which lie the tarns that nestle among the large *roches moutonnées* between the town and the moraine,[12] so, deep as the hollows of the great lakes of Maggiore and Como are, I believe they also were scooped out by the grinding power of long-enduring ice, where, under favorable circumstances, the glaciers were confined between the mountains, and therefore thicker than the glacier of Ivrea where it debouched on the plain. Diagrams illustrative of this subject should be drawn on a true scale; otherwise, height, depth, and steepness being exaggerated, the argument becomes vitiated. I have not the data for giving an actual outline of the bottom of the Lago Maggiore; but a line drawn from the upper end of the lake to the required depth near the Borromean Islands gives *an angle only of about* 3° *in a distance of about* 25 *miles*, and from thence to the lower end of the lake (12 or 13 miles) *of about* 5°. The depths of Maggiore and Como do not, in my opinion, militate against my view; for, if the theory be true, depth is a mere indicator of time and vertical pressure in a narrow space. It is interesting, and confirmatory of this view, that the deepest part of the Lago Maggiore is just at the point where the enormous glacier of the Val d'Ossola joined the great ice-stream that was formed by the united glacier-drainage of the valleys above Bellinzona and Locarno. Where these glaciers united, there the lake begins; and where the ice was on the largest scale near the Borromean Islands, there the lake is deepest.

Summary with regard to the Alpine Lakes.—And now, in reviewing the subject of the origin of the lakes of Switzerland and North Italy, I would remark—

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[12] **There are other well known lakes dammed up by the moraine of this great glacier.**

1st. That each of the great lakes lies in an area once covered by a vast glacier. There is, therefore, a connexion between them which can scarcely be accidental.

2nd. I think the theory of an area of *special subsidence* for each lake untenable, seeing no more proof for it in the case of the larger lakes than for the hundreds of tarns in perfect rock-basins common to all glacier-countries, present or past, and the connexion of which with diminished or vanished glaciers I proved originally in *The Old Glaciers of North Wales.* In the Alps there is a gradation in size between the small mountain-tarns and the larger lakes.

3rd. None of them lie in lines of *gaping fracture.* If old fractures ran in the lines of the lakes or of other valleys, and gave a tendency to lines of drainage, they are nevertheless, in the deep-seated strata, exposed to us as close fractures now, and the valleys are valleys of erosion and true denudation.

4th. They are none of them in simple synclinal basins, formed by the mere disturbance of the strata after the close of the Miocene epoch: nor,

5th, Do they lie in hollows of common watery erosion; for running water and the still water of deep lakes can neither of them excavate profound basin-shaped hollows. So deeply did Playfair, the exponent of the Huttonian theory, feel this truth, that he was fain to liken the Lake of Geneva to the petty pools on the New Red Marl of Cheshire, and to suppose that the hollow of the lake had been formed by the dissolution and escape of salts contained in the strata below.

6th. But one other agency remains—that of ice, which, from the vast size of the glaciers, we are certain must have exercised a powerful erosive agency. It required a solid body, grinding steadily and powerfully in direct and heavy contact with and across the rocks, to scoop out deep hollows, the situations of which might either be determined by unequal hardness of the rocks, by extra weight of ice in special places, or by accidental circumstances, the clue to which is lost, from our inability perfectly to reconstruct the original forms of the glaciers.

7th. It thus follows that, valleys having existed giving a direction to the flow of the glaciers ere they protruded on the low country between the Alps and the Jura, these valleys and parts of the plain, by the weight and grinding power of ice in motion, were modified in form, part of that modification consisting in the excavation of the lake-basins under review.

In connexion with this point, it is worthy of remark that glaciers, many of them very large in the modern sense of the term, on the south side of the Vallais (excepting those of Mont Blanc), and the large glaciers on the south side of the Oberland, all drain into the Lake of Geneva; those on the north of the last-named snow-field, also large glaciers, are drained through the Lakes of Breinz and Thun. These, among the largest existing glaciers of the Alps, are only the shrunken tributaries of the greater glaciers that in old times filled and scooped out the basins of the lakes. The rest of the lakes, as already stated, are in equally close connexion with the old snow-drainage of glacier-regions on the grandest scale,—all of them, excepting those of Neuchâtel, Bienne, and Morat, lying in the direct course of glaciers filling valleys that extend right into the heart of the mountains.

8th. Most of the lakes are broad or deep according to the size of the glaciers that flowed through the valleys in which they lie, this general result being modified according to the nature of the rock and the form of the ground over which the glacier passed. Thus, the long and broad Lake of Geneva, scooped in the Miocene lowlands, is 984 feet deep, and over its area once spread the broad glacier of the Rhone. Its great breadth and its depth evince the size of the glacier that overflowed its hollow. The lake of Constance, lying in the same strata, and equally large, is 935 feet deep, and was overspread by the equally magnificent glacier of the Upper Rhine. The Lakes of Maggiore and Como, deepest of all, lie in the narrow valleys of the harder Secondary rocks of the older Alps; and the bottom of the first is 1992 feet, and the latter 1043 feet, below the sea-level. Both of these lie within the bounds of that prodigious system of glaciers that descended from the east side of the Pennine Alps and the great ranges north and south of the Val Tellina, and shed their moraines in the plains of Piedmont and Lombardy. The depth of the lakes corresponds to the vast size and vertical pressure of the glaciers. The circumstance that these lakes are deeper than the level of the sea does not affect the question, for we know nothing about the absolute height of the land during the Glacial period.

The lakes of Thun and Brienz form part of one great hollow, more than 2000 feet deep in its eastern part, or nearly 300 feet below the level of the sea. They lie in the course of the ancient glacier of the Aar, the top of which, as *roches moutonnées* and striations show, rose to the very crests of the mountains between Meyringen and the Grimsel.

The Lake of the Four Cantons is imperfectly estimated at only 884 feet in depth; but here we must also take into account the great height and steep inclines of the mountains at its sides. The Lake of Zug, 1311 feet deep, lies in the course of the same great glacier, the gathering-grounds of which were the slopes that bound the tributaries of the Upper Reuss and the immense amphitheatre of the Urseren Thal, bounded by the Kroutlet, the Sustenhorn, the Galenstock, the St. Gothard, and the southern flanks of the Scheerhorn.

The lesser depths (660 feet) of the Lake of Zurich were hollowed by the smaller but still large glacier that descended the valley of the Linth.

This completes the evidence.

Lakes of the Northern Hemisphere generally.—I shall now make a few remarks on the bearing of this subject on the glacial question generally.

It is remarkable that in Europe and North America, *going northward*, lakes become so exceedingly numerous, that I have been led to suppose the existence of some intimate connexion between their numbers and the northern latitudes in which they occur.

Let any one examine the map of North America, and he will find that, from the Atlantic coast to the St. Lawrence, through New Hampshire, Vermont, the north of the state of New York, Maine, Nova Scotia, New Brunswick, Gaspé, and Newfoundland, the whole continent is strewn with lakes. North of the St. Lawrence and the great lakes, as far as the Arctic Ocean, the same sprinkling of unnumbered lakes over the entire face of the country is even more remarkable; and it is a curious circumstance that a large part of this vast area is so low and undulating, that some of its lakes drain two ways—towards the North Sea and the Gulf of Mexico, or towards the North Sea and the North Atlantic. This vast country, about as far south as lat. 40°, shows, almost universally, marked signs of the strongest glacial action, in the *moutonnée* forms, polish, and constantly recurring striation of the rocks. I have only seen a few of the above-mentioned lakes south of Lake Ontario; but I have closely questioned that able observer, Dr. Hector, who has examined the country north and west of the great American lakes, and he informs me that, though unable to account for it, he was struck with the circumstance that so many (he thought he might say *all*) of the smaller lakes are in *rock-basins*. I connect this circumstance with the universal glaciation of the country, still evinced on the grandest possible scale by every sign of ancient ice. These signs, I now believe, are far too universal and unvarying in their general directions to have been produced merely by floating ice, though in part of the glacial history of the continent floating ice has undoubtedly left large traces. But the lake-basins could only, I believe, have been scooped out by true continental glacier-ice, like that of Greenland; for the lakes are universal in all the ice-worn region.[13]

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[13] Since this memoir was written, I have conversed on the subject with Sir Wm. Logan, Director of the Geological Survey of Canada, who not only agrees in my views with respect to the origin of American lakes in general, but also believes that the great American lake-basins may have been scooped out by the same means. They are all true rock-basins, in areas occupied by comparatively soft rocks surrounded by harder strata. Given sufficient time, I see no difficulty in this

On the eastern side of the Atlantic, Wales, Cumberland, many parts of Ireland, the North Highlands, and some of the Western Isles are also dotted with unnumbered lakes and tarns. All of these are well-glaciated countries, both high and low; and for Wales and many parts of Scotland, I can answer that by far the greater proportion of these lakes lie in rock-basins of truly glacial origin.[14]

Loch Lomond and Loch Katrine, probably, like the greater lakes of Switzerland, are of the same kind, being merely large cases of glacier-erosion, though in the case of the former it may be that the alluvial deposits on the banks of the Leven prevent its being invaded by the tide. Its islands are mere *roches moutonnées.*[15]

In the lowlands of Scotland numerous examples of the same kind of rock-basins occur, some of them certain, others doubtful because of the surrounding drift, which indeed in some cases may be the sole cause of the retention of the water. Notable examples of both kinds occur in the lowlands of Fife and Kinross, and of true rock-basins in the Cleish and Ochil Hills, as for instance Loch Glow, Dow Loch, and the two Black Lochs, and more doubtfully Loch Lindores.

I have not yet had an opportunity of visiting the Scandinavian peninsula, which, geologists are aware, is through all its length and breadth, one of the most wonderfully glaciated countries in the world. On the west, descending from the great chain, striated *roches moutonnées* plunge right under the deep fiords; and on the east, in Sweden, all between the mountains and the Baltic, round the Gulfs of Bothnia and Finland, and up to the North Sea, the whole country is covered with a prodigious number of lakes, just like North America, the Lewes, and the North Highlands of Scotland. The intense glaciation which all of these countries have undergone, their similarity, and what I believe to be the intimate connexion of such crowded lakes with the movement of ice, induce me to believe that in Sweden also a great number of the lake-hollows must be true rock-basins

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view, to which I inclined while writing this paper, but refrained from stating it, considering that most readers would think it too strong, and thus that in general opinion I might damage the whole theory. Sir William says that the arrangement of the strata proves that the great lakes do not lie in areas of special subsidence.

[14] See 'The Old Glaciers of North Wales.' When I published my account of these glaciers, I was too timid to include the Lakes of Llanberis, Llyn Ogwen, Llyn Cwellyn, and some others of the larger lakes in this category. I now feel convinced that they are true rock-basins, and also that the shallower pools of Llyn Llegeirin, Llyn Felin-y-nant, and others in Anglesea had the same origin. The horizontal striations far up the side of Carnedd Dafydd, by Llyn Ogwen, were probably made by a glacier of immense thickness during the first great glacier-period, preceding the deposition of the stratified drift.

[15] When the lake was low, I have seen in Loch Lomond ice-striated surfaces of rock just above the water, the striations running in the direction of the length of the lake.

scooped out by the passage of glacier-ice into the Baltic area. Furthermore, as the glaciated sides and bottoms of the Norwegian fiords and of the saltwater lochs of Scotland seem to prove, each of these arms of the sea is merely the prolongation of a valley down which a glacier flowed, and was itself filled with a glacier; for the whole country was evidently, like the north of Greenland, moulded by ice. In parts of Scotland, some of these lochs being deeper in places than the neighboring open sea, I incline to attribute this depth to the grinding power of the ice that of old flowed down the valleys, when possibly the land may have been higher than at present.[16] It may, however, only arise from unequal deposition of detritus. If the former view be admitted, raise the land so as to lay bare the surrounding ocean-bottom, and in some respects of levels and depth they become approximately the counterparts of the deeper narrow lakes of Switzerland and North Italy, glaciers bounded by mountains having flowed through both, and debouched upon the plains beyond.

The Glacial Theory.—Furthermore, considering the vast areas over which the phenomena described are common in North America and Europe, I believe that this theory of the origin of lake-rock-basins is an important point, in addition to previous knowledge, towards the solution of the glacial theory; for I do not see that these hollows can in any way be accounted for by the hypothesis that they were scooped by floating ice.[17] An iceberg that could float over the margin of a deep hollow would not touch the deeper recesses of the bottom. I am therefore constrained to return, at least in part, to the theory many years ago strongly advocated by Agassiz, that, in the period of extremest cold of the Glacial epoch, great part of North America, the north of the Continent of Europe, great part of Britain, Ireland, and the Western Isles,[18] were covered by sheets of true glacier-ice in motion, which moulded the whole surface of the country, and in favorable places scooped out depressions that subsequently became lakes.

This was effected by the great original glaciers (probably connected with the origin of the *unstratified* boulder-clay) referred to in my memoir on the glaciers of North Wales,[19] but the magnitude of which I did not then sufficiently estimate. The cold,

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[16] But this is not essential, unless the lochs are so deep that the ice must have been floated up before reaching the deeper parts.

[17] I do not in any way wish to deny that much of the glaciation of the lower countries that came within the limits of the Drift was effected by floating ice on a large scale, which must have both polished and striated the rocks along which it ground. I have, with other authors, described this in various memoirs. But the two sets of phenomena are distinct.

[18] The Lewes is covered by small lakes.

[19] Quart. Journ. Geol. Soc. Lond., xviii, 371.

however, continued during the depression of North Wales and other districts beneath the sea, when they received the *stratified* erratic drift; and glaciers not only did not cease at this time of depression, but were again enlarged during the emergence of North Wales and other countries, so as to plough the drift out of many valleys. These enlarged glaciers, however, bore no comparison in size to the great original sheets of ice that converted the North of Europe and America into a country like North Greenland. The newer development of glaciers was strictly local. Amelioration of climate had already far advanced, and probably the gigantic glaciers of Old Switzerland were shrinking into the mountain-valleys.

Finally, if this be true, I find it difficult to believe that the change of climate that put an end to this could be brought about by mere changes of physical geography.[20] The change is too large and too universal, having extended alike over the lowlands of the Northern and the Southern Hemispheres. The shrunken or vanished ice of mountain-ranges is indeed equally characteristic of the Himalaya, the Lebanon, the Alps, the Scandinavian chain, the great chains of North and South America, and of other minor ranges and clusters of mountains like those of Britain and Ireland, the Black Forest, and the Vosges.

[In the *Philosophical Magazine* for November last, Prof. Ramsay has published an article "On the Excavation of the Valleys of the Alps," called out by some discussion of his views, in which he concludes as follows:—EDS.]

"No better proof could be required that in great part the valleys of the Alps were approximately as deep before the glacial epoch as they are at present; and I believe, with the Italian geologists, that all that the glaciers as a whole effected was only slightly to deepen these valleys and materially to modify their general outlines, and, further (a theory I am alone responsible for), to deepen them in parts more considerably when, from various causes, the grinding power of the ice was unusually powerful, especially where, as in the lowlands of Switzerland, the Miocene strata are comparatively soft. But for details on this point I must refer to my memoir in the Journal of the Geological Society."

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[20] It has been suggested to me by Dr. Sibson that the prodigious waste of the Alps by the gradual disintegration and diminution of the upper snow-fields, witnessed by the great moraines of North Italy and other phenomena, must have tended to lessen the glaciers. This is true, but, as he also believes, it is not of itself enough to account for the shrinking of the ice into the higher valleys where it is now alone found.

ART. XXXIV.—*Lucernaria the Cœnotype of Acalephæ;* by Prof. HENRY JAMES CLARK, of Harvard University, Cambridge.[1]

THE present communication is a mere sketch of a most thorough and exhausting anatomy of Lucernaria, which I have illustrated by numerous plates, and which I propose to publish in an extended memoir, in connection with some considerations upon the general morphology and systematic relations of Acalephæ. I have been engaged during the whole of the past year upon the organical and histological anatomy of this animal, in order to determine what are its relations to Radiata in general, and to Acalephæ in particular. I have had abundant materials for study, inasmuch as this species of Lucernaria is a very common inhabitant of our shores, wherever the eel-grass, *Zostera marina*, grows. Almost invariably Lucernaria is to be found upon the Zostera, and very rarely upon any other plant. It may be obtained from the last of August, when it is most frequently met with in a young state, until the last of June, at which time the young ones of the autumn season have developed to full-grown animals. In an adult state it measures nearly an inch across the disc, exclusive of the tentacles, and about the same in height. It varies in color from green, which is the most common tint, to deep olive; from light yellow to reddish brown, or from light violet to the deepest purple. In form it is octagonal, and most frequently it so comports itself that the four sides opposite the bifarious genitalia are shorter than those alternating with them, but frequently the same individual reverses the order of things, and the latter become either as short, or even shorter, than the first. From this we infer that the specific differences, based upon the approximation of the bunches of tentacles, two and two, are entirely erroneous, as this obtains in all octagonal Lucernarians, in a greater or less degree. As these animals are very sensitive and irritable, they contract upon the least disturbance; and, as the muscular system is most highly developed in the region which lies about the four partitions of the disc, it is most natural that when the creature contracts it should draw the two halves of the genitalia and the bunches of tentacles together more closely here than at the alternate quarters; hence arises the frequently-observed quadrate outline of the disc. Again, in regard to another feature oftentimes employed to discriminate between different species or even groups, I would say that the absence of auricles alone, without other differences in the animal, does not indicate a specific difference from those individuals possessing them, but rather an accidental

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[1] From the Proceedings of the Boston Society of Natural History, for March 19th, 1862; with additions and notes by the author.

atrophy of these organs; and that this fact is to be classed in the same category as the occasional development of one of the tentacles into a semiauricular body. I have always noticed that individuals in such a condition have an unnatural appearance; that they are not so lively as the others, and appear to be diseased.[2] I believe this species to be identical with *L. auricula*[3] of the English coast. The most characteristic figure that I know of, although unsatisfactory, is in Gosse's little book, *The Aquarium.*[4]

In order to contrast the structure of Lucernaria with that of the Steganopthalmatan Medusæ, and, moreover, in order that I may not complicate matters, I will compare it, organ for organ and part for part, with one of our most common medusæ, *Aurelia flavidula* Agassiz. The aboral side, which corresponds to the so-called dorsal region of other Acalephæ, projects at the apex into a moderately long columnar body, usually called the peduncle of Lucernaria. With the exception of the four equidistant channels and the four muscular cords which alternate with them, the peduncle is a solid gelatiniform mass, covered by the outer wall. This gelatiniform substance also constitutes the bulk of the disc, filling the entire space between the outer wall and the inner or lining wall of the digestive cavity, and is directly continuous with that in the peduncle. In Aurelia, Cyanea, and other Acalephs, this substance appears like an amorphous gelatiniform or semicartilaginous mass, with a few irregular cells scattered here and there;[5] but in Lucernaria it

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[2] I have found such specimens most frequent at that time of the year which is the breeding season of our common shore-crab,—*Cancer* (*Platycarcinus*) *irroratus*,—when it comes up out of deeper water, and is most abundant and active. At first, only now and then, I found a Lucernarian with one or two auricles bitten off; but later it was common to find specimens with all the auricles nipped, and nothing but a small portion of their base or a mere scar, left to indicate their former presence. The moment a Lucernarian is touched by a crab it jerks its tufts of tentacles inward, but the reverted auricles are left exposed, and all the more prominent by the act than usual, and a conspicuous morsel for the predaceous creature. As the season advances towards summer, the bunches of tentacles also disappear one after another, until it becomes quite common also to find individuals with two, three, or four bunches bitten off; and at the same time specimens become more and more rare, at the last of June, for instance, and finally, by the early part of July it is impossible, by the most diligent search, to find a single specimen. As this happens at the time when the Lucernarians are laying their eggs, it is clear that the destruction of the adult does not necessarily annihilate the race. During the next two months no Lucernarians are to be found, but in the last of August I have collected young ones, much less than $\frac{1}{16}$ of an inch in diameter.

[3] *Haliclystus auricula* H. J. C., Journal Boston Soc. Nat. Hist., March, 1863, page 559.

[4] The original figure by Rathke, *Müll. Zool. Danica,* iv, 1806, pl. clii, although sufficiently correct for identification, can neither be called characteristic nor graceful as far as attitude is concerned.

[5] In June, 1862, I made a careful study of the structure of the gelatiniform substance of *Aurelia flavidula* Ag. There are two kinds of fibro-cellular bodies which pervade the gelatiniform layer. One kind are irregular, dark, conspicuous cells, similar in appearance and size to those of the outer wall of the aboral side, with

has a highly organic structure. Extremely elongate, columnar, cell-like bodies extend in close proximity from the outer to the inner wall, so that, in a section of the thickness of the disc, it appears to be transversely striated. In the peduncle, as a transverse section reveals, these columnar cells are arranged about the axis in peculiar, regular groups; some columns pass from one channel to the next on either side; some diagonally across the axis from one channel to an opposite one, and others extend obliquely from the channel to the muscular cords which alternate with them. This arrangement reminds one of the methodical disposition of the great cells in the body of Pleurobrachia,[6]

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from one to four or five jagged, caudate prolongations projecting in every direction. These are most numerous next the aboral side of the disc, and departing from that region, they become less frequent as we approach the oral side, at which place they are very much scattered. The other kind of bodies are very faint, nucleated, nodose fibres, and form a vast anastomosing net-work, which, like the darker caudate cells, pervades the whole of the gelatiniform mass of the body, from the aboral to the oral side. It resembles elastic tissue very closely. Next the aboral side these fibres trend mostly parallelwise with the outer wall, or at very oblique angles to it; but, passing inwardly, they gradually assume a direction transverse to this, and then, anastomosing less frequently, they become in appearance like slender parallel columns, based upon the double wall in which the chymiferous channels run. Between the latter and the outer wall of the oral side the fibrous bodies are excessively faint, and less frequent, but still continue the trend which they have on the aboral side of the double wall. The peculiarities of these two kinds of bodies are fully described by Max Schultze, *Ueber den Bau der Gallertscheibe der Medusen. Müll. Archiv.*, 1856, p. 311, pl. xi, xii, from observations which he made upon *Medusa* (*Aurelia*) *aurita*, *Rhizostoma Cuvierii* and *R. Aldrovandii*; but in all of them he says the fibres run in every direction. "Sie laufen gestreckt in allen Richtungen, theilen sich häufig und verbinden sich unter einander unter allen möglichen Winkeln." Now in *Medusa* (*Aurelia*) *aurita*, which is very near, if not identical with our Aurelia, *A. flavidula* Ag., it is very probable that these fibres are arranged as in ours, and yet I cannot see how Schultze could have overlooked this arrangement. My observations were made upon perfectly fresh specimens, and without the help of any reagents. In our Lucernarian, and in fact in all the Lucernariæ (see *Journal Boston Nat. Hist. Soc.*, March, 1863) the fibrous bodies do not anastomose, but trend in direct lines from the outer to the inner wall.

[6] At the time the investigation of the gelatiniform mass of *Pleurobrachia rhododactyla* Ag. was made, I had not in my possession lenses of the proper definition and working distance to make out the histological elements with the requisite care that such excessively transparent bodies demand, and therefore, using inferior lenses, I fell into an error which I am only too glad to correct. Since that time I have obtained one of Tolles' half-inch objectives with an exceedingly sharp definition and an extraordinary working distance; so that I have been enabled to work with perfect freedom upon the living animal, and without injuring its tissues in the least. What formerly I mistook to be the outlines of the walls of enormous cells are in reality *elastic fibres*. The mistaking the fibres for the profile of cell walls does not affect the arrangement in the least, as I formerly described it, and which I have since verified with my new objectives. The elastic fibres assume various forms, according to the degree of expansion or contraction of the animal; sometimes they are perfectly straight and at others they are contracted either in a loose spiral, or retracted into a close coil. This is most easily observed in young specimens. In the young of another Ctenophoran, viz., *Bolina alata* Ag., about $\frac{1}{32}$ of an inch in diameter, at which size its proportions, shape, the considerable depth of the tentacular sockets, and the length of its tentacles render it remarkably like a Pleurobrachia, the elastic fibres are very few, but quite conspicuous, and have a peculiar mode of branching. Single fibres extend radiatingly from the corners of the stomach; when about half

as I have described them in Prof. Agassiz's third volume of his "Contributions to the Natural History of the United States." In the oral or lower side of the disc of Aurelia, the gelatiniform substance has the same structure as in the aboral side, while in Lucernaria, although it has all the regularity in the disposition of its components that obtains in the aboral side, yet it possesses a totally different nature, as I will describe hereafter in connection with the muscular system.

From the middle of the base of each of the four flat sides of the quadrate proboscis, a light streak, which has the deceptive appearance of a radiating canal, passes in a direct line nearly to the border of the disc; this is the line along which the oral and aboral floors of the disc unite, and form a solid partition, by which the digestive cavity is divided into four broad chambers, which communicate with one another at the inner or proximal ends, about the base of the proboscis, and also at the outer or distal ends through the narrow passage between the terminus of the partition and the edge of the disc. In the peduncle there are four equidistant broad tubes, which merge into one cavity at its base, and correspond in position to the four chambers of the digestive cavity. The grouped tentacles which occupy the eight corners of the disc are hollow, as, likewise, are the auricles, and communicate openly and directly with the digestive cavity. This is all that constitutes the chymiferous circulatory system of Lucernaria. In Aurelia we have radiating canals at the points corresponding to the partitions of Lucernaria, as well as in the intermediate sections.

In Aurelia, the genitalia are four single circular organs, one of each being placed opposite the flat side of the proboscis; whereas in Lucernaria each genital is a double organ, the halves of which have a peculiar shape, and are situated respectively one on each side of the partition, and extend along the inner face of the oral floor of the disc from the base of the proboscis to the extreme limits of the corners of the disc, where they almost touch the bases of the tentacles. Across the proximal end of each partition, triple or quadruple rows of slender digitiform bodies extend each way for a considerable distance along the border of each half of a genital, thus forming the common

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way to the surface of the body, each fibre forks two or three times, and then one prong goes to each of the two nearest longitudinal chymiferous tubes, and the third one extends to the base of the deep tentacular socket. This is the general arrangement at this age, although occasionally one of the prongs of the fork is absent, or only partially developed. Sometimes each prong forks again, at a narrow or wide angle. From the tentacular sockets fibres extend also to the surface midway between the mouth of the former and the adjacent longitudinal chymiferous tube. So few are all the fibres, however, that with a casual glance they might be mistaken for light, unimportant streaks here and there, instead of such methodically arranged bodies.

appendages of the two, and clearly indicating their *unity*.[7] Each half of a genital has a peculiar form, which may be represented by an inequilateral triangle whose longest side extends nearly in a straight line from the inner end of the partition to the tentacles, and the two other sides, slightly curving outwardly and meeting at a very broad angle, form the rest of the outline. In the adult, the longest side of the triangle is to its height as two to one. This feature, alone, has a degree of speciality which raises these organs in rank above all others of their kind among Acalephæ; but when we examine their components, we find an unlooked-for structure, hitherto unknown among Acalephæ. What appear, to the naked eye, to be eggs of enormous size, are really little pouches, which contain either numerous eggs or matrices of spermatic particles, according as the individual is male or female. Each pouch, or *genital saccule*, as it may be called, projects freely into the digestive cavity, and is attached by a very short and rather narrow neck to the inner wall of the oral floor of the disc. This constitutes another step in the specialization of these organs, but does not complete the process. At the base of each genital saccule, and on that side which faces toward the proboscis, there is a small aperture, which leads to the interior, where there is a considerable cavity. This cavity is formed by the lateral inversion of the single wall of the saccule upon itself, and the constriction of the wall about the entrance to the chamber. The eggs or spermatic material[8] are enclosed in saccular folds of the wall of this chamber, into which they fall when mature, and pass thence outwardly through the lateral outlet at the base of the saccule. One may see at a glance that this is a type of the reproductive organs not to be found among the other Acalephæ.

In Aurelia, the generative products, whether eggs or spermatozoa, lie immediately beneath the *outer wall*, and imbedded in the muscular layer which extends throughout the length and breadth of the oral face of the disc, as I have described it in the fourth volume of Professor Agassiz's "Contributions." Between

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[7] In the family Cleistocarpidæ, as I have recently characterized it (*Journal Boston Nat. Hist. Soc.*, March, 1863), the genital halves are directly united to each other, so as to form a continuous organ across the proximal end of the partition; thus there can be no doubt that there are but four genitals in Lucernariæ, and not eight. as described by various authors.

[8] The spermatic particles have an elongate-cordate body, from the broad end of which an excessively long tail-like filament trails in broad curves as it swims; at the pointed end are attached two exceedingly delicate filaments, which are in constant motion, bending and coiling, or stretching in every direction, as if they were the tactile organs of an Euglena or some other similar Infusorian. These pseudo-probosces defy detection with ordinary objectives; in fact, to determine their presence with certainty requires very careful manipulation of such objectives as have the most accurate defining power, and which are to be obtained only from our best makers. The spermatic particles of our common Echinus, *E. granulatus*, also possess a double pseudo-proboscis.

the muscular layer and the inner wall, which forms the immediate parietes of the digestive cavity, a thick layer of gelatiniform substance intervenes, and its presence naturally suggests the inquiry, how are the eggs or sperm to escape into the digestive cavity, as they are known to do? The spermatic particles I have observed frequently escaping directly through the outer wall into the ocean, and I have seen them, with the broadest end out, projecting like bundles of hairs from the cavity of the matrix through the apertures in the outer wall. When the reproductive material is fully ripe, the inner wall, with the gelatiniform layer, and the muscular layer as far as it includes the material in question, splits off from the outer wall along two lines corresponding to the two borders of the generative organ, and hangs loosely, in ribbons, in the digestive cavity. From the newly-formed raw face of these ribbons the eggs or spermatic particles escape into the main chamber of the disc. This I take to be the universal rule, and such the type of genitalia among all Steganophthalmata; a structure totally unlike that of Lucernaria, in which the *inner wall* alone is concerned in the highly complicated reproductive organs.

Passing now to the consideration of the *muscular system*, I will call your attention to the four white, slender columns which alternate with the four dark tubes which are imbedded in the gelatiniform substance of the peduncle. Sars was the first to indicate the true nature of these columns, and he rightly called them muscular cords. They extend from the base of the peduncle to the base of the proboscis, coursing along just beneath the outer wall, but still within the gelatiniform substance, until they reach the upper third of the peduncle, and then gradually approximating the axial line, they meet the inner wall of the disc just below the base of the proboscis, and thence they pass along still beneath this wall, for a short distance, and, finally *each one enters the oral side of the disc* at the inner or axial end of the partition. At this point, each muscular column expands and forms a fan-shaped layer just beneath the outer wall, and extends laterally so as to occupy the whole space between the two halves of a genital. At the distal end, this layer diverges right and left of the partition into a broad muscular band which borders the disc, and, eventually, is distributed in ridges or cords beneath the outer wall of the tentacles and the auricles. At the inner end of the partition, the muscular layer also passes into the base of the proboscis, and forms a stratum immediately beneath the outer wall. At four equidistant points, alternating with the partitions and genitals, and opposite the four corners of the proboscis, there is a weaker muscular layer, which occupies the same relative position in regard to the outer walls as does the stronger system of muscles first mentioned. On the one hand, it passes into the marginal muscular band, and on the other it enters the corners of the proboscis, and forms a layer in common with the one extending from the partitions. By these alternating stronger and weaker divisions of the muscular layer, the disc is relieved of the sameness which prevails in the muscular system of the Steganophthalmata, and we have indubitable proofs of a higher degree of specialization than in the latter order, where the unvarying repetition of similar divisions all around the disc unmistakably indicates inferiority. Moreover, in addition to this, we have a peculiar specialization of the gelatiniform layer, which is embraced by the outer and inner walls of this floor, or rather between the muscular layer and the inner wall; instead of repeating, as occurs in Aurelia, the peculiarities of the gelatiniform layer of the aboral floor, it has a totally different appearance and consistency, and an almost unlimited degree of expansion and contraction. In the tentacles it occupies a very deep space between the outer wall, or rather the muscular layer, and the inner wall. In this latter respect, Lucernaria is again peculiar, since in addition to the muscular layer, which alone is present in the young, it develops this gelatiniform layer,—the *musculo-gelatiniform layer* as I propose to call it,—the like of which does not exist in the tentacles either of Steganophthalmata or Gymnophthalmata. In the auricles, we have also a specialization peculiar to Lucernaria; for, in addition to the pigment eye-spot which is imbedded in the base of the oral face of these bodies, the auricles, which in the young cannot be distinguished from the tentacles, gradually thicken the outer wall as age advances, and peculiar, granuliferous, adhesive vesicles are developed between the cells. In the adult, their tentacular nature is almost, or altogether, obliterated, and the swollen outer wall, together with the enormous thickness of the musculo-gelatiniform layer, forms an oval mass, thickly studded with adhesive organs, by which they cling, in a most tenacious manner, to any body which they may touch. These organs, and the base of the peduncle, are the only means of adherence which Lucernaria possesses; although it is true that the tentacles are used, as in Aurelia, for prehension, they are, comparatively, very weak, and can only serve to retain the prey, and never effect the purpose for which the auricles are constructed.[*] In consideration of the very obvious office of an auricle, I would propose the name *anchor* for it.

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[*] The nettling organs, or lasso-cells, which crowd the globular tips of the tentacles, are of two kinds, and both are imbedded in the intercellular substance which fills the spaces between the columnar cells of the outer wall. One kind consists of an oval, thick-walled vesicle, about $\frac{1}{2000}$ of an inch long, or a little less, one end of which is introverted, and projects, in the form of a stout hollow shaft, along the axis of the cell about four-fifths of its length, and then, rather suddenly thinning into a slender thread which also is hollow, it bends upon itself, returns nearly to the

Were the above-mentioned features in the organism of Lucernaria alone to be taken into account, there could be no hesitation in saying that this genus should be considered as the highest of the class of Acalephæ; because of its highly complicated and specialized gelatiniform mass; the high grade, and the peculiar and distinctive grouping of its muscular system; the definite and bilateral form of the genital organs, as well as their saccular subdivision; the two-fold nature and disposition of the prehensile organs, the tentacles and anchors: and, moreover, that it belongs to an order separate from either orders of Acalephæ, because of the typical elements of its genital saccules, which are altogether different from either the Steganophthalmic or Gymnophthalmic type of genitals; and also on account of the anchors, which have no parallel in all the class of Acalephæ. But there are parts of the Lucernarian organism which are of a lower grade than those of similar nature among the other Acalephæ. I refer, in the first place, to the hydra-like form of Lucernaria, and its comparatively stiff and hydroidal tentacles, evidently indicating

aperture of the cell, and pressing closely against the inner face of the cell wall it forms a close coil which terminates at the end opposite the mouth of the introversion. When the coil of thread is ejected, which is accomplished by sliding through the hollow axial shaft, which in its turn retroverts also, just as the finger of a glove is turned inside out, the whole aspect of the apparatus is changed. The oval cell is considerably diminished in size, and from its aperture the enormously enlarged hollow shaft projects in a straight line; the half of the shaft next the cell is cylindrical, and half as broad as the latter, with a slight expansion where it joins the mouth of the cell; the distal half abruptly expands into an oval form, half again broader than the cylindrical portion, and rapidly tapers into a smooth, trihedral, twisted thread. The oval part of the shaft is endowed with three equidistant spiral rows of setæ, which number about a dozen in each row. The setæ are comparatively large, and in length equal two thirds the broadest diameter of that part of the shaft from which they project. Each row makes but one turn about the shaft, and terminates as if in continuation of the angles of the trihedral thread. There is not the least trace of setæ or projections of any kind upon the trihedral thread, but it continues, with a very gradual taper, perfectly smooth, to the blunt termination. The angles of the thread appear, at first glance, as if they might be spiral rows of setæ, but a most careful and prolonged examination, with one of Spencer's ¼-inch objectives, convinces me that they are truly the angles of a twisted trihedral filament. The extent of the thread is from twenty to twenty-four times the length of the cell. The other kind of nettling cell is much more simple in structure, but yet more remarkable. The introverted shaft is very slender, in fact no larger than the rest of the thread; it does not project into the axis of the cylindrico-oval cell, but presses close to the side of the latter, and extends four-fifths of the way to its opposite end, and then bending abruptly upon itself, the thread passes with a long curved sweep nearly to the aperture of the cell, from whence it again returns, with another long sweep, which is repeated eight to ten times, until the inner face of the cell wall is lined by a close coil which winds lengthwise, instead of transversely as it does in the other kind first described. When extended, the thread is from twelve to fourteen times the length of the cell; it offers not the least sign of appendages of any kind, but is simply a smooth, round filament, of uniform thickness throughout, except at the end, where it tapers slightly and terminates in a blunt tip. The cell itself, when retroverted, is sensibly diminished in size, and narrows rapidly into the prolonged filamentary portion. It would seem to be perfectly incontestable that, as the cell diminishes in size with the expulsion of the thread, it forms the propelling power, and, by the contraction of its wall, forces its contents outward.

a typical affinity to the fixed hydroid generation of the Sarsiæ, Bougainvilliæ, Steenstrupiæ, etc. The simple, almost unilocular chymiferous system is hardly more medusoidal, as regards the multiplicity of its subdivisions, than in some of the Tubularians, such as Tubularia and Corymorpha, which are described in Professor Agassiz's fourth volume of his "Contributions." In connection with the hydroid form of Lucernaria, I would also mention the total absence of a veil. This might, at first thought, appear to furnish an argument in favor of the high relations of this genus; but I think it is to be deemed as one of the signs of its inferior connections. However, let us look at the progress of velar development. In the *ephyra* state of all Steganophthalmata, the veil is at one time greatly in the preponderance, when compared with the size of the whole individual; but with growth it gradually becomes less conspicuous, and, finally, in some adult genera of this order, it remains as a mere trace of a veil, or, as in Cyanea and some Rhizostomidæ, it is altogether obscured. Now, it is noteworthy that among the lowest of this order, such as Pelagia, we have a strong resemblance to the ephyra state, and the ephyroid, tongue-like veil is quite prominent; and in Chrysaora it is hardly less so; ascending the scale, we find it yet more inconspicuous in Aurelia, and still more so in Cassiopeæ; and, finally, altogether absent in Cyanea,[10] the highest, in my opinion, of all the Steganophthalmata. Now, one might suppose Lucernaria, in respect to the veil, to be in the same category with Cyanea, which has resorbed its veil; this, however, is not the case, for as I know, from the study of the younger stages of Lucernaria, that it never passes through the veiled phase, it falls short in its development as regards this particular feature of Acalephan morphology. We must take into consideration, also, the eyes, which are found to be as low in point of structure as the merest pigment eye-spot of the Gymnophthalmata.

Thus, in balancing the value of the organisms of this animal, we are inevitably led to the conclusion, on the one hand, that Lucernaria does not stand *as a totality* above all other Acalephæ, nor, on the other hand, does it, by any means, belong below them; and that much less does it affiliate exclusively with the

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[10] The ephyra-like appearance of Cyanea is illusory; the lobes about the eyes, comprise not only the original ocular lappets, but also a part of the tentacular margin; in fact one half of each margin on each side of an eye is continuous with the ocular lappet adjacent. The tentacular margin being incurved toward the centre of the disc, the veil must be still farther inward, and very probably the margin of the muscular bands corresponds to it, the two merging into each other. The wide lacunar character of the radiating canals is not a feature of inferiority, as might appear, but represents a continuation of the tendency,—as may be seen in the progressive stages of growth of Aurelia,—to channel out the whole breadth of the disc, until it finally becomes a simple cavity. In Rhizostoma. Stomolphus and Polyclonia, the channeling is less carried out than in Cyanea; in fact, in the former it is but a little beyond Aurelia in this respect.

Gymnophthalmata. The only relation that it possibly can be considered under is that of a *correlation to both types of Acalephæ*, —viz.: to the Gymnophthalmata, including the Siphonophoræ, and to the Steganophthalmata; yet not as a graduated connecting link, which would seem to show that the two orders pass into each other, but as an *ordinal type*, equivalent in value to either of the others, by reason of the peculiar and distinctive morphology of certain of its organs. On this account, Lucernaria is to be considered, and may be designated, as the *cœnotype* (κοινός, common) of the Acalephæ. In this respect, it holds such relations to the other two orders of Acalephæ as do the Crinoids to the other orders of Echinodermata; or the Annelidæ to the rest of the Articulata; or the Selachians to the true fishes and the reptiles; but, at the same time, containing organic features which separate each of them as a type from the others.

In order that no confusion may arise here, I would state most explicitly that I do not consider the Ctenophoræ as one of the orders of Acalephæ, but deem them to be a class by themselves, equal in value to either of the classes of Radiata, whether Polypi, Acalephæ, or Echinodermata, and standing next in rank to the Echinodermata. The division of the alimentary system of Ctenophoræ into *two portions*, as among Polypi, is sufficient to separate them from the Acalephæ, since the typical form of the corresponding system in the latter is a *unity;* moreover, the position and peculiar relations of the tentacles of Ctenophoræ are hardly of less importance, in these considerations, as distinctive characters. I cannot conceive that the Ctenophoræ may be included in the same classific type with the Acalephæ without doing violence to correlative ideas such as are expressed in the organism of the former; and much less can I admit that they have the most distant relation to the Polypi, excepting that, like the latter, they are Radiates. The same kind of arguments that have been used to show that Ctenophoræ and Polypi belong to one class might, with equal justice, be advanced to prove that the Acalephæ are Polypi. We must not mistake a similarity for an identity, any more than that the cry of a child would identify it with a cat, because their voices sound alike, and cannot always be distinguished the one from the other by any single faculty of our senses.

The following tabular view presents at a glance the relations of the Lucernariæ to the other orders of Acalephæ, and at the same time indicates the position of the Ctenophoræ among the other classes of Radiata.

POLYPI.	ACALEPHÆ.		CTENOPHORÆ.	ECHINODERMATA.
		Steganophthalmata.		
	Lucernariæ.			
		Gymnophthalmata.		

ART. XXXV.—*On the use of Prisms of Flint Glass and Bisulphid of carbon for Spectral Analysis;* by Prof. O. N. ROOD.

IN a letter to Prof. B. Silliman, Jr., which was published by him in the September No., 1862, of this Journal, I described a new form of bisulphid of carbon prism, provided with compound faces, which corrected the distortion usually attendant on such prisms. I ventured at that time to suggest that large prisms of this kind approached a degree of optical perfection not attainable by the best flint glass prisms yet produced. Some late experiments of Sigmund Merz,[1] one of the successors of Fraunhofer, furnish a confirmation of my opinion, which I certainly did not expect to receive from that particular quarter. In my letter I mentioned the discovery of two new lines in the interior of the line D, which made in all three fine lines that were thus enclosed, one having previously been laid down by Kirchhoff. To effect this, three bisulphid of carbon prisms of 60°, with a flint glass prism of 45° were employed; the sum of the refracting angles was then 225°. Now Merz states that by the use of a number of *glass* prisms, the sum of their refracting angles being 270°, or 45° greater than that employed by me, he discovered a second line in the interior of D, but nothing more; the third line it appears was invisible. This second line observed by him I may remark, in my spectroscope was apparently as strong as that laid down by Kirchhoff, so that it was a matter of some wonder that it had escaped resolution in his hands.

Merz then employed eleven glass prisms, the sum of their refracting angles being 480°; with these he discovered the third line I had previously seen, along with two additional quite fine lines. He therefore describes the line D to consist of: two quite broad lines, (those commonly known,) two of less breadth, and three fine lines.

When we consider that this optician had at his command the best flint glass prisms in the world, and observing telescopes that have hardly ever been surpassed, the argument to be drawn in favor of bisulphid of carbon prisms properly corrected, is I think a strong one; particularly when I mention that the telescopes used by me were the common cheap French article, variously amended to secure an approximation to achromatism.

Farther, according to the observations of Merz, a single *large* glass prism (43 lines) used with a large condensing telescope (34 lines in diameter), shows D resolved into five lines, demonstrating thus the value of *size* in the apparatus; this seems again to me an excellent reason for the use of bisulphid of carbon on the ground of its far greater cheapness.

Peace Dale, R. I., March 10th, 1863.

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[1] *Ueber das Farben Spectrum von Sigmund Merz in München. Pogg. Annalen,* Band cxvii, stück 4. (Aus einer vom Hrn. Verf. übersandten Abhandlung ein Kunst-und Gewerbeblatt d. polytechn. Vereins für d. Königr. Bayern, Oct. 1862.)

ART. XXXVI.—*On certain Appearances produced by Revolving Discs;* by Prof. O. N. ROOD.

DOVE, some years ago, succeeded in producing a lustrous appearance, by the binocular combination of geometrical figures, executed in black and white, or in complementary colors,[1] and later I showed that *surfaces* without drawings produced the same effect.[2]

In both these cases, two masses of light were continuously presented to the two eyes of the observer. It subsequently appeared to me of interest to examine the effects produced by a more or less rapid alternation of these impressions, and accordingly some experiments were made with this object in view.

A circular disc of white card-board, 9 inches in diameter, with half its surface painted of a dead black, was caused to rotate by clock work at varying rates, while the bright light from a window fell upon it. A stereoscope, from which the ground glass had been removed, was provided with a card-board in which were cut two square apertures, at such a distance asunder that their binocular union could be easily effected, and, while the disc was at rest, the stereoscope was arranged so that through the right-hand aperture some of the white portion of the disc was seen, and through the left-hand aperture a part of the blackened surface. On communicating rotary motion to the disc, a more or less rapid alternation of black and white was the result.

It was found that with slow rates of rotation ($2\frac{3}{10}$ revolutions per sec.) the strength of the lustre was not impaired, and it was just as plainly perceptible with more rapid rates.

But when the disc was made to revolve so fast that its surface seemed covered by a uniform tint of grey, and the so-called flickering had ceased, no lustre in the proper sense of the term could be seen, the appearance being exactly that which is presented to a single eye under similar circumstances.

When a disc of this kind revolves at such a rate as to appear of a uniform tint, the duration of the impression produced on the eye by the white half lasts with undiminished force while the black half is passing before the same eye, so that while the right eye is being objectively impressed by the white surface, the left eye has retained a subjective impression of exactly the same nature and strength: both eyes are then really *in effect* impressed all the time in exactly the same way, and in consequence of this no lustre is perceptible. But when the rates of rotation are lower than that above indicated, a different binocular com-

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[1] Farbenlehre, pp. 171 and 177.

[2] This Journal, May, 1861.

bination takes place; here, while one eye has objective white light presented to it, the other retina is affected by a rapidly fading subjective impression, so that the two impressions are during most of the time of unequal intensity; the result is lustre.

In this connexion, a remark on the appearance of rotating discs with black and white sectors, when viewed by a single eye, may not be out of place. Let us take for the sake of convenience a disc with seven white and seven black equal sectors, and cause it to revolve by clock work. As long as the rate is quite slow, the figure remains undistorted, but as it is increased to $1\frac{3}{10}$ revolutions per second there is a loss of definition, and directly the appearance becomes a little puzzling; with a higher rate, as for example $4\frac{2}{10}$ per sec., the disc takes on a very remarkable appearance, described by some as flickering, by others as "*glittering.*" To make a little examination of it undisturbed by its surroundings, I cut a circular aperture 2 inches in diameter in a large piece of card-board, and viewed through this with a single eye a portion of the revolving disc. The appearance presented I can describe in no other terms than by calling it lustrous, with rapid variations in the intensity of the light. In this case the strong objective light is seen through the weaker fading subjective impression, and the latter is of course at regular intervals perceived distinct by itself, so that the eye is in effect acted on by two masses of light of unequal intensity, and is also sensible of their separate presence.

A disc of this kind is remarkable in one other respect, viz: that with both eyes it is impossible exactly to locate its surface without reference to the edge or centre. The disc often seems to me to have a depth of some inches, the rapid shifting of the figure not allowing binocular vision to come fairly into action.

Finally, if the disc be made to rotate so rapidly that the surface appears quite uniform, an attentive examination shows that its surface presents an appearance not a little singular, so that if the experiment be properly made, the surface, taken by itself, cannot be located with any degree of precision, the marks ordinarily used are found to be abstracted, and nothing but a mass of light is seen. It much resembles a mass of *luminous air*, if the expression may be allowed.

To ascertain whether this aerial appearance depended in any degree on the rapid alternations of white and black, I colored a smaller disc grey, the same tint in strength with that produced by the sectors of the disc in revolution, and placing both on the same axis made them rotate together. One looked exactly like the other, and hence it is to be concluded, that this aerial appearance is caused solely by the disappearance of everything like markings or texture on the paper.

Peace Dale, R. I, March 10th, 1863.

ART. XXXVII.—*Abstract of Results of a Magnetic Survey of Pennsylvania and parts of adjacent States in* 1840 *and* 1841, *with some additional results of* 1843 *and* 1862, *and a map;* by A. D. BACHE, LL.D., F.R.S., Mem. Corr. Acad. Sci. Paris, Mem. Nat. A. S., Superintendent U. S. Coast Survey.

INTRODUCTION.

IN the years 1840 and 1841, I made a detailed magnetic survey of Pennsylvania and adjacent parts of New York, Ohio and Maryland, determining at a number of stations suitably selected, with regard to the course of the isomagnetic lines, the magnetic declination, dip and intensity; to these I added some dip and intensity observations in 1843, while on a tour through western New York and Canada.

The total number of declination stations is 16, and of dip and intensity stations 48. On assuming the duties of Superintendent of the U. S. Coast Survey, in 1843, I could not find the necessary leisure to work up these observations, although Mr. J. Ruth and Mr. G. Davidson had commenced preparing, under my direction, a partial abstract, confined to dip and intensity observations and to relative results. In the spring of 1862, I availed myself of the service of Charles A. Schott, Assistant in the U. S. Coast Survey, who reduced, under my direction, the observations, discussed the distribution of the three magnetic elements, presenting the latter results also graphically, and prepared this abstract for the press.

In the summer of 1862, Mr. Schott visited six of the stations previously occupied by me, and redetermined the magnetic elements. Three of these stations falling within the scope of the operations of the U. S. Coast Survey, were at the expense of the Coast Survey, the observations at the three Western stations were secured by the liberality of the Secretary of the Smithsonian Institution, who, at the same time, offered to publish the observations and results in the *Smithsonian Contributions to Knowledge.* The observations of 1862 greatly enhance the value of my older operations, and furnish the means of presenting results for two epochs, about 20 years apart, thus, not only giving the most modern values but also determining, by the known secular change of the three elements, any intermediate results.

The fruits of these labors, undertaken for this continent, at a comparatively early period and comprising the three elements, and the whole conducted systematically, with instruments well constructed for the time, will no doubt afford adequate means of watching, hereafter, the secular changes of terrestrial magnetism within the geographical extent of this survey.

The declinations were determined with a new Gambey declinometer belonging to the Girard College: the astronomical observations were made with a sextant and vertical circle and chronometer. (Grant, No. 3861.) The dip was determined with a portable circle by Robinson, and the intensity with Lloyd needles by Robinson, and a magnetic bar and cylinder according to the method described by me in the *American Phil. Trans.*, vol. v, 1837, in which the vibrations are made in a rarefied medium.

The full paper, with records, will shortly be printed in the *Smithsonian Contributions to Knowledge.*

Abstract of results of Declinations, observed in Pennsylvania and adjacent States in 1840–41.

These observations were made with a Gambey declinometer belonging to the Girard College.

One division (small) of the scale was found equal to 14″·54, as determined in 1844 at Sandy Hook by Lieut. G. M. Bache. (See *Coast Survey Records.*) 1 large division = 60 small divisions.

The observations were made with telescope *direct*, with slit to the right hand or *E.*, and with telescope *inverted* with slit to the left or *W.*; also with needle *direct* or hairs *up*, and with needle *inverted* or hairs *down*. With needle north, W. readings are +, E. readings −; with needle south, W. readings are −, E. readings +.

Recapitulation of Results for Magnetic Declination, 1840.

1.	Harrisburg, Penn.,	July 25,	3° 12′·5 W.
2.	Huntingdon, "	July 30,	1 52 ·3 "
3.	Homewood, near Pittsburg,	Aug. 10,	0 08 ·0 "
4.	Johnson's Tavern, near Brownsville,	Aug. 17,	0 25 ·2 W.
5.	Irwin's Mill, near Mercersburg,	Aug. 24,	0 54 ·4 "
6.	Baltimore, Md.,	Aug. 27,	2 16 ·5 "

Recapitulation of Results for Magnetic Declination, 1841.

1.	Philadelphia,	Penn.,	July	20 and Nov. 1,	3° 53′·7 W.
2.	Easton,	"	"	23,	3 38 ·0 "
3.	Williamsport,	"	"	28,	3 31 ·2 "
4.	Curwinsville,	"	Aug.	1,	1 45 ·1 "
5.	Mercer,	"	"	4,	0 51 ·2 E.
6.	Erie,	"	"	9,	0 30 ·0 W.
7.	Dunkirk,	N. Y.,	"	12,	0 52 ·5 "
8.	Ellicottsville,	"	"	14,	2 35 ·7 "
9.	Bath,	"	"	19,	3 31 ·4 "
10.	Silver Lake,	Penn.,	"	23,	4 30 ·2 "

Recapitulation of observed Latitudes, 1841.

Williamsport,	Penn.,	41° 14′·0
Curwinsville,	"	40 57 ·7
Mercer,	"	41 13 ·8
Erie,	"	42 07 ·5

Dunkirk,	N. Y.	42	29 ·3
Ellicottsville,	"	42	18 ·1
Bath,	"	42	20 ·8
Silver Lake, Penn.,		41	56 ·6

Comparison of Declination for secular change. Results of 1840-41 *and of* 1862.

			1862. (Schott.)	Annual Increase.
Philadelphia, Girard College,	July & Nov. 1841	3° 53′·7 W.	5° 00′·0 W.	3′·2
Harrisburg,	July, 1840	3 12 ·5 "	3 44 ·5 "	1 ·5
Williamsport,	" 1841	3 31 ·2 "	4 25 ·7 "	2 ·6
Johnson's Tav. near Brownsville,	Aug, 1840	0 25 ·2 "	1 13 ·6 "	2 ·2
Erie,	" 1841	0 30 ·0 "	1 33 ·0 "	3 ·0
Bath,	" 1841	3 31 ·4 "	4 47 ·9 "	3 ·6
			Mean,	2 ·7

Harrisburg was occupied in July 1862, and all the other stations of 1862 in August.

	Longitude.			
	By Chronom.	From Lake Survey.	Previously adopted.	Final adopted.
	° ′	° ′	° ′	° ′
Williamsport,	77 01·3		77 03·5	77 02
Curwinsville,	78 36·6		78 35	78 36
Erie.[1]	80 12·5	80 05	80 06	80 06
Dunkirk,[2]	79 27·0	79 22	79 22	79 23
Ellicottsville,	78 46·6		78 42	78 44
Silver Lake,	75 59·3		76 05	76 02
Milford,	74 53·1		74 50	74 51·5

Distribution of the Magnetic Declination for the epoch 1842·0.

From the comparison of observations for secular change, we have:

From the preceding 6 stations the average annual increase 2′·7. At Toronto (between 1845 and 1855) 2′·3 (see vol. iii of the *Toronto Observations*).

General table of results referred to the common epoch 1842·0.

No.	Station.	Date.		Observed decl. W.	Re'd to epoch.	Declination 1842·0.
				° ′	′	° ′
1	Harrisburg,	1840,	July 25	3 12·5	+4·0	3 16 5
2	Huntingdon,	"	" 30	1 52·3	"	1 56·3
3	Near Pittsburg,	"	Aug. 10	0 08·0	"	0 12·0
4	Near Brownsville,	"	" 17	0 25·2	"	0 29·2
5	Near Mercersburg,	"	" 24	0 54·4	"	0 58·4
6	Baltimore,	"	" 27	2 16·5	"	2 20·5
7	Philadelphia,	1841,	{ July 20 Nov. 1	3 53·7	+0·7	3 54·4
8	Easton,	"	July 23	3 38·0	+1·3	3 39·3
9	Williamsport,	"	" 28	3 31·2	"	3 32·5
10	Curwinsville,	"	Aug. 1	1 45·1	"	1 46·4
11	Mercer,	"	" 4	−0 51·2	"	−0 49·9
12	Erie,	"	" 9	0 30·0	"	0 31·3
13	Dunkirk,	"	" 12	0 52·5	"	0 53·8
14	Ellicottsville,	"	" 14	2 35·7	"	2 37·0
15	Bath,	"	" 19	3 31·4	"	3 32·7
16	Silver Lake,	"	" 23	4 30·2	"	4 31·5

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[1] Colton's Map, 80° 10′.

[2] Ibid., 79° 22′·5.

No.	Station.	Latitude.	Longitude.	Decl. W. 1842·0.
1	Harrisburg,	40°·27	76°·88	3°·27
2	Huntingdon,	40·51	78·03	1·94
3	Near Pittsburg,	40·47	79·99	0·20
4	Near Brownsville,	39·99	79·80	0·49
5	Near Mercersburg,	39·78	77·93	0·97
6	Baltimore,	39·30	76·61	2·34
7	Philadelphia,	39·97	75·17	3·89
8	Easton,	40·70	75·25	3·65
9	Williamsport,	41·23	77·03	3·54
10	Curwinsville,	40·96	78·60	1·77
11	Mercer,	41·23	80·27	−0·83
12	Erie,	42·13	80·10	0·52
13	Dunkirk,	42·49	79·38	0·90
14	Ellicottsville,	42·30	78·73	2·62
15	Bath,	42·35	77·35	3·55
16	Silver Lake,	41·94	76·03	4·52
	Mean,	40·98	77·95	2·08

The small extent of the survey, as well as the comparatively small number of observations, will not permit the introduction of curvature in the isogonic lines, they are therefore treated as straight lines. This assumption also serves for the recognition of any local disturbances as indicated by the differences of observed and computed values.

Let

$$D = +2^\circ{\cdot}08 + x\,dL + y\,dM \cos L,$$

where

$$dL = \text{lat.} \quad -40^\circ{\cdot}98$$
$$dM = \text{long.} \quad -77\ {\cdot}95.$$

The 16 conditional equations have been formed and values of x, y and D found from the normal equations are as follows:

$$x = +0{\cdot}5102$$
$$y = -1{\cdot}206$$
$$D = +2^\circ{\cdot}08 + 0{\cdot}5102\ dL - 1{\cdot}206\ dM \cos L.$$

A comparison of the observed and computed declinations shows the necessity of introducing a term involving $dLdM \cos L$; this has been done, and the solution of the normal equations gives us the following expression.

$$D = +2^\circ{\cdot}14 + 0{\cdot}513\ dL - 1{\cdot}231\ dM \cos L - 0{\cdot}203\ dLdM \cos L.$$

Comparison of observed and computed values.

Stations.	Observed Declination.	Computed Declination.	Observed − Computed.
Harrisburg,	3°·27	+2°·67	+36′
Huntingdon,	1·94	1·82	+07
Near Pittsburg,	0·20	0·13	+04
Near Brownsville,	0·49	0·16	+20
Near Mercersburg,	0·97	1·54	−34
Baltimore,	2·34	2·21	+08

Table continued.

Stations.	Observed Declination.	Computed Declination.	Observed − Computed.
Philadelphia,	3°·89	3°·81	+05′
Easton,	3·65	4·41	−46
Williamsport,	3·54	3·16	+23
Curwinsville,	1·77	1·51	+16
Mercer,	−0·83	0·04	−52
Erie,	0·52	0·44	+05
Dunkirk,	0·90	1·29	−23
Ellicottsville,	2·62	1·96	+40
Bath,	3·55	3·50	+03
Silver Lake,	4·52	4·66	−08

The probable error of any single representation is ±19′·4. The curves of 0°, 2°, 4°, pass through the following positions:

0°	Lat. 41° 00′ Long. 80 15	Lat. 42° 30′ Long. 80 33	Lat. 39° 30′ Long. 79 54
2°	Lat. 41° 00′ Long. 78 07	Lat. 42° 30′ Long. 78 46	Lat. 39° 30′ Long. 77 05
4°	Lat. 41° 00′ Long. 75 56	Lat. 42° 30′ Long. 76 59	Lat. 39° 30′ Long. 74 17

These curves have been finally adopted.

Distribution of the Magnetic dip, and construction of the isoclinal lines, for 1842.

For the more convenient application of the usual analytical expression for the representation of the observed dips and for their interpolation, the stations have been divided into six groups, as follows:

No.	Group I.	Latitude.	Longitude.	Date.	Observed dips.
1	Philadelphia,[3]	39° 58′·4	75° 10′·0	Feb. 1842	71° 57′·1
2	Doylestown,	40 18	75 10	July 1841	72 23·1
3	Easton,	40 42	75 15	" 1841	72 39·0
4	Reading,	40 19	75 55	" 1840	72 32·2
5	Frenchtown,	39 35	75 51	? Aug. 1840	71 40·2
6	Baltimore,	39 17·8	76 36·6	" 1840	71 33·9
7	Washington,[4]	38 53·1	77 00·2	Sep. 1841	71 15·9
8	Harrisburg,	40 16	76 53	July 1840	72 20·5
9	Duncan's Island,	40 25	77 01	" 1840	72 35·0
10	Near Mercersburg,	39 47	77 56	Aug. 1840	71 47·3
	Mean,	39 57·1	76 16·8	1841·0	72 04·4

[3] The dip is the mean from groups of December 1840, October 1841, and August 1843.

[4] This station has been added to the discussion, as we have observations in 1840 and 1841; see *Appendix No. 26, Coast Survey Report* of 1858. Mean dip from several observers in 1841·0, 71° 18′·3, and in 1842·5, 71° 13′·5. Mean, 71° 15′·9 in 1841·8.

No.	Group II.	Latitude.	Longitude.	Date.	Observed dip.
		° ′	° ′		° ′
1	Armagh,	40 29	79 04	Aug. 1840	72 18·7
2	Frostburgh,	39 41	78 56	" "	71 31·3
3	Near Brownsville,	39 59·5	79 47·8	" "	71 53·5
4	Near Pittsburg,	40 28	79 59 5	" "	72 32·1
5	Economy,	40 37	80 16	" "	72 35·0
6	Wheeling,	40 08	80 42	" "	72 08·9
7	Steubenville,	40 25	80 39	" "	72 32·8
	Mean,	40 15·4	79 54·9	1840·6	72 13·2

No.	Group III.	Latitude.	Longitude.	Date.	Observed dip.
		° ′	° ′		° ′
1	Warren,	41 17	80 50	Aug. 1841	72 59·9
2	Mercer,	41 13 8	80 16	" "	72 57·2
3	Ashtabula Landing,	41 54	80 47	" "	73 23·5
4	Erie,	42 07·5	80 06	" "	73 46·6
5	Dunkirk,	42 29·3	79 23	" "	74 17·2
6	Ellicottsville,	42 18·1	78 44	" "	74 17·8
7	Berlin's Tavern,	41 16	79 36	" "	72 52·8
	Mean,	41 48·0	79 57·4	1841·6	73 30·7

No.	Group IV.	Latitude.	Longitude.	Date.	Observed dip.
		° ′	° ′		° ′
1	Curwinsville,	40 57·7	78 36	Aug. 1841	72 49·7
2	Belvidere,	42 13	78 06	" "	74 09·5
3	Bath,	42 20·8	77 21	" "	74 27·5
4	Owego,	42 08	76 17	" "	74 13·9
5	Silver Lake,	41 56·6	76 02	" "	73 41·5
6	Wilkesbarre,	41 14	75 58	July "	73 10·0
7	Williamsport,	41 14·0	77 02	" "	72 54·4
8	Bellefonte,	40 55	77 49	" "	72 42 3
9	Lewistown,	40 35	77 36	" 1840	72 30·0
10	Huntingdon,	40 30·5	78 02	" "	72 17·8
	Mean,	41 24.5	77 16·9	1841 4	73 17·7

No	Group V.	Latitude.	Longitude.	Date.	Observed dip.
		° ′	° ′		° ′
1	Niagara Falls,	43 04	79 05	Aug. 1843	74 51·0
2	Toronto Ob.,	43 39·5	79 21·5	" "	75 11·4
3	Rochester,	43 07	77 39	" "	74 43·5
4	Geneva,	42 53	77 02	July "	74 33·2
5	Syracuse,	43 03	76 09·3	" "	74 51·2
6	Oswego,	43 26	76 35	Aug. "	75 07·1
	Mean,	43 12.1	77 38·6	1843·6	74 52·9

No.	Group VI.	Latitude.	Longitude.	Date.	Observed dip.
		° ′	° ′		° ′
1	Utica,	43 05	75 14	July 1843	74 50·3
2	Schenectady,	42 48	73 57	" "	74 54·8
3	Troy,	42 43·7	73 40·7	Aug. "	74 47·9
4	West Point,	41 23·4	73 57 0	July "	73 12·2
5	New York,[6]	40 46·1	73 56·3	Dec. 1841	72 39·6
6	Milford,	41 19	74 51·5	Aug. "	73 47·6
7	Bushkill,	41 07	75 02	" "	73 31·4
8	Princeton,	40 20·7	74 39·6	July 1843	72 38·3
	Mean,	41 41·6	74 24·8	1842·9	73 47·8

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[6] See *Appendix No.* 32, *Coast Survey Report* of 1856. This station was added, owing to the numerous observations taken in this locality (at Lunatic Asylum). Dip in 1841·3, 71° 41′·0; in 1842·5, 72° 38′·3.

Recapitulation.

No.	Group.	Latitude.	Longitude.	Date.	Observed dip.
		° ′	° ′		° ′
10	I.	39 57·1	76 16·8	1841·0	72 04·4
7	II.	40 15·4	79 54·9	1840·6	72 13·2
7	III.	41 48·0	79 57·4	1841·6	73 30·7
10	IV.	41 24·5	77 16·9	1841·4	73 17·7
6	V.	43 12·1	77 38·6	1843·6	74 52·9
8	VI.	41 41·6	74 24·8	1842·9	73 47·8
	Mean,	41 23·1	77 34·9	1841·85 (November)	73 17·8

(Number of observations = 48.)

By comparing the differences in latitude and corresponding differences in dip, for each place, with the mean values of the group, their general accordance was ascertained. None of the differences was large enough to require an exclusion from the series. It need hardly be remarked, that a slight consideration shows that the dip depends almost exclusively upon the latitude, and the longitude factors will, therefore, necessarily be very small.

Method of discussion.—The interpolation formula, proposed by the Rev. H. Lloyd in 1838 (see the *8th Report of the British Association*, vii, 91), will be used here in a slightly altered form, to allow for the convergence of the meridians.

Let I = resulting dip or inclination.

I_0 = assumed dip for the epoch adopted (1842·0) and the mean latitude and longitude, i its correction.

dL = difference of latitude, d M = difference of longitude.

x, y, z, p, q, as well as i, are to be determined by application of the method of least squares, from the observations themselves.

$$I = I_0 + i + x\,dL + y\,dM \cos L + z\,dL\,dM \cos L + p\,dL^2 + q\,dM^2 \cos^2 L.$$

Correction to epoch.—The mean epoch of the six groups is November 1841, for which we can substitute without material loss of accuracy January 1842 (or 1842·0). Comparing the observations made by Assistant Chas. A. Schott in July and August 1862, with the corresponding observations about the epoch 1842, we have the following table of differences of results for an interval of nearly 20 years:

Locality.	Date.	Dip.	Date.	Dip.	Av. Annual Increase.
		° ′		° ′	′
Washington,	Sept. 1841	71 15·9	Aug. 1862	71 19·0	+0·15
Harrisburg,	July 1840	72 20 5	July "	72 31·6	+0 50
Near Brownsville,	Aug. "	71 53·5	" "	71 56·9	+0·15
Erie,	" 1841	73 46·6	Aug. "	73 52·2	+0·27
Bath,	" "	74 27·5	" "	74 26·2	−0·06
Williamsport,	July "	72 54·4	" "	72 51·0	−0·16
Philadelphia,	Feb. 1842	71 57·1	" "	72 05 8	+0·43
				Mean,	+0·18

Mean total change in 21 years $= 3'{\cdot}8$.

The increase in the dip is, therefore, very slight, and if we consider that, according to Mr. Schott's investigation (*Appendix, No.* 32, *Coast Survey for* 1856), the dip near the Atlantic coast about the years 1841–1844 was at its minimum value and hence could not have changed sensibly for several years—we can, without sacrificing anything in the accuracy of our reduction, use our results as if all belonging to the mean epoch 1842·0. No reduction to epoch has therefore been applied. It is probable that the present annual increase amounts to about 1′. At Toronto, between 1844 and 1855 (see *Toronto Observations,* vol. iii), the annual increase was $0'{\cdot}8$. In the formula of interpolation, I retain the factor cos L, thus making it comparable with similar expressions for other localities where the introduction of cos L may be more important.

The value of the magnetic survey of Pennsylvania is increased from the fact that the isoclinal lines are presented for an epoch at which the dip was probably near its minimum value.

The conditional equations are of the form

$$O = I_0 - I + i + x dL + y dM \cos L + z dL dM \cos L + p dL^2 + q dM^2 \cos^2 L.$$

Next, nine groups of five or six observations in each, were formed, arranged in regard to the geographical position and area with as much regularity as the nature of the case admits of.

Recapitulation of mean values of groups.

Group.	Latitude.	Longitude.	Dip.
I.	40°·40	75°·02	72°·47
II.	39·56	76·85	71·73
III.	40·22	80·06	72·20
IV.	41·56	80·32	73·20
V.	40·65	78·02	72·54
VI.	42·75	78·93	74·56
VII.	41·53	76·07	73·50
VIII.	42·96	76·95	74·74
IX.	42·26	74·33	74·31
Mean,	41·32	77·39	73·25

The trial of an equation of the form,

$$I = I_0 + i + x dL + y dM \cos L + z dL dM \cos L;$$

and of the form,

$$I = I_0 + i + x dL + y dM \cos L + q dM^2 \cos^2 L,$$

showed that the extent of the survey is not sufficiently great to admit of the determination of curvature of the isoclinal lines, and finally the following expression was adopted:

$$I = 73^\circ{\cdot}25 + 0{\cdot}912\, dL - 0{\cdot}069\, dM \cos L.$$

This equation represents the observations as follows:

Group.	Observed Dip.	Computed Dip.	Diff. observed − computed.
	°	°	°
I.	72·47	72·54	−0·07
II.	71·73	71·68	+0·05
III.	72·20	72·11	+0·09
IV.	73·20	73·31	−0·11
V.	72·54	72·61	−0·07
VI.	74·56	74·47	+0·09
VII.	73·50	73·51	−0·01
VIII.	74·74	74·76	−0·02
IX.	74·31	74·26	+0·05

The isoclinal lines of 71°, 72° 73°, 74° and 75° pass through the following positions:

71°,	Long.	77° 00′		
	Lat.	38 49		
72°,	Long.	75 00	78° 00′	81° 00′
	Lat.	39 49	39 59	40 10
73°,	Long.	74 00	78 00	81 00
	Lat.	40 50	41 05	41 15
74°,	Long.	74 00	78 00	81 00
	Lat.	41 57	42 11	42 22
75°,	Long.	75 00	77 00	79 00
	Lat.	43 07	43 13	43 20

These lines have been finally adopted.

Comparison of the observed and computed dip.

	Observed Dip.	Computed Dip.	Diff. observed − computed.
Group I.	°	°	°
New York,	72·66	72·93	−0·27
Easton,*[8]	72·65	72·80	−0·15
Princeton,*	72·64	72·51	+0·13
Doylestown,*	72·39	72·44	−0·05
Reading,*	72·54	72·42	+0·12
Philadelphia,	71·95	72·14	−0·19
Group II.			
Frenchtown,*	71·67	71·75	−0·08
Baltimore,	71·57	71·45	+0·12
Washington,	71·26	71·06	+0·20
Harrisburg,	72·34	72·32	+0·02
Near Mercersburg,	71 79	71·88	−0·09
Group III.			
Frostburgh,*	71·52	71·67	−0·15
Near Brownsville,	71·89	71·91	−0·02
Wheeling,*	72·15	71·99	+0·16
Steubenville,*	72·56	72·26	+0·30
Near Pittsburg,	72·53	72·24	+0·29
Economy,*	72·58	74·46	+0·12

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[8] All stations where the dip has been found indirectly only, by means of the Lloyd needles, are marked with an asterisk,—27 in number. Total number of stations 48.

Table continued.

	Observed Dip.	Computed Dip.	Diff. observed − computed.
Group IV.			
Berlin Tavern,*	72°·88	73°·09	−0°·21
Mercer,	72·95	73·02	−0·07
Warren,*	73·00	73·03	−0·03
Ashtabula,*	73·39	73·60	−0·21
Erie,	73·78	73·85	−0·07
Group V.			
Duncan's Island,*	72·58	72·45	+0·13
Lewistown,*	72·50	72·57	−0·07
Huntingdon,	72·30	72·48	−0·18
Armagh,*	72·31	72·40	−0·09
Bellefonte,*	72·70	72·86	−0·16
Curwinsville,	72·83	72·86	−0·03
Group VI.			
Belvidere,*	74·16	74·03	+0·13
Ellicottsville,	74·30	74·05	+0·25
Dunkirk,*	74·29	74·21	+0·08
Niagara Falls,*	74·85	74·76	+0·09
Toronto,	75·19	75·28	−0·09
Group VII.			
Bushkill,*	73·52	73·19	+0·33
Williamsport,	72·91	73·19	−0·28
Wilkesbarre,*	73·17	73·24	−0·07
Silver Lake,	73·69	73·88	−0·19
Owego,*	74·23	74·05	+0·18
Group VIII.			
Bath,	74·46	74·19	+0·27
Rochester,*	74·72	74·87	−0·15
Geneva,	74·55	74·69	−0·14
Syracuse,	74·85	74·89	−0·04
Oswego,*	75·12	75·21	−0·09
Group IX.			
West Point,*	73·20	73·49	−0·29
Milford,	73·79	73·38	+0·41[7]
Utica,*	74·84	74·96	−0·12
Schenectady,	74·91	74·77	+0·14
Troy,*	74·80	74·72	+0·08

The probable error of any single observation is ±0°·12=±7′·2; the probable error of any observation with the regular dip needles and the Lloyd needles combined is ±0°·13; with the latter needles alone, ±0°·11. This shows that the irregularities in the observed dip are due to local attractions rather than to imperfections in the needles employed. It is proper therefore to assign equal weights to results by the direct and indirect method of observing.

If we apply Peirce's criterion for the rejection of observations differing too much from the regular value indicated by all other observations, we find the limit of rejection to be ±0°·46 or ±28′; the maximum difference in the preceding table is 25′, hence no observation is excluded.

[7] **Maximum difference = 25′.**

Gen. Sabine's resulting isoclinal lines in his seventh contribution to terrestrial magnetism (*Phil. Trans. Roy. Soc.*, Part III, 1846, p. 237) refer to an average period between 1840 and 1842, and correspond in their position very closely to those now presented;—they are deduced from independent data.

Distribution of the Magnetic Horizontal Intensity, and construction of isodynamic lines for 1842.

If we group the observed intensities in the same manner as the dip, the mean epoch 1842·0 may likewise be assumed, and all observed intensities be reduced to that date.

Correction to epoch.—We have the following direct comparisons with Mr. Schott's observation of 1862.

Locality.	Date.	X.	Date.	X_1.	$X-X_1$.	Annual decrease.
Washington,[8]	Jan. 1843	4·320	Aug. 1862	4·255	0·065	0·0033
Harrisburg,	July 1840	4·078	July "	4·012	0·066	0·0030
Near Brownsville,	Aug. "	4·207	" "	4·138	0·069	0·0031
Erie,	" 1841	3·792	Aug. "	3·728	0·064	0·0030
Bath.	" 1841	3·677	" "	3·639	0·038	0·0018
Williamsport,	July 1841	3·983	" "	3·924	0·059	0·0028
Philadelphia,[9]	Jan. 1842	4·166	" "	4·088	0·078	0·0039
					Mean,	0·0030

The average annual decrease in the value of X, between 1840 and 1862, is, therefore, 0·0030, or when expressed in parts of X, equal to 0·00076. This result agrees tolerably well with that deduced by Mr. Schott in the *Coast Survey Report* of 1861, where 0·00110 was found.

Supposing the dip to increase at the rate of 1′ a year, and the total intensity to remain constant, the corresponding decrease of the horizontal intensity would amount to nearly the quantity found above, and we can not, therefore, as yet decide whether the total intensity remains stationary or is slightly changing. At Toronto (see *Toronto Observations*, vol. iii), the annual decrease of X between 1845 and 1852 inclusive was 0·0037 (in absolute measure), or 0·00105 when expressed in parts of X.

Formation of groups for the analytical expression of the distribution of the magnetic horizontal force, referred to the epoch 1842·0.

At stations marked thus *, the horizontal force was determined by vibrations; at those not marked, by Lloyd's statical method.

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[8] From *Coast Survey Report* of 1861 (yet in manuscript),
in 1842·5, Capt. Lefroy, X=4·347
" 1843·5, Dr. Locke, =4·292 (mean of three results).
Mean in 1843·0, =4·320

[9] In July and November, 1840, X=4·160
" " " " 1841, 4·166
" July, 1843, 4·172
Mean, 4·166, for 1842·0

	Date.	X.	Correction to epoch.	$X_{1842\cdot0}$
Group I.				
Philadelphia,*	1842·0	4·166	0·000	4·166
Doylestown,	1841·6	4·189	−0·001	4·188
Easton,	1841·6	4·121	−0·001	4·120
Reading,	1840·6	4·000	−0·004	3·996
Frenchtown,	1840·6	4·312	−0·004	4·308
Baltimore,*	1840·6	4·265	−0·004	4·261
Washington,	1843·0	4·320	+0·003	4·323
Harrisburg,	1840·6	4·078	−0·004	4·074
Duncan's Island,	1840·6	3·963	−0·004	3·959
Near Mercersburg,*	1840·6	4·188	−0·004	4·184
			Mean,	4·158
Group II.				
Armagh,	1840·6	4·038	−0·004	4·034
Frostburg,	1840·6	4·298	−0·004	4·294
Near Brownsville,*	1840·6	4·207	−0·004	4·203
Near Pittsburg,*	1840·6	4·049	−0·004	4·045
Economy,	1840·6	4·008	−0·004	4·004
Wheeling,	1840·6	4·053	−0·004	4·049
Steubenville,	1840.6	3·947	−0·004	3·943
			Mean,	4·082
Group III.				
Warren,	1841·6	3·978	−0·001	3·977
Mercer,*	1841·6	4·000	−0·001	3·999
Ashtabula,	1841·6	3·838	−0·001	3·837
Erie,*	1841·6	3·792	−0·001	3·791
Dunkirk,	1841·6	3·621	−0·001	3·620
Ellicottsville,*	1841·6	3·726	−0·001	3·725
Berlin's Tavern,	1841·6	4·026	−0·001	4·025
			Mean,	3·853
Group IV.				
Curwinsville,*	1841·6	3·999	−0·001	3·998
Belvidere,	1841·6	3·669	−0·001	3·668
Bath,*	1841·6	3·677	−0·001	3·676
Owego,	1841·6	3·614	−0·001	3·613
Silver Lake,*	1841·7	3·782	−0·001	3·781
Wilkesbarre,	1841·6	3·961	−0·001	3·960
Williamsport,*	1841·6	3·983	−0·001	3·982
Bellefonte,	1841·6	4·069	−0·001	4·068
Lewistown,	1840·6	3·984	−0·004	3·980
Huntingdon,*	1840·6	4·109	−0·004	4·105
			Mean,	3·883
Group V.				
Niagara Falls,*	1843·6	3·565	+0·005	3·570
Toronto Ob.,*	1843·6	3·537	+0·005	3·542
Rochester,	1843·6	3·560	+0·005	3·565
Geneva,*	1843·7	3·635	+0·005	3·640
Syracuse,*	1843·6	3·556	+0·005	3·561
Oswego,	1843·6	3·467	+0·005	3·472
			Mean,	3·558

Table continued.

	Date.	X.	Correction to epoch.	$X_{1842\cdot0}$
Group VI.				
Utica,	1843·6	3·541	+0·005	3·546
Schenectady,*	1843·6	3 502	+0·005	3·507
Troy,	1843·6	3·575	+0·005	3·580
West Point,	1843·6	4·033	+0·005	4·038
New York,[10]	1841·9	4·014	0·000	4·014
Milford,*	1841 7	3·769	−0·001	3·768
Bushkill,	1841·7	3·866	−0·001	3·865
Princeton,	1843·5	4·222	+0·005	4·227
			Mean,	3·818

Recapitulation.

Group.	No.	Latitude.	Longitude.	$X_{1842\cdot0.}$
I.	10	39° 57′·1	76° 16′·8	4·158
II.	7	40 15·4	79 54·9	4·082
III.	7	41 48·0	79 57·4	3·853
IV.	10	41 24·5	77 16·9	3·883
V.	6	43 12·1	77 38·6	3·558
VI.	8	41 41·6	74 24·8	3·818
	Mean,	41 23·1	77 34·9	3·892

Let $X=$ resulting horizontal force.

$X_0=$ assumed mean horizontal force for 1842·0 at the mean latitude and mean longitude, χ its correction.

$dL=$ difference of latitude, $dM=$ difference of longitude.

x, y, z, p, q and χ to be determined from the observations.

$$X=X_0+\chi+x dL+y dM \cos L+z dL dM \cos L+p dL^2+q dM^2 \cos^2 L.$$

Forming the conditional and normal equations, we find the expression

$$X=3{\cdot}890-0{\cdot}1787\, dL+0{\cdot}0085\, dM \cos L+0{\cdot}0161\, dL dM \cos L-0{\cdot}0017\, dL^2+0{\cdot}0027\, dM^2 \cos^2 L.$$

where

$$dL=\text{lat.}\ -41^\circ{\cdot}38$$
$$dM=\text{long.}-77\ {\cdot}58.$$

This formula is applied for determining the relative weights of the observations from vibrations and by deflections of the dipping needle; for this purpose, the horizontal force was computed by the formula, and the results compared with observation. From the differences, we find the probable error of an observation (and local irregularity) $=\pm0{\cdot}036$ for the bar and cylinder vibrations, and $\pm0{\cdot}062$ for the Lloyd needle deflections and dip; the relative weights therefore become 754 for the former and 257 for the latter, or nearly as 3 to 1.

These weights have been adopted.

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[10] At New York we have: 1841·5, Dr. Locke, 4·015; 1842·7, Dr. Locke, 4·008; 1842·7, Capt. Lefroy, 4·010; mean, 4·014, for 1841·9.

Nine groups of five or six observations in each, with weights, were then formed.

Recapitulation of mean (weighted) values of groups.

Group.	Latitude.	Longitude.	X.
I.	40°·39	74°·83	4·107
II.	39·68	77·01	4·199
III.	40·22	79·99	4·103
IV.	41·61	80·26	3·912
V.	40·68	78·14	4·035
VI.	42·89	79·00	3·618
VII.	41·56	76·27	3·858
VIII.	42·85	77·17	3·606
IX.	42·17	74·37	3·665
Mean,	41·34	77·45	3·900

$$X = X_0 + \chi + x dL + y dM \cos L + x dL dM \cos L + p dL^2 + q dM^2 \cos^2 L.$$

$$dL = \text{lat.} \; - 41^\circ{\cdot}34$$

$$dM = \text{long.} - 77\;{\cdot}45.$$

Forming the conditional and normal equations we deduce:

$$X = 3{\cdot}920 - 0{\cdot}1936\, dL + 0{\cdot}0146\, dM \cos L + 0{\cdot}0203\, dL dM \cos L - 0{\cdot}01587\, dL^2 - 0{\cdot}0005\, dM^2 \cos^2 L.$$

It is, however, preferable to shorten the formula and use instead the following:

$$X = 3{\cdot}900 - 0{\cdot}1934\, dL + 0{\cdot}0134\, dM \cos L + 0{\cdot}02\, dL dM \cos L.$$

Comparison of observed and computed values.

Group.	X observed.	X computed.	Observed −computed.
I.	4·107	4·095	+0·012
II.	4·199	4·227	−0·028
III.	4·103	4·100	+0·003
IV.	3·912	3·887	+0·025
V.	4·035	4·028	+0·007
VI.	3·618	3·651	−0·033
VII.	3·858	3·842	+0·016
VIII.	3·606	3·599	+0·007
IX.	3·665	3·670	−0·005

The next and last hypothesis,

$$X = 3{\cdot}900 - 0{\cdot}1934\, dL + 0{\cdot}0134\, dM \cos L,$$

in which the isodynamic lines are treated as straight lines, presents perhaps the best and most simple expression of the *irregular* distribution of the horizontal force.

These lines are nearly parallel with the dip lines.

Comparison of observed and computed values on this hypothesis.

Group.	X observed.	X computed.	Observed −computed.
I.	4·107	4·057	+0·050
II.	4·199	4·216	−0·017
III.	4·103	4·143	−0·040
IV.	3·912	3·876	+0·036
V.	4·035	4·035	0·000
VI.	3·618	3·616	+0·002
VII.	3·858	3·846	+0·012
VIII.	3·606	3·605	+0·001
IX.	3·665	3·708	−0·043

The difference between the lines of this and the previous hypothesis shows the large amount of local irregularity.

The lines of this hypothesis pass through the following positions:

4·2	Long. 81°·0	Long. 77°·5	Long. 74°·0
	Lat. 39 58′	Lat. 39 47′	Lat. 39 36′
4·0	Long. 81°·0	Long. 77°·5	Long. 74°·0
	Lat. 41 01′	Lat. 40 49′	Lat. 40 39′
3·8	Long. 81°·0	Long. 77°·5	Long. 74°·0
	Lat. 42 02′	Lat. 41 51′	Lat. 41 41′
3·6	Long. 81°·0	Long. 77°·5	Long. 74°·0
	Lat. 43 04′	Lat. 42 53′	Lat. 42 43′

The observed and computed values of X by the previous and last hypothesis compare as follows:

Station.	X observed.	X by previous hypothesis.	Δ	X by last hypothesis.	Δ
Philadelphia,*	4·17	4·19	−0·02	4·14	+0·03
Doylestown,	4·19	4·11	+0·08	4·08	+0·11
Easton,	4·12	4·02	+0·10	4·00	+0·12
Reading,	4·00	4·10	−0·10	4·08	−0·08
Frenchtown,	4·31	4·27	+0·04	4·22	+0·09
Baltimore,*	4·26	4·32	−0·06	4·29	−0·03
Washington,	4·32	4·38	−0·06	4·37	−0·05
Harrisburg,*	4·07	4·11	−0·04	4·10	−0·03
Duncan's Island,	3·96	4·08	−0·12	4·07	−0·11
Near Mercersburg,*	4·18	4·21	−0·03	4·20	−0·02
Armagh,	4·03	4·06	−0·03	4·08	−0·05
Frostburgh,	4·29	4·20	+0·09	4·24	+0·05
Near Brownsville,*	4·20	4·14	+0·06	4·19	+0·01
Near Pittsburg,*	4·05	4·06	−0·01	4·09	−0·04
Economy,	4·00	4·04	−0·04	4·07	−0·07
Wheeling,	4·05	4·11	−0·06	4·17	−0·12
Steubenville,	3·94	4·07	−0·13	4·11	−0·17
Warren,	3·98	3·94	+0·04	3·95	+0·03
Mercer,*	4·00	3·94	+0·06	3·95	+0·05
Ashtabula,	3·84	3·80	+0·04	3·83	+0·01
Erie,*	3·79	3·81	−0·02	3·77	+0·02
Dunkirk,	3·62	3·70	−0·08	3·70	−0·08
Ellicottsville,*	3·72	3·75	−0·03	3·73	−0·01
Berlin's Tavern,	4·02	3·93	+0·09	3·94	+0·08
Curwinsville,*	4·00	3·98	+0·02	3·99	+0·01
Belvidere,	3·67	3·75	−0·08	3·74	−0·07
Bath,*	3·68	3·70	−0·02	3·70	−0·02
Owego,	3·61	3·73	−0·12	3·74	−0·13
Silver Lake,*	3·78	3·76	+0·02	3·77	+0·01
Wilkesbarre,	3·96	3·93	+0·03	3·91	+0·05
Williamsport,*	3·98	3·92	+0·06	3·92	+0·06
Bellefonte,	4·07	3·99	+0·08	3·99	+0·08
Lewistown,	3·98	4·05	−0·07	4·05	−0·07
Huntingdon,*	4·10	4·06	+0·04	4·07	+0·03
Niagara Falls,*	3·57	3·62	−0·05	3·58	−0·01
Toronto,*	3·54	3·53	+0·01	3·47	+0·07
Rochester,	3·56	3·57	−0·01	3·56	0·00
Geneva,*	3·64	3·59	+0·05	3·60	+0·04
Syracuse,*	3·56	3·53	+0·03	3·56	0·00
Oswego,	3·47	3·46	+0·01	3·49	−0·02

Table continued.

Stations.	X observed.	X by previous hypothesis.	Δ	X by last hypothesis.	Δ
Utica,	3·55	3·49	+0·06	3·54	+0·01
Schenectady,*	3·51	3·51	0·00	3·58	−0·07
Troy,	3·58	3·52	−0·06	3·59	−0·01
West Point,	4·04	3·85	+0·19	3·86	+0·18
New York,*	4·01	4·01	0·00	3·97	+0·04
Milford,*	3·77	3·88	−0·11	3·88	−0·11
Bushkill,	3·86	3·92	−0·06	3·92	−0·06
Princeton,	4·23	4·07	+0·16	4·06	+0·17

For the last hypothesis (straight lines), we find the probable error of an observation and local irregularity from the bar and cylinder vibrations ±0·029, and from the Lloyd needle deflection and dip ±0·062. For the previous hypothesis, these quantities are respectively ±0·030 and ±0·059, showing but little gain in the representation of the observations by the additional term $dLdM \cos L$.

For the general representation, the probable errors are ±0·050 and ±0·051.

Representation of the total force.

From the expressions

$$X = 3{\cdot}900 - 0{\cdot}1934\, dL + 0{\cdot}0134\, dM \cos L,$$

$$I = 73^\circ{\cdot}25 + 0{\cdot}912\, dL - 0{\cdot}0690\, dM \cos L,$$

we have to deduce the total force $\varphi = X \sec I$.

In the expression for X,

$$dL = \text{lat.} - 41^\circ{\cdot}34 \text{ and } dM = \text{long.} - 77^\circ{\cdot}45,$$

in the expression for I,

$$dL = \text{lat.} - 41^\circ{\cdot}32 \text{ and } dM = \text{long.} - 77^\circ{\cdot}39.$$

We have in

$$\left.\begin{array}{ll}\text{Long. } 81^\circ{\cdot}00 & X = 4{\cdot}200 \\ \text{Lat. } 39\ {\cdot}97 & I = 71^\circ{\cdot}828\end{array}\right\}\ \varphi = 13{\cdot}47$$

$$\left.\begin{array}{ll}\text{Long. } 77^\circ{\cdot}50 & X = 3{\cdot}600 \\ \text{Lat. } 42\ {\cdot}89 & I = 74^\circ{\cdot}676\end{array}\right\}\ \varphi = 13{\cdot}62$$

$$\left.\begin{array}{ll}\text{Long. } 74^\circ{\cdot}00 & X = 4{\cdot}200 \\ \text{Lat. } 39\ {\cdot}60 & I = 71^\circ{\cdot}861\end{array}\right\}\ \varphi = 13{\cdot}49.$$

Assuming in the expression for the total force,

$$\varphi = \varphi_0 + f + x\,dL + y\,dM \cos L,$$

dL and dM as in the expression for X, we find:

$$\varphi = 13{\cdot}55 + 0{\cdot}0451\, dL - 0{\cdot}00682\, dM \cos L.$$

The lines of equal total force of 13·45, 13·5, 13·55 and 13·6 pass through the following positions:

13·45	Long. 81° Lat. 39 31′	Long. 77°·5 Lat. 39 07′	
13·50	Long. 81° Lat. 40 37′	Long. 77°·5 Lat. 40 13′	Long. 74° Lat. 39 49′
13·55	Long. 81° Lat. 41 43′	Long. 77°·5 Lat. 41 19′	Long. 74° Lat. 40 55′
13·60	Long. 81° Lat. 42 49′	Long. 77°·5 Lat. 42 25′	Long. 74° Lat. 42 01′

The observed and computed values of φ, at the stations where the bar and cylinder were employed, compare as follows:

Station.	φ observed.	φ computed.	Observed − computed.
Philadelphia,	13·45	13·50	−0·05
Harrisburg,	13·44	13·50	−0·06
Huntingdon,	13·51	13·51	0·00
Homewood,	13·49	13·50	−0·01
Johnson's Tavern,	13·54	13·48	+0·06
Irwin's Mill,	13·40	13·48	−0·08
Baltimore,	13·49	13·46	+0·03
Williamsport,	13·55	13·55	0·00
Curwinsville,	13·55	13·53	+0·02
Mercer,	13·64	13·53	+0·11
Erie,	13·57	13·57	0·00
Ellicottsville,	13·77	13·59	+0·18
Bath,	13·72	13·60	+0·12
Silver Lake,	13·47	13·58	−0·11
Milford,	13·50	13·56	−0·06
Schenectady,	13·45	13·63	−0·18
Syracuse,	13·61	13·63	−0·02
Geneva,	13·63	13·62	+0·01
Niagara Falls,	13·64	13·62	+0·02
Toronto,	13·84	13·65	+0·19

The probable error of any representation is ±0·066.

Art. XXXVIII.—*On some questions concerning the Coal Formations of North America;* by Leo Lesquereux. (Continued from vol. xxxiii, p. 216.

Concluding Remarks on the Fossil Ferns.

The examination of the fossil ferns of the coal, as far as it has passed under review in the former papers,[1] would apparently authorize the three following conclusions.

1st. That the family of the Ferns was represented, at the coal epoch, by species whose forms are easily referred to very few typical forms. For, if we consider only the figure of the leaves, viz., their contour and nervation, the only part generally preserved in the shales of the Coal Measures, all the species may

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[1] Vol. xxxii, p. 193, Sept., 1861, and vol. xxxiii, p. 206, March, 1862.

be comprised in the three sections formerly examined: the *Neuropterideæ*, the *Pecopterideæ* and the *Sphenopterideæ*.

2d. That, from the scarcity of fructified specimens of fossil ferns in the Coal Measures, it would be supposed that most of the species were without fruit. If not, how can we account for the total destruction of the sporanges, either borne on peculiar stems, or attached to the lower surface of the leaves, as we find them in the species of our time?

3d. That the scarcity of large stems that have been or might be referred to ferns would lead us to suppose that, during the formation of the coal, the fern trees were of rare occurrence, at least when compared with the great number of ferns, which, in opposition to arborescent species, can be called herbaceous or shrubby.

These three questions must be considered separately.

1st. If it is certain that characters taken from the form of the leaves and from their nervation are sufficient for a kind of general classification, applicable to the stratification of the Coal Measures, it is true also that this classification fails to give us a clear insight into the true relation and the affinity of our fossil species. To be exact and scientific, an analysis of the ferns must take into account the form and the position of the fructifications; and when these are absent or undiscernable, as is generally the case with the specimens found in the Coal Measures, we are not authorized to believe that all the species, referable by their nervation and the form of the leaves to a common type, are equally related to it, by more essential but unknown characters. Indeed, though the attempt at a classification of the fossil ferns of the coal, from their fructifications, has been till now an abortive effort, the little we know of these fructifications shows a far greater diversity of typical and generic forms than are indicated by the leaves and their nervation. The fruiting leaves of the *Neuropterideæ* are known, from European specimens, only for the genus *Odontopteris*, which, as Mr. Brongniart has remarked, do not bear any relation to ferns of our time. Species of this genus have their spores enclosed in a kind of bladdery sporange, or between the surfaces of the leaflets, which, thus inflated, wrinkled and without any trace of nerves, entirely lose their original shape. American specimens of this species perfectly agree with the beautiful figures that Mr. Gœppert has given of it in his *Genera*. The peculiar shape of the fructifications of this genus is still more remarkable on the fruiting specimens of *Odontopteris Britannica* Gutb., a species which has not yet been found in our American Coal Measures. Its sporanges, placed along a strong rachis and on both sides of it, have the form of an oval-pointed nutlet and rather resemble a raceme of fruit, or rather a branch bearing buds of flowers, of a dicotyledonous species. Fine specimens of these supposed *Antholites* have been published by Lindley and Hutton, from the Coal Measures of England, and by Dr. Newberry, from our own coal fields. I have found also some small specimens of these peculiar remains at Pomeroy, Ohio, and at Port Carbon, Penn. All these, either naked or bracteated nutlets, appear to be only branches of fruiting stems of some ferns of an unknown type.

The fructifications of the genus *Neuropteris*, which, by the form of the leaves and the nervation, is closely allied to *Odontopteris*, appear to have a far different character. These fructifications, I think, are not known from European specimens; but we have a few from the American Coal Measures, which can be reliably considered as the remains of fruiting parts of some species of this genus. Two of them represent reduced forms of the upper part of a penna of *Neuropteris hirsuta* Lsqx. The leaflets are longer and narrower; the rachis and the medial nerve are flat and broad, and look rather like the branches and divisions of a panicle bearing sporanges. The veins are prominent, granulate, just as if a series of small fruit dots connected together had been placed either along them, or in the narrow space that separates them. If this appearance is real, these fructifications would bear a likeness of position to those of the *Danaeæ* of our time. But not of direction, indeed; for, in this species of our Coal Measures, the nervules are arched and dichotomous or forking like those of a true *Neuropteris*. Another remarkable specimen, preserved in a pebble of carbonate of iron, from Morris Co., Illinois, represents also a branch of a species of fructified *Neuropteris*. In this, the short, ovate, slightly pointed leaflets, about one inch long, and deeply cordate at the base, are attached to the rachis by a short pedicel. They are slightly convex or inflated in the middle, with a narrow margin apparently reflexed, but at the same time flattened all around. The scarcely visible veins are distant and apparently forked once, or the surface, generally quite smooth, is marked by irregular undulate cross-wrinkles, somewhat resembling those of the fructifications of an *Odontopteris*. In this case, the spores appear to be placed in large flakes, covering, except a narrow border, the whole of the lower surface of the leaves, as is the case with the fruit-bearing leaves of some species of *Osmunda* of our time. Thus, in the same genus, there are apparently two far different types of fructifications.

A peculiar specimen of fruiting fern, belonging to the Cabinet of Amherst College, and labelled, Mansfield,? Mass., shows a pinnately divided frond or rather panicle, whose secondary rachis is pinnately subdivided into short branches, bearing numerous groups of fruit dots, placed four by four on each side of a common branchlet. They appear attached to it, each by a very slender pedicel; and, round as they are, with a depressed point in the middle, they look, at first sight, like the fruit dots placed on both sides of the medial nerve of a *Pecopteris*, whose derma or foliaceous tissue has been entirely destroyed. As no trace of this tissue can be seen, as the pedicels do not resemble veins, but are curved in a peculiar way, and as the fruit dots are at some places scattered and not in regular order, this fossil raceme is more likely the fruit-bearing part of a species whose sterile frond is possibly known with other characters. If it is so, this species would have a relation to the genus *Aneimia* of the living ferns, and thus, it could not enter into any of the three general divisions mentioned above.

The same can be said of *Staphylopteris stellata* Lsqx., of the low coal of Arkansas.[2] The figured specimen represents a smooth, main stem or branch, pinnately divided into short, thick, horizontal branchlets, each bearing at its extremity a group of four or five oval sporanges, attached to a common receptacle. This species has no affinity whatever with any other fossil remains of ferns, found in the Coal Measures, and thus it is without a place in our general classification.

From a number of fruiting branches of still undescribed fossil ferns, I will only briefly describe another remarkable species recently found at Mason Creek, Morris Co., Ill., by Mr. Even, who has sent, from the same locality, many interesting specimens, beautifully preserved in pebbles of carbonate of iron.[3] The specimen shows the upper part of a pinnately divided frond. The divisions are short, (one inch) and comparatively broad, (one-sixth of an inch) linear, obtuse, spreading, decurring in preserving the same breadth on a slender rachis, which, thus broadly winged, looks rather like the primary nerve of a secondary pinna. The veins, emerging in a broad angle from this common rachis, are straight, pretty thick, ascending to the top of the divisions and pinnately branching. The distant simple veinlets, no more than three or four on each side, slightly arched, diverging in a broad angle, bear at their extremity a group of six oval sporanges, placed just on the borders of the divisions. These sporanges, united by their margins around a common receptacle, appear, by this disposition, like small stars with round lobes. Considering only the form of the leaves, this species should be

[2] Geological Report of the State Survey of Arkansas, ii, 309, pl. 2 fig. 2.

[3] A deposit of the same nature, a bank of clay iron ore with pebbles of carbonate of iron, is also found in Southern Ohio, northwest of Marietta. Nearly all the pebbles have as a matrix a piece of fern or of some other fossil plant. As the species are the same both in Illinois and in Ohio, I consider both these strata, from palæontological evidence, as having the same geological horizon. Their place, according to the same evidence, is at or near the level of Coal No. 4, just below the base of the Mahoning sandstone. The most abundant species are *Pecopteris unita* Brgt., *Neuropteris hirsuta* Lsqx., *Pecopteris arborescens* Brgt., *Pecopteris Miltoni* Brgt., *Hymenophyllites hirsuta* Lsqx., *Alethopteris Serlii* Brgt., *Asterophyllites*, *Sphenophyllum*, *Annularia* and *Neuropteris Loschii* Brgt.

placed in the genus *Alethopteris*. But it differs widely from it by its nervation and especially by its fructifications. These would bring this species near the genus *Asterocarpus* of Gœppert, or the *Heptocarpus* of Braun, to which it has no affinity whatever by the leaves and the nervation. From examples like this, which, though few in number, are nevertheless every day multiplied by new discoveries, we can admit, I think, for the coal epoch, a far greater diversity of typical forms than could be supposed at first sight and from superficial researches.

2. What is said above is already an answer to the second question concerning the scarcity of fruiting specimens of ferns in the Coal Measures. This scarcity, like the paucity of typical forms in the fossil ferns, is rather casual than real. By careful researches at some places, where the remains of a species are found in abundance, one may generally succeed in finding traces of fructifications. They are especially preserved on specimens found as matrix of iron agglomerations, which have not been exposed to maceration in water for too long a time. This of course confirms the validity of the conclusions arrived at by Prof. Lindley and Prof. Gœppert from their experiments on the action of the maceration in destroying or preserving the forms of some species of plants. Most of the species of ferns of our time, under a protracted and continual immersion, have preserved well enough the forms of their leaves with evident traces of their nervation; but they have lost their fructifications. The sporanges have been detached from their supports and destroyed.

It is moreover known that, nearly always, the fern leaves are attached to the shales by their lower surface. Thus, even when the fructifications are preserved, we cannot see them, or we have only an indistinct outline of their form, printed in relievo through the carbonized tissue of the leaves. This of course renders the study of the fossil fruiting ferns very difficult.

3. Is the small proportion of fossil remains of true arborescent ferns in the Coal Measures, compared with the great quantity of leaves and stalks or petioles of the same family, a proof that, contrary to the opinion generally admitted, the arborescent ferns were not a predominant character of the vegetation of the coal epoch? If we consider as remains of true arborescent ferns, only those whose bark is marked by large oval cicatrices, left at the base of the fronds, at the point of their parting from the main stem, in short those known under the family name of *Caulopterideæ* or *Protopterideæ*, it is certain that they are very scarce in the Coal Measures both of Europe and of America. In his *Genera*, Mr. Unger counts in the *Protopterideæ* of the coal ten species only, distributed in five genera. And from these species, five are considered by Brongniart, Lindley and other authors as pertaining to *Sigillaria* or *Lepidodendron*. In his

Tableau des genres, Brongniart enumerates only six species of *Caulopterideæ;* Geinitz in his *Wersteinerungen von Sachsen,* four species, three published by Brongniart as *Sigillaria,* and one, a *Megaphytum,* by Artes; and Gœppert, in his *Fossil Flora des Uebergangsgebirges,* has none. In my examination of the fossil plants of our Coal Measures, I have seen, from the roof shales of the coal, only three specimens of two different species found at Carbondale,[4] and one found in Illinois.[5] And from the sandstone of the Coal Measures, I have in my cabinet a single specimen from Ohio, and there is another of a different species in the Illinois State Cabinet.[6] A few others, like *Sigillaria Cistii* Brgt., from Wilkesbarre, Penn., *Sigillaria discoidea* Lsqx., from Summit Lehigh, Penn., *Megaphytum protuberans* Lsqx., *Megaphytum Wilburianum* Lsqx., and *Lepidodendron radicans* Lsqx., from Illinois; these three last figured and described in the Geological Report of that State, may still be referable to this group of plants.

If, on the contrary, we admit with most of the European authors, that the fossil trunks, generally comprised in the genus *Psaronius,* did belong to arborescent ferns, we have to come to quite a different conclusion, concerning the distribution of the vegetation of the ferns at the coal epoch; for these trunks are found in great abundance in some parts of the Coal Measures. But Prof. Brongniart, judging from their internal structure, considers *Psaronius* as a genus related to the *Lepidodendra* rather than to the *Protopteridæ* or ferns. As the *Psaronius* species have their stems generally encased in a thick coat of roots or rootlets, grown and petrified together, the surface of the stems and the cicatrices with which they were originally covered are scarcely to be seen. Nevertheless, among the great quantity of specimens which I have examined in Southern Ohio, I have found a few, the smallest in size, whose uncovered stems evidently bear the long oval scars, the external character of the arborescent ferns.

Now, admitting the species of *Psaronius* as true arborescent ferns, the question of their distribution in the Coal Measures and of the place and importance which they occupied in the vegetation of the coal epoch is still unsolved. Where did they come from, all these trunks of the same genus; all with the same peculiar structure; all horizontally broken in fragments varying from one inch to one foot in length, and thus scattered at some peculiar and isolated localities, where they appear as if they had been heaped by some wonderful and unaccountable agency? I do not know in our Coal Measures of another deposit of petrified trunks of fern trees except that of Shade river, Ohio. It begins at Athens and extends southward as far as Charleston, Va. At least, I have seen trunks of *Psaronius* scattered along

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[4] Penn. Geol. Rept. p. 869, pl. 13, figs. 1 and 2.

[5] Ill. Geol. Rept. ined., pl. 13, fig. 1, under the name of *Caulopteris insignis.*

[6] *Caulopteris Worthenii,* sp. nov., Ill. Geol. Rept. ined., pl. 14, fig. 1.

the banks of the Great Kanawha from its mouth to Charleston. The geological horizon of the strata with which they are connected is not satisfactorily determined; though it is certain that their place is not far above the top of the Mahoning Sandstone. They are apparently imbedded in a kind of soft sandstone, which at Shade river is separated by a covered space of 10 feet from a bed of coal 10 inches thick, which I consider as the equivalent of Coal No. 5. I say apparently, because it is not certain that they were originally derived from this bed of soft sandstone or hard clay, exposed on the high water of Shade river, where they are seen in great quantity, heaped in all possible positions and directions, just as if they had been transported and deposited there by a strong eddy. Nevertheless, they do not bear any trace of erosion by water. The fracture is clean and often sharply marked all around their circumference. When they appear eroded, this erosion is evidently due to the process of maceration, at or before the time of petrification. As no remains of this genus are found in connection with the shales of the coal strata, I think that forests of these peculiar arborescent ferns did cover some dry, sandy places of the Coal Measures, in the vicinity of some hot springs perhaps, or under the influence of peculiar atmospheric action. There they may have lived around the marshes, and their prostrated stems have been petrified afterwards by a local influence. I believe that if we could satisfactorily explain the dispersion and the transformation into silex of the fossil woods of the Tertiary, whose specimens abound in some parts of Arkansas, Mississippi, &c., this explanation would apply as well to the silicified trunks of the Coal Measures. In any case, and though we know but little about the distribution of the vegetation at the coal epoch, we are authorized to conclude, from the former remarks, that the species of ferns predominant in the marshes of the coal were especially shrubby or herbaceous species of small size, while those of the sandy or dry solid ground were especially arborescent.

Before leaving the *Caulopterideæ* I have still a few words to say of the size of the cicatrices of their bark, compared with the diameter of their stems. These cicatrices, generally distant, placed on the stems in the spiral order two-fifths, are, when found in a good state of preservation, nearly oval or obovate and elongated at both ends, by a somewhat deep furrow. They bear in the middle the mark of a simple fascicle of vessels in the form of a horse-shoe, and the central scar is surrounded by an oval annulus. Of the two specimens formerly mentioned as having been found in the sandstone of our Coal Measures, and whose somewhat flattened stems have preserved their form as well as the cicatrices of the bark, the one, four inches in its greatest diameter, has the scars just one inch broad. In the second, three inches and a half in diameter, the scars are not quite one inch broad. Now the largest and most remarkable specimen of a *Caulopteris* that I have ever seen and a notice of which has ever been published (*Caulopteris insignis* Lsqx.), shows a piece of bark with a single but entire cicatrice of just three inches in diameter. Admitting that the proportion of the cicatrices to the stem is, in this species, the same as in the former ones, this must have belonged to a trunk of fern of less than one foot in diameter. This agrees well with the size of the trunks of *Psaronius* of Shade river, whose diameter is mostly between four and eight inches, rarely reaching one foot.

The genus *Megaphytum* Art., should, according to Prof. Brongniart's opinion, be united with the genus *Bothrodendron* or *Ulodendron* and referred to *Lepidodendron*, as representing merely a modification of this last genus. Our American specimens do not authorize this conclusion. *Megaphytum protuberans* Lsqx., of the State Cabinet of Illinois, has the cicatrices closely placed above each other, oval, convex, with their top somewhat squarely cut at the point of junction. They bear, near the upper end, the scars of fascicles of vessels, in the form of a horse-shoe; just like the *Caulopterideæ*, but without a marked annulus. These scars were evidently left at the base of large petioles or fronds, and are not cicatrices of leaves or of adventive buds as Mr. Brongniart supposes. It is even evident, from the forms of the cicatrices, which are a little flattened at their base and more elevated at the upper part, that the fronds which were originally attached to them were ascendent and closely appressed upon each other at their base. Moreover, this species has its surface deeply and irregularly striated and furrowed as if it had been covered by rootlets, just like the surface of a *Psaronius.* The cicatrices of *Megaphytum Wilburianum* Lsqx., still more nearly resemble those of a large *Caulopteris.* They are 4 inches broad, round, or square with rounded corners, flattened, with the scars of the vessels placed in the middle, and surrounded by an annulus. From this, it appears evident, that these remarkable stems did belong to a genus of the fern family, bearing two-ranked or distichous fronds. Prof. Geinitz has already admitted the genus *Megaphytum* as intermediate between the *Lycopodiaceæ* and the ferns.

Calamitariæ.

The species of this group of fossil plants have as common characters: the stems hollow, regularly striated, articulated, with articulations more or less distant, marked by a depressed or circular ring, or by an elevated margin, bearing whorls of leaves more or less united at their base. The five principal genera of fossil plants of the Coal Measures, which have been placed in this group, *Equisetites*, *Calamites*, *Asterophyllites*, *Sphenophyllum* and *Annularia*, have between themselves no evident and acknowledged relation. Considering the first two of these genera as belonging to the family of the *Equisetaceæ*, Mr. Brongniart has separated from it the last three, placing them with the dicotyledonous gymnospermous plants. The essential reason for this separation is, that species of *Asterophyllites* sometimes bear, in the axils of their leaves, small, flattened, oval, somewhat winged seeds, resembling those of the Yew, and, at the extremity of these branches, a kind of cone containing a pulverulent matter, which this great author considers as pollen. An inflorescence of this kind resembles that of the conifers. If we consider only the more evident characters, viz: the hollow, striated, articulated stems; the leaves more or less united at the base and placed like sheaths around the articulations, this separation appears inadmissible. It is for this reason that most of the European authors have put it aside. Nevertheless, it is evident, from good though small specimens found in our Coal Measures, that, at least, two species of *Asterophyllites* bear, in the axils of their leaves, those small oval or cordate-oval seeds, observed by Mr. Brongniart, and far different from the cones of the same genus which he considered as male flowers. It is certain also, that, from the examination of a great number of these cones, very common at some places in the shales, in connection with branches and large stems of *Asterophyllites equisetiformis* Ll., they contain nothing under their scales but a pulverulent matter, as Mr. Brongniart has seen it. Possibly the flattened seeds, in the axils of the leaves of *Asterophyllites*, could be considered as a kind of tubercles; but I really believe they are true seeds and that all the species of the genus *Cardiocarpum* are referable, if not to the genus *Asterophyllites*, at least to plants related to it. At some places where *Asterophyllites* are abundant, these seeds are seen sometimes in plenty, varying in form from round or oval to cordiform, generally bearing a narrow wing, emarginated at the top, and even broadly winged, as shown by the beautiful specimens figured and described by Dr. Newberry.[7] They vary much in size, being generally as small as a pea, but sometimes as large as a walnut. If then, as is evident, these fruits belong to *Asterophyllites*, or to plants related to this genus, it is not possible to refer them to *Equisetaceæ*, and so the opinion of Mr. Brongniart is confirmed. But now, the fruits of the genus *Calamites* are still entirely unknown. A single specimen, figured in Sternberg's *Flora*, vol. ii, pl. 14, fig. 1, under the name of *Volkmannia arborescens*, apparently coming from a stem of *Calamites*, has the form of a long ear or cone, bearing whorls of narrow, linear, obtuse, somewhat open leaves, resembling the cones of *Asterophyl-*

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[7] **Annals of Science, No. 13, (May 1, 1853), p. 152, No. 2.**

lites and, as I believe, of the species *Ast. lanceolata* Lsqx., of the *Pennsylvania Geological Report.* The only difference is in the form of the leaves. In our American specimens they are linear, *pointed*, never obtuse as Mr. Sternberg figures and describes them. In my specimens of *Asterophyllites lanceolata* the ears are always attached to a curved, half an inch thick, articulated and striated pedicel, having just the same form as a small branch of *Calamites approximatus* Art. The form of the pedicel, curved upwards, shows that these cones were attached to the side of a large stem and not placed at the top of some branches, and thus explains the reason and the form of large cicatrices, irregularly placed above the articulations of stems of some species of *Calamites.* But species of this same genus have also smaller, round cicatrices regularly placed around their articulations. Though, according to Prof. Geinitz, these scars are left as the point of attachment of some roots, they may nevertheless be only the marks left by fruits like those of *Asterophyllites.* Thus the relation of both genera, a relation so striking, if we consider the other appreciable characters, would be complete. But, even if this affinity of forms was perfectly ascertained, the question concerning the true relative place of these plants would not be settled. For the internal structure of the *Calamites*, as far as it is known, removes them evidently from the *Dicotyledonous* and establishes their relation with the *Equisetaceæ.* It is one of those numerous dilemmas offered for a solution, to the patience and long researches of the Palæontologist.

American specimens do not add much to what was already known of the different genera of this group. I have not seen in our Coal Measures a single trace of an *Equisetites.* I did not even suppose that species of this genus could be found in the Coal Measures. The beautiful specimens figured and described by Geinitz do not leave any doubt on this question.

There is near Carbondale a forest of standing *Calamites* imbedded in a bank of compact, coarse, hard sandstone. Numerous fragments of their stems have been taken out from a tunnel cut in this sandstone. These fragments show nothing but the external surface of the stems. Even the coaly matter which sometimes covers it has disappeared. The species are *Calamites Suckowii* Brgt., *Calamites ornatus* Brgt., which Mr. Geinitz considers as the same species; *Calamites Cistii* Brgt., and *Calamites approximatus* Art. The size of the stem varies from three to six inches, rarely attaining eight inches. A number of them appear to have been crushed upon themselves when still standing, for the bark, or rather the external surface, is often pushed and folded within the stem, all around the circumference. This, of course, proves that the stems of the *Calamites* were hollow cylinders, covered with a thin but strong bark. No remains at all of roots, of fruits, or of leaves, are found in this sandstone and in connection with the *Calamites.*

It is very difficult to establish the relation of the cones of *Asterophyllites* with the branches, to which they are rarely found attached, and thus to fix the true species. For this reason, I think it more convenient, though less scientific, to give different names to each of the parts of the plants, as long as they have not been found in evident connection. The roots and floating filaments, formerly known under the names of *Hydatica prostrata* Art., are now considered by Prof. Geinitz as the roots of *Asterophyllites foliosa* Lindl. They have been found attached to large stems apparently belonging to this species. The roof shales of the coal at Pomeroy, Ohio, are, in some places, covered with these radiculose filaments, and, though I have not seen them attached to the stem, the abundance of branches of *Asterophyllites foliosa*, found on the same shales, confirms the views of the celebrated German author. But Mr. Geinitz also refers the cones known as *Asterophyllites tuberculata* Ll. & H., to the same species, and these cones are not found at Pomeroy. Per contra, they abound on the shales of the red ash coal at W. W. Woods and at the Salem vein of Port Carbon, near Pottsville, where *Asterophyllites equisetiformis* is plentiful, and where I have not found *Asterophyllites foliosa* or *Hydatica*. At W. W. Woods, with numerous remains of *Calamites*, the three species of cones named *Asterophyllites tuberculata* Ll. & H., *Asterophyllites aperta* Lsqx., and *Asterophyllites lanceolata* Lsqx., are also in great quantity of fragments.

A beautiful species of *Sphenophyllum*, *S. bifurcatum* Lsqx., has been found in the coal inferior to the Millstone Grit of Arkansas. It may be the same species as the small specimen figured and described in the *Pennsylvania Report* as *Sphenophllum trifoliatum* Lsqx. Difficult as it is to fix the specific characters of a *Sphenophyllum*, this species, from the great number of specimens examined, may be considered as a true one. It shows that the leaves of this genus are united at the base by a narrow margin. This union exists for the leaves of *Asterophyllites* and of *Annularia;* and thus their whorls of leaves are more of the nature of sheaths, deeply cut in laciniæ of various forms, than of true leaves.

Since the time (1854) when I delivered my report on the fossil plants of Pennsylvania, I have seen nothing in our fossil plants to change my opinion concerning the fructifications of the genus *Annularia*. I supposed then, and still suppose, that these fructifications were borne on the top of the leaves, within the inflated and hollowed medial nerve, in a kind of funnel-like cavity, like the spores of some species of *Hymeno-*

phyllaceæ of our time. Prof. Geinitz, indeed, has published, in his magnificent work on the fossil plants of Saxony, as fructifications of *Annularia*, (pl. 18, figs. 8 and 9) a beautiful cylindrical long ear with an articulated and striated stem, bearing, at the articulations, whorls of short, linear, pointed leaves, and in their axils round sporanges or fruits. These fruits are undoubtedly of the same kind as those of the fragments described above, and, to my belief, belong to the genus *Asterophyllites*. Against my opinion, still is this fact: that nothing, among our recent ferns, would lead us to suppose that there ever lived species of ferns with whorled leaves. But we see, in the vegetation of the coal epoch, some peculiar features of a far more abnormal and unexplainable character. The question can be decided only by well preserved specimens. And though I have recently seen two specimens of *Annularia sphenophylloides* Ung., the one from Newport, R. I., the other from Illinois, whose appearance did perfectly agree with what I suppose to be the fruit-bearing leaves of *Annularia*, this appearance is not distinct enough to permit a positive assertion. If my supposition concerning the fructifications of *Annularia* should be confirmed, this genus would appear as a link of transition between the *Equisetaceæ* and the Ferns, as the genus *Sphenophyllum* appears to be one between the *Lycopodiaceæ* and the Ferns.

ART. XXXIX.—*On two Oceanic species of Protozoans related to the Sponges*; by JAMES D. DANA.

THE Sphærozoum figured below (fig. 1*a*) was collected by the writer in the Pacific, near latitude 30° N. and longitude 178° W., during a calm, on the 26th of May, 1841.

Figure 1*a* represents the gelatinous globule of natural size.

Fig. 1.

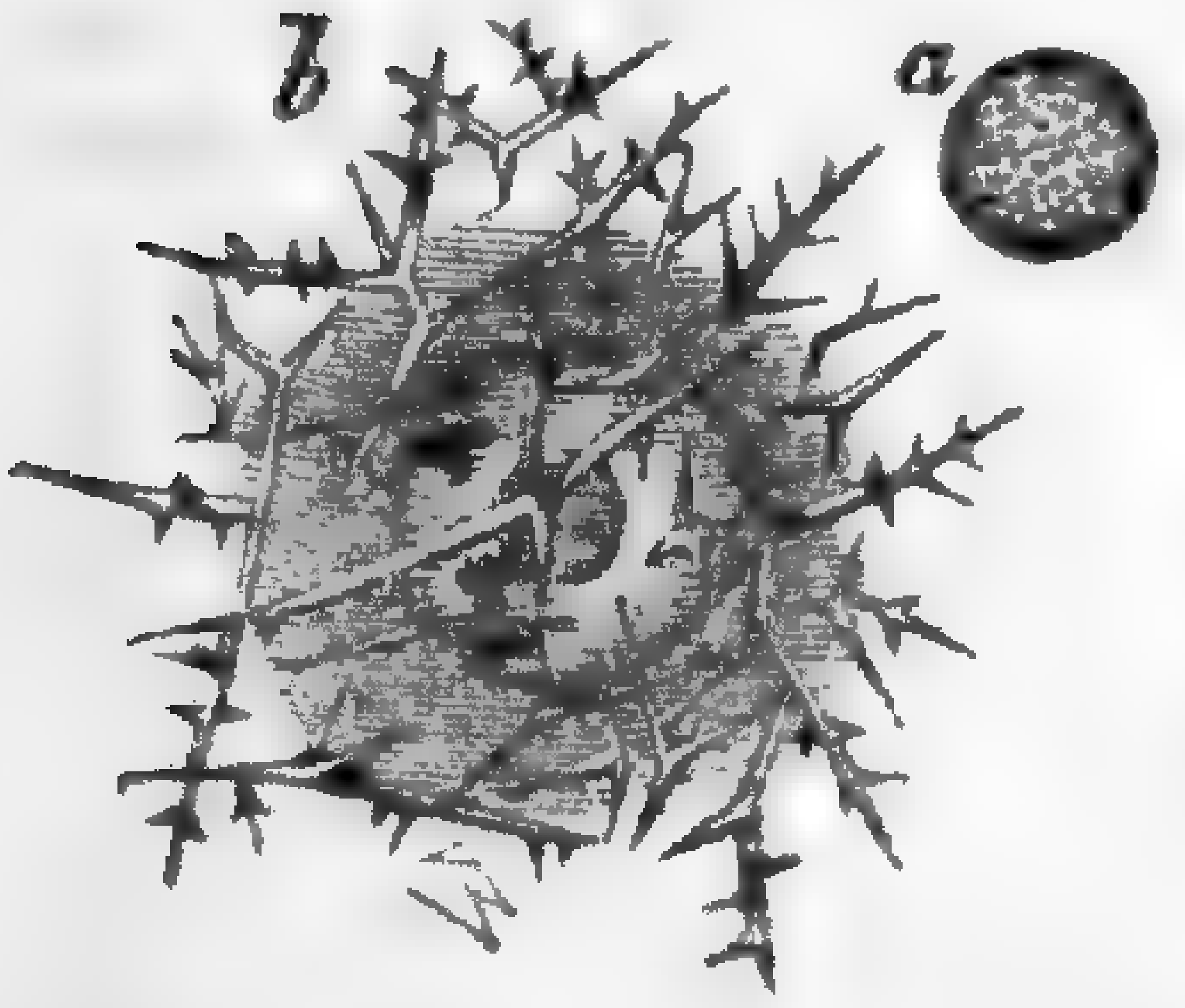
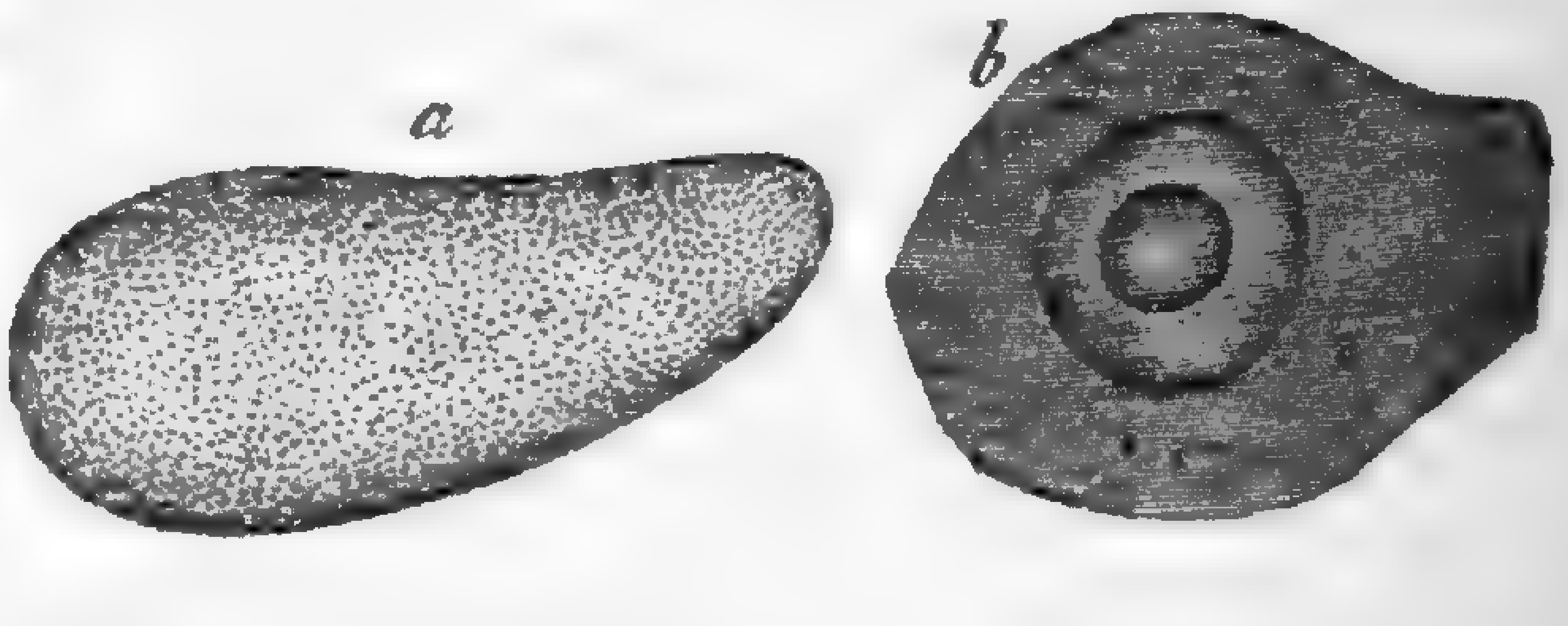


Fig. 2.



The ocean's waters were filled with this species, and another represented in figure 2*a*. The minute dots covering the globule, one of which is magnified in figure 1*b*, were closely crowded, as shown in figure 1*a*. In this respect, the species differs widely from the figure of a species by T. H. Huxley in the *Annals and Magazine of Natural History,* xliii, 433, pl. 16; and, as it hence appears to be distinct, the writer has named it *Sphærozoum orientale.* About the dots, or ocelliform spots (zooids), the spicules (supposed to be siliceous) were very numerous and much branched as in fig. 1*b*. The general mass had an exceedingly faint bluish tinge; the centre circle of the ocelliform spots was of the same tint, while the ring around was of a very faint ochreous shade. The globules represented on the ocelliform spots in fig. 1*b* were yellow.

The other species (fig. 2*a*) had the same general color, and similar ocelliform spots as to form, color and numbers, without the spicules. Figure 2*b* represents one of the ocelliform spots; the dots in the surrounding mass correspond to minute yellow globules or cells. This species is included with the Sphærozoum under the genus *Thalassicolla* of Huxley. This name has been since restricted to Huxley's *T. nucleata,* and the name *Collosphæra* applied to forms much like fig. 2 by Müller. The mass was less firm to the touch than that of the preceding. A fuller examination of this and the related species is required to decide whether the one here figured is new or not.

Both of the species had the power of motion by a movement like expansion and contraction, and also the power of sinking and rising at will in the water. No external opening could be distinguished.

As the species are probably related to the sponges, as suggested by Huxley, they have considerable interest, and especially the Spherozoa, which, like most sponges, seem to have the power of secreting silica. The extent to which the ocean, over an area of many square leagues, was crowded with them, suggests that such floating sponges may have been, in past time, of geological importance as one of the sources of silica for the flint or hornstone and siliceous petrifactions of ancient limestones and other rocks.

These species received from the author but a partial study, as those of another class—oceanic Crustaceans—were engaging his attention at the time. The above figures and descriptions are from colored drawings made on the spot, and from the notes accompanying them.

ART. XL.—*Key West Physical Notes.*—1. *Zodiacal Light.* 2. *Atmospheric Transparency.* 3. *Gulf Stream Cloud Bank.* 4. *Ray Bands.* 5. *Northers.* 6. *Hurricanes.* 7. *Ventilation.* 8. *Yellow Fever.* 9. *A Water Moonrise;* by Major E. B. HUNT, Corps of Engineers, U. S. A.

SOME observations on physical phenomena, incidentally made by me during my period of duty at Key West, (1857–62,) may not be devoid of interest, and their discussion may have some scientific value.

1. *Zodiacal Light.*—During the winter, and especially in February, the zodiacal light habitually attains at Key West a remarkable degree of distinctness. I have repeatedly traced it nearly to the zenith, but never reliably beyond. The main point to which I would draw attention, is the great amount of light proceeding from this source. I have over and over again observed a distinct *shadow* cast by the zodiacal light. Walking from it, I have seen my shadow moving before me on the white roadway, as if cast by moonlight, though without definite boundaries. I have, by passing along close to a whitewashed wall, seen my shadow very positive in darkness, though obscure in outline. Waving my arm up and down within a few inches of the wall, a tolerably defined outline of shadow resulted. In all respects, the shadows are what should result from so diffused a light. It may be remarked that much the largest volume of light comes from the portion below 15° to 20° from the horizon. Sometimes Venus, by its brilliancy and position, rendered the observations doubtful; but I have seen these shadows unmistakably when Venus was not visible, and so late as to exclude the idea of twilight refractions as their cause. I do not know if shadows by zodiacal light have before been noted, but other persons corroborated my impressions, leaving no doubt that real, but dimly outlined shadows, of readily observable darkness, are habitually produced by the winter zodiacal light. This gives a more correct idea of its great increase of brightness on nearing the tropics, than can be conveyed by general terms. It is indeed a singularly beautiful thing, to see this grand mass of mellow light, softly fading out into the clear sky, and quite obscuring the lustre of the Milky Way by its superior brightness. Where it intersects the Milky Way, I think the two are, at the brightest, about equal in glow, but from thence to the horizon the zodiacal light so increases in radiance as to seem almost a prolongation of twilight.

2. *Atmospheric transparency.*—There is a beauty in the sky at Key West, which can hardly fail to impress even casual observers. The stars shine out with a clear lustre and fullness of numbers,

which almost exceeds the display on the brightest and coldest nights of a northern winter. It seems singular to find a climate so moistened by the Gulf Stream, still glorying in the starriest of nights. Association had made a lavish display of the starry hosts seem the peculiar prerogative of clear, cold, winter nights, and yet here they came forth, amid moisture-laden tropic airs, with a magnificence and profusion I had never seen excelled. It needed no long acquaintance with the equable climate, the nearly unvarying temperature and the steady trade winds, to see that the reason of this phenomenon is to be found in the prevalent tranquillity of the atmosphere, where it is so little influenced by contrasts of land and sea. These small keys scarcely vary the ocean conditions. I have known the thermometer at Boston pass through a longer range in one day, than in the whole year at Key West. The winds are mostly gentle and steady in direction. There are usually no conditions of great contrast and no irregular admixtures between upper and lower strata. The requisites for developing visible vapor are rarely prevalent, and I have only twice known positive fogs at Key West. However moist the air may be, if the atmosphere lacks the conditions of contrast and intermixture to make that moisture visible as vapor, the sky should seem habitually clear. Such is the obvious fact at Key West. With a climate never, even after the severest northers, below 45°, rarely down to 55°, and seldom rising to 90° in the shade, it is not to be expected that the admixture of contrasted currents should often cool to the dew point portions of this moist warm air. The equability of atmospheric conditions is thus the real reason of the rare beauty of the sky and the rich display of starry splendors, so attractive amid the soft and balmy airs of this locality, which lacks but one degree of being tropical. There is much in the quality of these nights to suggest that the astronomer would find his paradise here, but the summer mosquitoes, rain and yellow fever are rebutting facts. For winter observations, the conditions are truly admirable.

3. *Gulf Stream Cloud Bank.*—Among the striking local phenomena of Key West, is the formation, shortly before and after sunset, of a grand bank of clouds above the Gulf Stream, rising some 200 to 500 feet in prevailing height. In running along the Gulf Stream or its margins, this bank is habitually seen during the sunset hours, and a profuse atmospheric moisture is felt while sailing in the evening over the warm-water belt. Key West being about 12 miles north of the regular Gulf Stream waters, this cloud bank rises gradually along the southern horizon, stretching from E. to W. in massive and irregular fleeces, dark below and silver gilt above, under the rays of the setting sun. When the prevailing S.E. wind is brisk, this cloud bank

drifts northward and portions are often brought into the western horizon, where they are tinged with a rich red glow. The sunset scenery is in great part the result of this movement of Gulf Stream clouds, and a certain mannerism or monotony of sunset effects follows. There is much beauty of configuration and magnificence of coloring in these warm sunset clouds, but the lack of contrasting land masses detracts not a little from their variety and picturesque effects. The cloud battalions are habitually formed for these evening dress-parades, but during the morning and midday hours there is usually clear bright sunshine, occasionally mottled with a few lounging cloud-waifs which seem to drift idly and without purpose on the sea breeze. There is rarely any other marked coloration of clouds than red, orange and yellow, with simple white and dark, according to the light or shadow of the portions seen. The exclusive exhibit of warm colors in this tropical atmosphere and the glowing impression of perennial heat which the eye thus drinks in, naturally raise queries concerning the subtle affinity which couples literal warmth with warmth of color. What exquisite thermometry resides in the optic nerve, which perceptively tells us how the great source of heat has ruled the day and shall rule the morrow? It must be something more than chance which associates the heat rays of the spectrum with those primitive colors which the artist calls warm. The connection must be causal, and may be due to a positive perception of heat in the optic nerve itself. This causal impression grows into one's faith as he looks forth, evening after evening, on the fervent coloration of these Gulf Stream clouds, tropical alike in origin and promise.

The cause of the evening cloud bank along the Gulf Stream is not hard to find. During the day the sun is constantly heating up the air above the water surface, thus adding to its capacity for holding moisture in invisible suspension. With the growing heat, the point of saturation rises. The warm Gulf Stream water, under the steady radiations, vaporizes rapidly along its surface, and contributes great daily increments to the invisible atmospheric waters. When the meridian is past, and the falling sun acts with decreasing force, the atmospheric temperature declines, until, as the sunset approaches, the water laden stratum over the Gulf Stream cools to the dew point, and the invisible vapor is bodied forth in cloud masses. The superior temperature of the Gulf Stream water, by augmenting the daily evaporation, brings the air above it to the point of saturation, while the surrounding cooler waters fail so to change the adjacent air as to reach this point when the sun declines. Along the whole course of the Gulf Stream, the principle of this daily scene-shifting applies.

The famous fogs of Newport are obvious consequences of the transfer, by a wind blowing in shore, of great masses of air, heavily charged with invisible vapor from the Gulf Stream surface. As these air masses arrive over the littoral and Narragansett waters, still cold with the accumulated cooling of the winter, their temperature rapidly sinks until the dew point is reached, and a fog results. It is in spring and early summer that this fog mechanism is perfect; but as the Bay, shore and shore waters get heated up in the advancing season, the change of temperature by shoreward transfer grows less, until in the late summer and fall, when fogs are rare.

4. *Ray-bands.*—The appearance familiarly known as "the sun drawing water" is very frequent at Key West. It is not uncommon to see the rays in the east, converging to the point opposite the sun, and as much below the horizon as the sun is above, which I will call the *anti-sun*. Sometimes the converging ray-bands in the east are nearly or quite as distinct as those in the west. The unusual frequency of these exhibitions is a result of the inshore drift of the Gulf Stream Cloud Bank. The ray-beams, through the breaks in the cloud masses, are made visible by the diffused and tenuous vapor incident to the evening cooling.

The remarkable observation on ray-bands which I wish to note, I have had occasion to make several times, when a faint haze has rendered them distinct throughout their whole course from west to east. The result is that the W. and E. systems of convergent rays visibly run into each other, producing continuous arches of light across the entire sky. The portion of each band near the perpendicular to its length was seemingly much the broadest, and the band thence tapered towards the sun and anti-sun, according to the customary perspective. Here is a notable point of singularity. So long as the W. and E. systems of ray bands are seemingly distinct, they appear to the eye as truly rectilinear and convergent. When a ray band is distinguished entirely across from W. to E., it has the appearance of a grand arch, curved in its entire extent. This is an optical delusion, caused by the mental identification of the band with the sky-dome. The observer is really placed amid a system of strictly parallel solar beams of constant cross section. The portions nearest the eye seem broadest, by reason of the greater visual angle subtended at and near the perpendicular. So long as we see only the disjoined W. and E. systems of convergent bands, we see them correctly in space according to simple perspective laws, just as when we look at the rails in a long, straight reach of railway. When however we look on a continuous luminous band across the sky, no distinctness of mental or logical conviction can make that straight band or beam in atmospheric space seem anything but a grand arch, widest near the crown, and resting on the sun and anti-sun as piers. I think it safe to say that no clearness of geometric conception can make the eye tell a different story.

Undoubtedly we entertain the habitual, perspective fallacy of a sky-dome, truly spheroidal, with the minor axis vertical. No force of conviction prevents our seeing this dome, day by day, and thus giving it a vital reality, utterly contrary to reason. From childhood, this beautiful, phantasmal sky seems ever bending over us, and with just as much reality as the houses and forests. When we say that this sky is blue, we really mean that somewhere, not many miles away, there is a blue crystalline sphere, under which we dwell, and in which the stars are set. However perfect may be our logical conviction that atmospheric air is a blue, transparent medium, which gives us the impression of a distant blue sky-dome, we always see that dome as a reality. When therefore we see a ray band stretching from sun to anti-sun, across the face of this apparent sky-dome, we see a curvature, under the despotism of a beautiful and perennial phantasm, which has grown with our growth, until it has for us as much perspective reality as the solid ground itself. Were we to see a straight wire or timber, supported above us from the earth, and running out of sight in each direction, we should never confuse it with any sky phantasms; nor do we in the simple case of seemingly divergent ray-bands, although we find it hard to recognize true parallelism in this apparent case of radiation from a centre which we fancy to be not very remote. I think the ray-band arch is an appearance admirably fitted to teach us how great may be the delusive power of ideas which we logically repudiate but perceptively retain.

5. *Northers.*—The relaxation and enervation due to the warm and moist climate, which the Gulf Stream carries with it, is in the winter occasionally relieved by the dry, cool, exotic air of the "norther." The wind before a norther nearly always goes around by the south and west. The south wind is apt to blow one or two days with some steadiness, and I know no more debilitating and unnerving influence than the south wind at Key West. The traverse of the wind through the western quadrant is usually quite rapid. When it reaches the W. or W.N.W. point, a lull sets in, and the practiced eye looks in the N.N.W. for the rising of the "Norther Bank." A long, low, dark line shows itself above the horizon and rises with increasing rapidity, the dark mass preserving its upper margin sharply defined and horizontal. The front moves down magnificently upon us, and for a few moments, amid profound calm, we see its wild rush and hear its dull murmur. Suddenly it strikes us, and instantly all is uproar, noise, confusion, dust and darkness. Leaves and other light articles career madly, blinds are violently slammed, and it is all one can do to shut doors and windows to exclude the wild puffs of dust and leaves. Sometimes, for a few moments

there will be a dash of rain, which however speedily gives way to clear, dry, cool air. Amid all the wild inaugural ceremonies of the norther, the cool, brisk air sweeps away languor and exhaustion, and raises an effervescence of spirits which is quite equal to enjoying the mad dance, with all its dust and darkness. In a few minutes the wild humor passes, and the norther settles itself to work. Steadily it blows on from the N.N.W. or N. for a day or two, working around very slowly to the eastward. About the third day, its force is mainly spent and it shades out into a mild and delicious N.E. breeze. Still working slowly eastward, it settles at E.S.E. when the regular trades prevail for a season, until another excursion by the south preludes another circuit of the compass.

The norther of Key West is unmistakably a stratum of cold air, moving along the earth's surface from N. to S. with a flow as of a great air river. During the moments of admixture between the head of this current and the previous, warm, moist air, there is such a sudden cooling of portions of the latter, that it sends down sometimes a few dashes of rain drops, and forms the dark vaporous mass which shows in the distance as the "Norther Bank." When the current is fully established, there is no more admixture and hence no more rain, but instead a bright, clear sky and a flow of dry cool air, which braces the lungs, and brings out a crop of efflorescent crystals on the surfaces of the brick walls of Fort Taylor, making it seem suddenly gray with age. There are usually from five to ten regular northers during the winter half-year, the first coming in November and the last in March, though feeble imitations occur late and also during the winter. Last winter there was no thorough norther until March, and there is considerable irregularity about their numbers and occurrence, but, in all, the type is as above defined.

6. *Hurricanes.*—As the Key West winter has its northers, so the summer has its hurricane or hurricanes. I have witnessed but two; one quite severe and the other moderate. Mr. Redfield has so fully worked this ground, that it need only be remarked by me, that these two gales conformed to his theory of revolving storms. I here introduce two sets of barometer observations, taken at Key West during the August gale of 1861. The first was made by Mr. Charles Howe, the Collector, at the Custom House, as follows:

Date.	Barometer.		Wind.	Character of the Weather.
1861.	6 A. M.	2 P. M.		
Aug. 14,	30·50	30·46	North.	Fresh.
15,	30·30	30·28	N.E.	Very fresh at 11½ o'c. P. M. Barometer 29·94: at 1 o'c. A. M. wind shifted from N.E. to S. and blew until 5 o'c. when it commenced moderating and barometer commenced rising.
16,	30·06	30·24	South.	
17,	30·40	30·60		

"***Note.*—The thermometer during the past 3 days has ranged from 80° to 82°."**

The second series was made at the Coast Survey and Smithsonian Magnetic Observatory on the Fort Taylor grounds.

Aug. 14th.	9 P. M.	29·936	Aug. 16th.	2 P. M.	29·796
15th.	7 A. M.	29·788	"	9 "	29·900
"	2 P. M.	29·700	17th.	7 A. M.	29·990
"	9 "	29·500	"	2 P. M.	30·058
16th.	7 A. M.	29·504	"	9 "	30·140

A comparison of these records shows that one of these barometers has a large constant error, but the fluctuation is alike marked in both. The sudden shift from N. to S. was followed by a rapid rising of the waters in Key West Harbor, and in the gale of 1846 this heaping up on the south side of the Key amounted to about 7 feet.

7. *Ventilation.*—The close neighborhood of the Gulf Stream renders the air of Key West peculiarly warm and moist. This makes free ventilation and shade the chief essentials for all personal comfort. A peculiar difficulty exists in the preservation of all kinds of perishable articles of food, the combination of warmth and moisture being the very condition for rapid decay. I think there can be but little doubt that, for many articles, the correct plan for preservation is, to seal them up in close, shaded chambers, in which the air is kept as dry as possible. An experiment which I made on the preservation of flour, in a room opening at top into the Fort Taylor bakery, and the air of which was thus kept artificially dry, indicated that flour could there be kept sweet at least twice as long as when stored in a very dry, wooden storehouse, which would usually be chosen as the very best storage. I have no doubt that the legitimate method of keeping powder magazines dry there, is by totally excluding all ventilation. A magazine free from leakage, once filled with dry powder, with the air once dry and then sealed hermetically, would remain utterly unchanged and the powder could not get any moisture to absorb, hence it must perforce keep dry. By the use of chlorid of calcium or other moisture absorbents, or by the induction of occasional changes of heated air, all moisture could be kept from approach to the powder. If we admit free ventilation, we furnish a constant supply of moisture for absorption. The effect of opening ventilators in the Fort Taylor magazines is sometimes actually to *wet* the floor and other surfaces on which the moist air blast is thrown. The interior of the magazine is enough cooler than the outer midday air to cause an active deposition of moisture; so that the nearly saturated noon and afternoon air is the worst of all in its effects. There seems to me but little doubt, that a careful study of physical principles, in their application to the preservation of supplies,

in store at Key West and other like positions, would reverse much of the existing practice, and would enable us to preserve for a long time the stores which are now so speedily ruined by moisture. The adoption of closed inner chambers, artificially dried, with an exterior ventilation, under the roof and within the outer walls, to keep down the temperature, would add enormously to the durability of perishable supplies, and to the dry storage of gunpowder or other moisture-absorbing stores. These views have unfortunately had but little chance of practical test, except in the instance of flour storage already cited. Their great importance in their application to such public stations as Key West, the salvation of which may turn on the preservation of flour and other perishable stores, would certainly justify a most careful experimental research under the strict guidance of scientific indications.

8. *Yellow Fever.*—I will venture here to introduce a singular and significant observation, concerning the characteristic disease of tropical shores. On two separate occasions, when there were cases of yellow fever in the U. S. Marine Hospital, which building I passed daily and saw almost habitually, I have seen a flock of buzzards, circling over and near the roof of the hospital by the hour together, and continuing this day after day. I have never seen them do this except when there were yellow fever cases in progress under the roof. So marked is this fact, as to have produced a common belief in town, that they only hover over the hospital when there is yellow fever there. I am quite persuaded that such is the fact, and can only interpret what I have myself seen as indicating that an odor is then thrown out on the air which the keen scent of the scavenger bird detects from afar. The material particles, whose diffusion is thus testified to, seem likely to afford the means of transporting the disease on the air, in a manner quite agreeing with the facts of its propagation. The hint, thus afforded by the keen-scented buzzards, may have value in assisting to comprehend the mode of conveying and diffusing this fatal malady, and the particles scented may indeed be the actual *fomites* so much talked of and so little understood, in discussing the controverted questions of contagion and communication.

9. *A Water Moonrise.*—When becalmed in a beautiful evening between the Reef and the Key, the water being very tranquil, I saw the moon rise over the sea with some interesting appearances. The long reflection of the emergent disc on the water was well defined, and seemed to be a part of the moon itself. As the under semicircle of the disc began to rise above the water, there was an appearance of drawing in at the sides of the combined luminous figure. As this seeming contraction progressed, the outline showed a curved figure, like that made by water in

raising a cohering disc from its surface. There was no cusp point between the disc and the disc-reflection, but a seemingly distinct curve, concave outwards. As the disc rose above the water, this curve opened, and a broad connecting column seemed to bind the disc and its reflection, just like a coherent water column between the lifted disc and the level water surface. Instantly this seeming column parted as if broken, when the moon was seen to be distinctly above the water by about a fourth of its diameter, as nearly as I could estimate. The sudden shock of rupture appeared perfectly distinct, and the semblance of a material connection between the disc and reflection was perfect, both before and at the instant of visible separation. This observation has interest in its relation to the contact phenomena of eclipses.

ART. XLI.—*Observations upon some of the Brachiopoda, with reference to the genera Cryptonella, Centronella, Meristella, and allied forms;* by JAMES HALL. Abstract of a paper read before the Albany Institute, February 3d, 1863.[1] (Communicated by the author.)

IN the study of the Palæozoic Brachiopoda, we are often forced to rely upon the general external form, and texture of the shell, for determination of the generic relations, until more extensive collections may furnish us with weathered specimens, or with crystalline or silicified ones, which, admitting of being cut, and macerated in acid, will enable us to ascertain the true interior characters.

In many instances, so nearly do very distinct genera approach each other in their external form, that reliance on this alone is very uncertain, and will surely lead to much confusion, if insisted upon as the means of generic determination.

For a long time, and until we began to learn something of interior structure, a large number of species, now known to belong to distinct genera, were embraced in the designations *Terebratula* and *Atrypa.* At a later period, when the genus *Rhynchonella* had been established in its application to many Palæozoic species, we find numerous species, which from external form had been referred to that genus, possessing characters incompatible with it.

One of the most common of these is *Terebratula cuneata* = *Rhynchonella cuneata* = *Retzia cuneata,* and which will probably

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[1] From the Transactions of the Albany Institute, with some verbal corrections and the introduction of subsequent observations by the author.

be found to differ from true *Retzia*, taking its place near *Rhynchospira.*

So long as we remain unacquainted with the interior of the shell, we are compelled to refer the species to some genus having similar external forms, though the fibrous or punctate texture may in many instances prove a valuable aid in these references.

Among the forms most difficult to determine, are the numerous smooth or finely striated terebratuloid shells, having either ovoid, elongate, sub-circular or transverse forms. Among the genera of one family which in recent times have been established and proposed to receive these, are *Athyris* (= *Spirigera*), *Merista* (= *Camarium*), *Meristella* and *Charionella;* while the subdivisions of the terebratuloid forms in another direction have given *Terebratula* proper, *Terebratulina*, *Waldheimia*, *Terebratella*, *Centronella*, *Cryptonella*, *Rensselœria*, etc.

The first four are of the athyroid type, and have internal spires, as in *Spirifer.* *The shell in all these is fibrous, and we have therefore in the external shell the means of separation from those of the other type.*

In all the latter group we find modifications of the internal appendage, called in *Terebratula* the loop; but in none of them do spires exist. Moreover, *in all these the external shell is punctate;* and we do not yet know a punctate shell, of the external character here indicated, which contains internal spires.[2]

The external characters, therefore, of the terebratuloid forms may be made useful in indicating the family relations of the species, and may prevent us from referring to the family of *Spiriferidœ* those which belong to the family of *Terebratulidœ.*

In the *Thirteenth Report on the State Cabinet*, published in 1860, I proposed the name of *Meristella* for certain forms which I regarded as separable from *Athyris* and *Merista;* and for the semi-plicated forms otherwise of similar character, I suggested the name *Leiorhynchus.* At the same time I described under *Terebratula* the following species: *T. Lincklœni*, *T. rectirostra*, *T. Lens* and *T. planirostra;* under each one, distinctly stating the shell structure to be punctate, which character at that time afforded me the principal means of distinguishing these from athyroid species of similar form, as *Meristella Haskinsi*, *M. Barrisi* and *M. Doris*, which, with *Atrypa scitula* (*4th Dist. Report*) = *Meristella scitula*, have at a later peroid been placed by Mr. Billings among the typical forms of his Genus *Charionella.*

Having ascertained some farther characters of these punctate Terabratuloid shells, I proposed in the *Fourteenth Report on*

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[2] The plicated forms of *Retzia* and *Rhynchospira* are of course not included in the designation above made. *The Nucleospirœ* also approach the terebratuloid forms, but these shells have an area on the ventral valve and a different hinge structure.

the State Cabinet,[3] page 102, the name *Cryptonella*, giving as one of the characters "shell structure finely punctate." I remarked in a concluding paragraph:

"The species of this genus are more elongate than *Merista* and *Meristella*, and those now known are less distinctly marked by mesial fold and sinus; while the beak is more attenuate, often a little flattened, and rarely so closely incurved as in the genera cited. The punctate structure of the shell is a distinguishing feature."

In the *Fifteenth Report on the State Cabinet*, I gave (at page 161 [133], pl. 3) some illustrations of the muscular imprints, dental lamellæ, etc., with figures of a single additional species from the Lower Helderberg group.[4]

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[3] Made to the Legislature April 10th, 1861, and published in July, 1861.

[4] In the *Canadian Naturalist and Geologist* for October, 1862, we find the following exposition of the relations of the genus *Cryptonella:*

"The genus *Cryptonella*, illustrated on pl. 3, p. 133, is precisely identical with *Charionella*, described by me in the *Canadian Journal* of March, 1861, p. 148, and illustrated in the May number, pp. 273, 274. It includes the species described by Prof. Hall in the Thirteenth Report under the names of *Meristella Haskinsi, M. Barrisi, M. Doris, Terebratula Lincklæni, T. rectirostra, T. Lens* and *T. planostria*, [*T. planirostra*]. Besides these, the *Atrypa scitula* of the New York Reports, *C. Circe*, and apparently a number of European species belong to it. *Cryptonella* was first published in July or August, 1861, three or four months after the learned author became acquainted with its characters through the study of my papers."

The following is the description of the genus *Charionella*, copied from the *Canadian Journal* (March, 1861), No. XXXII, p. 148:

Genus CHARIONELLA. "Since the foregoing article on Devonian fossils was written, I have ascertained the generic characters of the so-called *Atrypa* or *Athyris scitula*. It has internal spires with their apices directed outwards, as in *Athyris* and *Spirigera*, but the dorsal hinge-plate has its anterior margin and a large portion along the middle anchylosed to the bottom of the valve. In another congeneric species, the middle portion of the same plate is obsolete, there remaining only two small, thin, nearly vertical septa (socket plates), one on each side of the cavity of the umbo. The perforation in the beak of the ventral valve is bounded on the lower side by a deltidium of either one or two pieces, or by a portion of the shell. The mesial septum in the dorsal valve is either rudimentary or entirely absent.

"The several species of this group, at present known to me, resemble *Athyris*, but are not so convex, and are besides more elongate ovate, or approaching to *Terebratula* in general form. I shall give further details and some figures in the next number of the *Journal*.

"The genus is only proposed as a sub-genus, to be retained in case *Athyris* is divided."

In the *Canadian Journal*, No. XXXIII, p. 273, we have "*Charionella Circe*, n. sp." (referring to the illustrations). "The first figure exhibits a specimen with the dorsal valve partly removed, showing *the internal spires*. The other two figures are a side and ventral view of another specimen."

"By treating partially silicified specimens of this genus with acids, I have ascertained that the structure of the hinge plate differs from that of Spirigera in being either obsolete along the middle or anchylosed to the bottom of the valve. In *Athyris* (=*Meristella* Hall) there is a well developed hinge plate, supported beneath by a strong mesial septum, which extends sometimes nearly to the front of the valve. In *Charionella* there is either no mesial septum, or one that is merely rudimentary. In one specimen there is a remarkable partition, which runs obliquely from near the beak to the margin near the front. It completely divides the internal cavity into two parts. This I believe to be not a mesial septum, but a

In September, 1862, Prof. A. Winchell, in his "*Descriptions of fossils from the Marshall and Huron Groups, of Michigan*," published a description of *Centronella Julia*, in which he describes the loop, which is proved not to be in accordance with that of *Centronella* as described and illustrated in the *Canadian Naturalist and Geologist*, vol. iv, April, 1859.

Through the kindness of Prof. Winchell, I have been put in possession of some specimens of this species, with parts of others illustrating the internal structure, together with drawings representing the loop.

An examination of the external characters shows that the shell has the form and texture of *Cryptonella*. "Both valves with regular lens-like convexity, shell obsoletely striate concentrically, and having a minutely punctate structure." The form and other characters of the cast are like those of species referred by me to *Cryptonella*. In the ventral valve are two delicate, slightly curving dental lamellæ, which are shown in casts by a narrow slit on each side of the beak. "The casts exhibit on the ventral side a delicate impressed line extending from the beak to the middle, and on the right and left of this a fainter one; on the dorsal side, a median impression, with two fainter ones on the right and two on the left." These characters appertain to the casts of *Cryptonella* (see fig. 9), as shown in the ventral side of large individuals; having three defined, slightly impressed spaces, limited by narrow lines which extend to the middle of the shell, below which there are sometimes vascular impressions visible.

On the dorsal side, we have the median impressed line with two fainter ones on each side, which, in some conditions of preservation, are obscured by the muscular impression; and below these are frequently seen diverging vascular impressions.

The internal loop of *Cryptonella Julia*, illustrated from drawings of Prof. Winchell, is shown in figures 1 and 2, which are four times enlarged, and are thus described: "A delicate ribbon-like loop originates from the stout blunt crura on each side of the socket-valve, having its flat sides at first vertical; the two branches of the loop proceed at first in lines parallel or a little convergent, and then gradually diverge, widening as they proceed, and assuming an inclined position, until, approaching the front of the valve by a regular curvature, the lower edge has become anterior, giving the band an angle of 30° with the plane

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temporary wall formed by disease of the animal, *because both spires are crowded into the smaller of the two cavities, the larger being empty.*"

The genus *Charionella*, therefore, clearly belongs to the *Spiriferidæ*, and the typical species cited are, in part those originally placed by me under the genus *Meristella*, in 1860 (*Thirteenth Report on the State Cabinet*, p. 84), and in part under *Terebratula*, from the characters of which I proposed the genus *Cryptonella* in 1861. The former belong to the *Spiriferidæ*, and the latter to the *Terebratulidæ*.

of the shell: approaching the median line, the band rapidly widens, and the front margin is drawn forward in a long acumination, while the inner margin is regularly concave, except that near the median line it turns abruptly forward so as to meet that line at an acute angle. The loop thus forms an urceolate figure on its inner margin, and on the outer a somewhat oval one, truncated behind and attenuately acuminate before. In the median line where the two branches meet, both are suddenly deflected downwards, forming a double vertical plate, not quite reaching the ventral valve; the upper edge of which, when viewed from the side, is flatly roof-shaped, while the lower edge describes two convexities, the greater anterior, leaving a notch between them. The surfaces of the loop and median plate are covered with minute obliquely conical pustules, in some places seeming to become spinulous."

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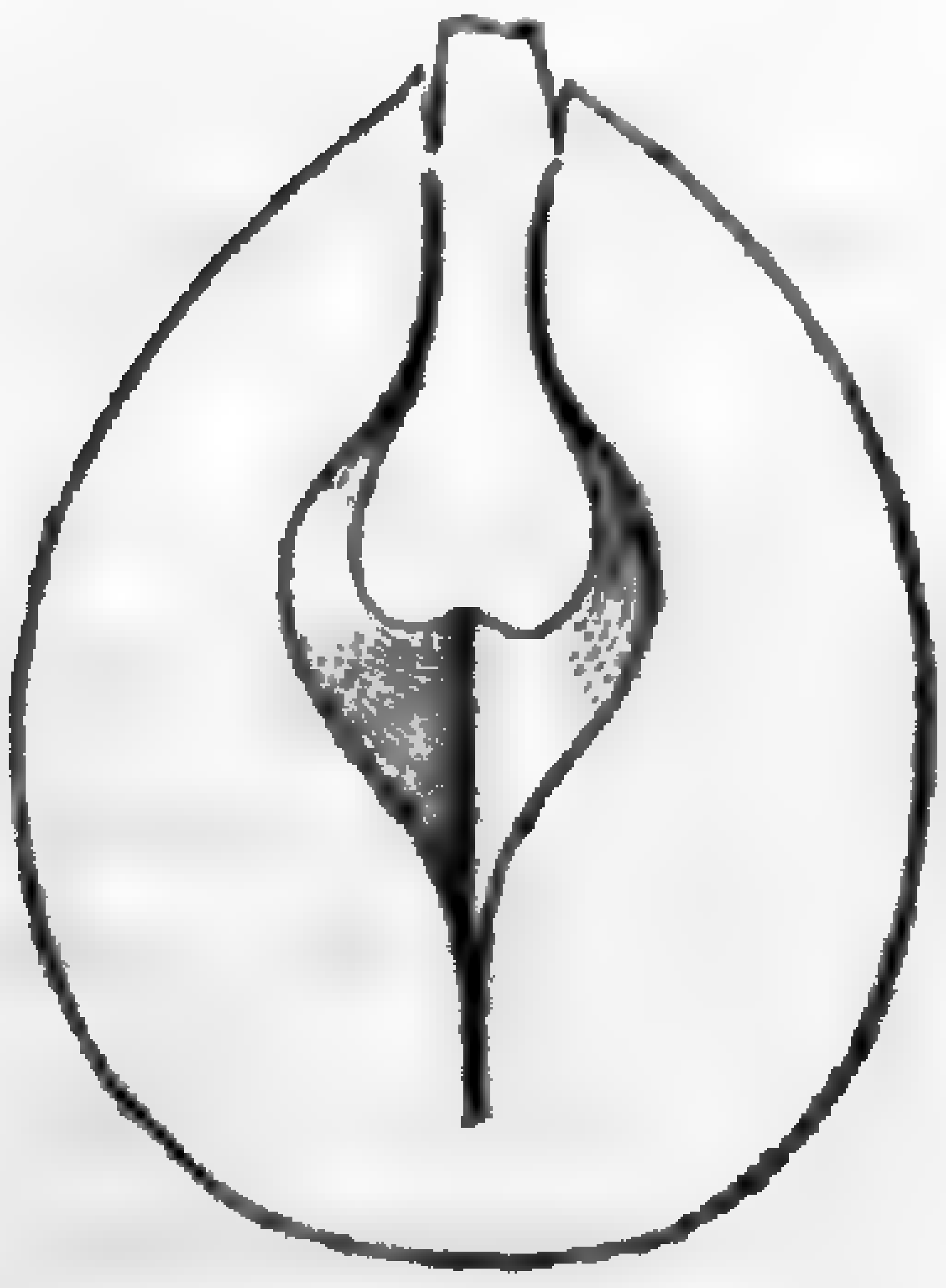

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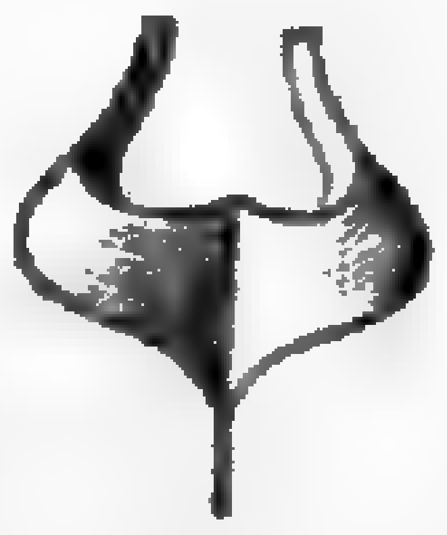

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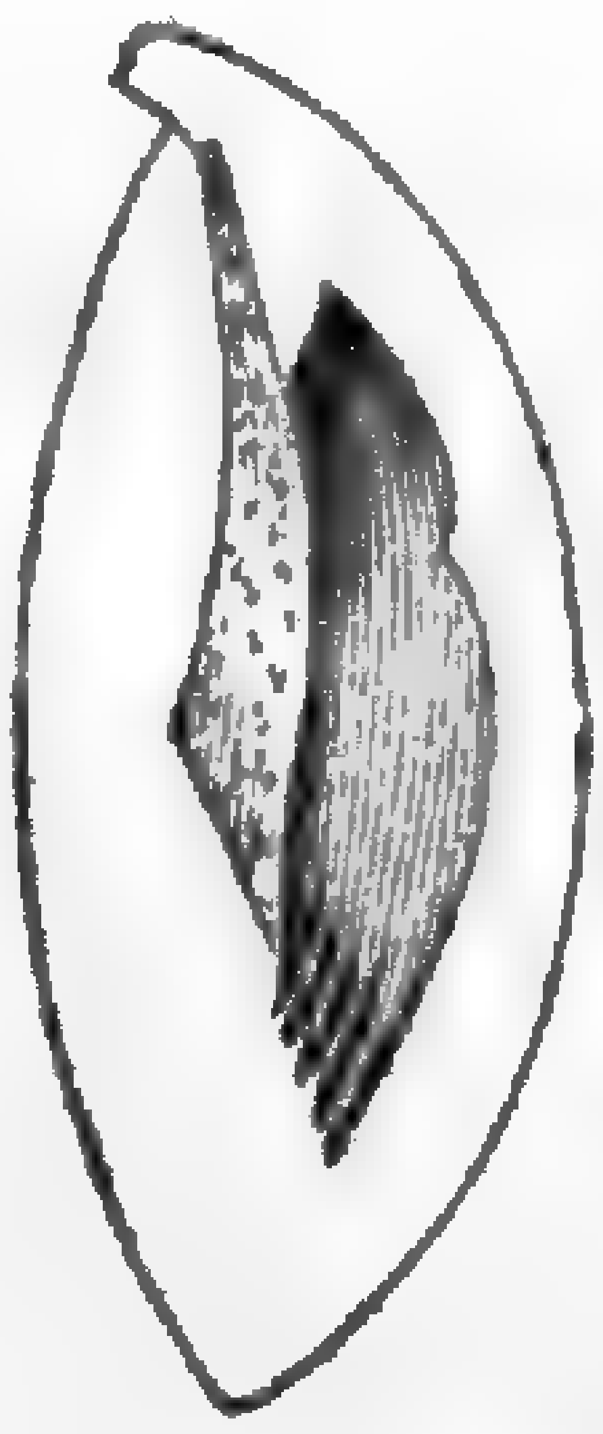

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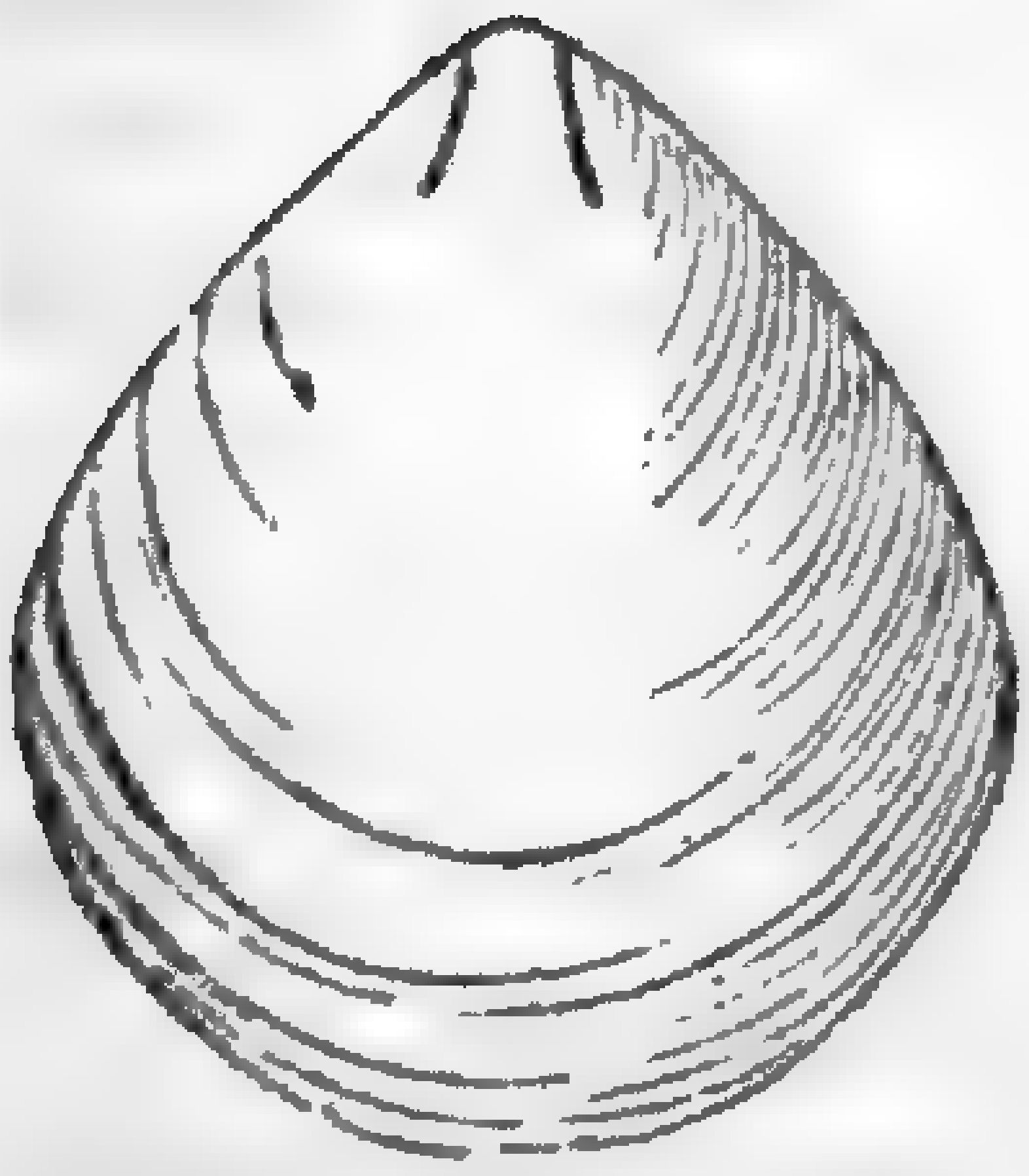

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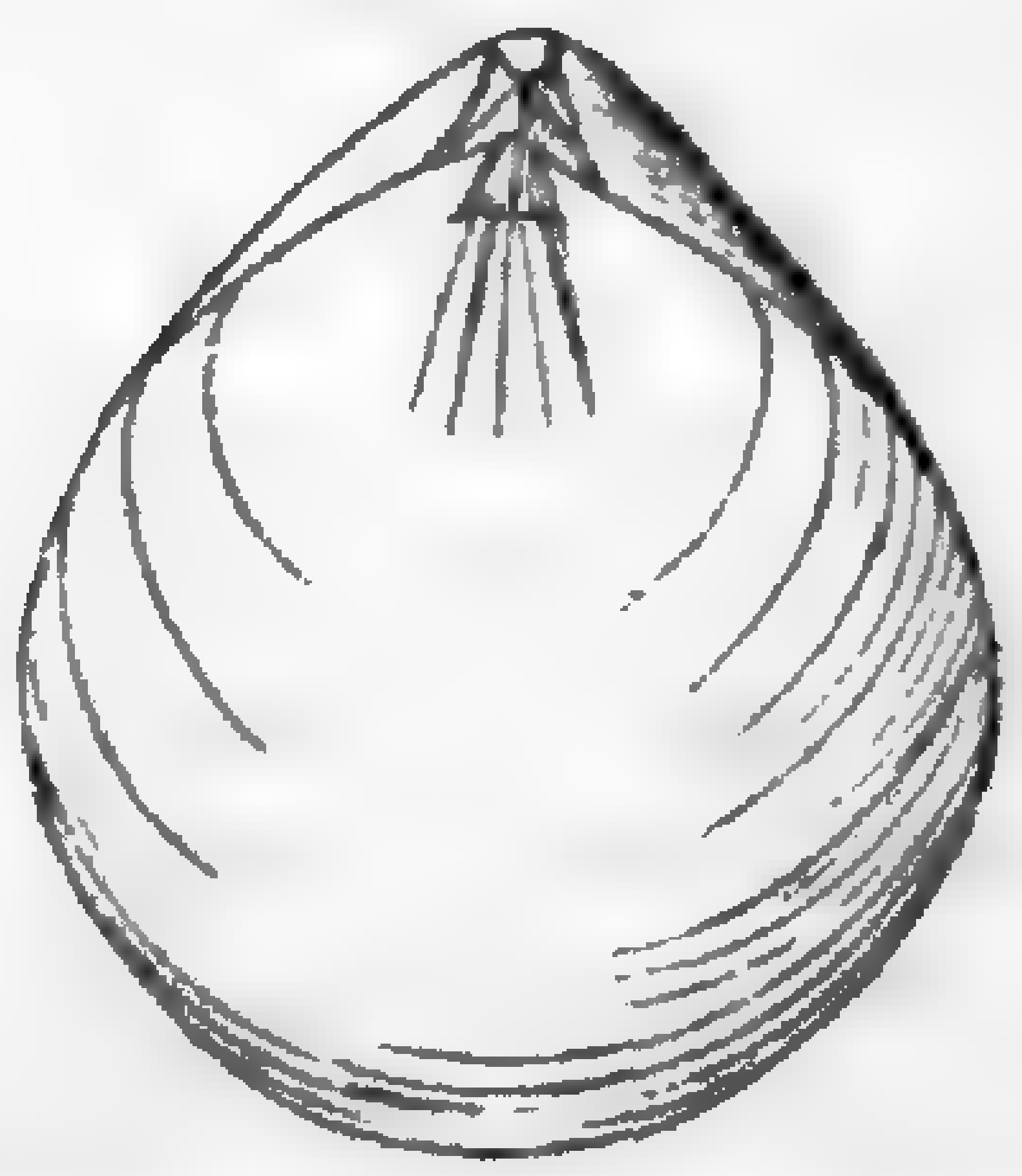

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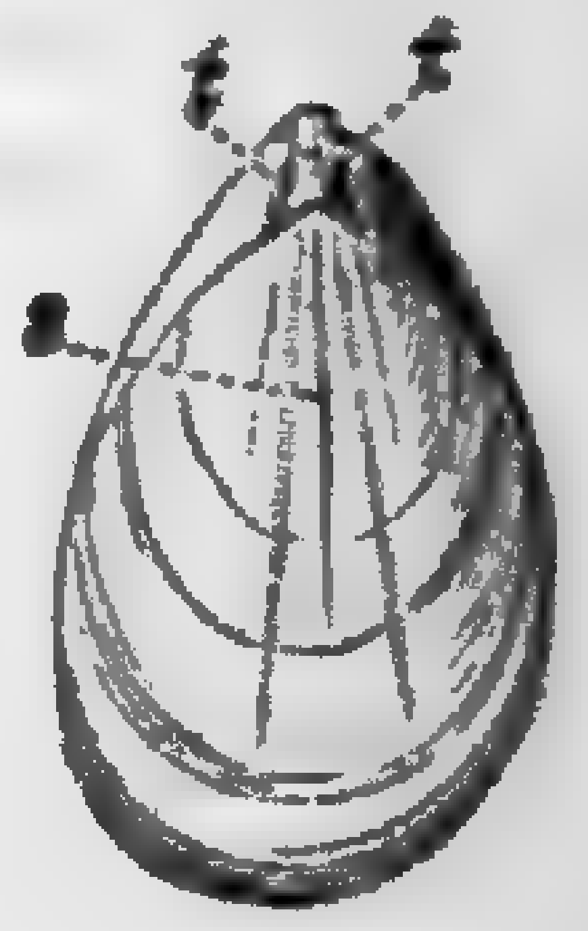
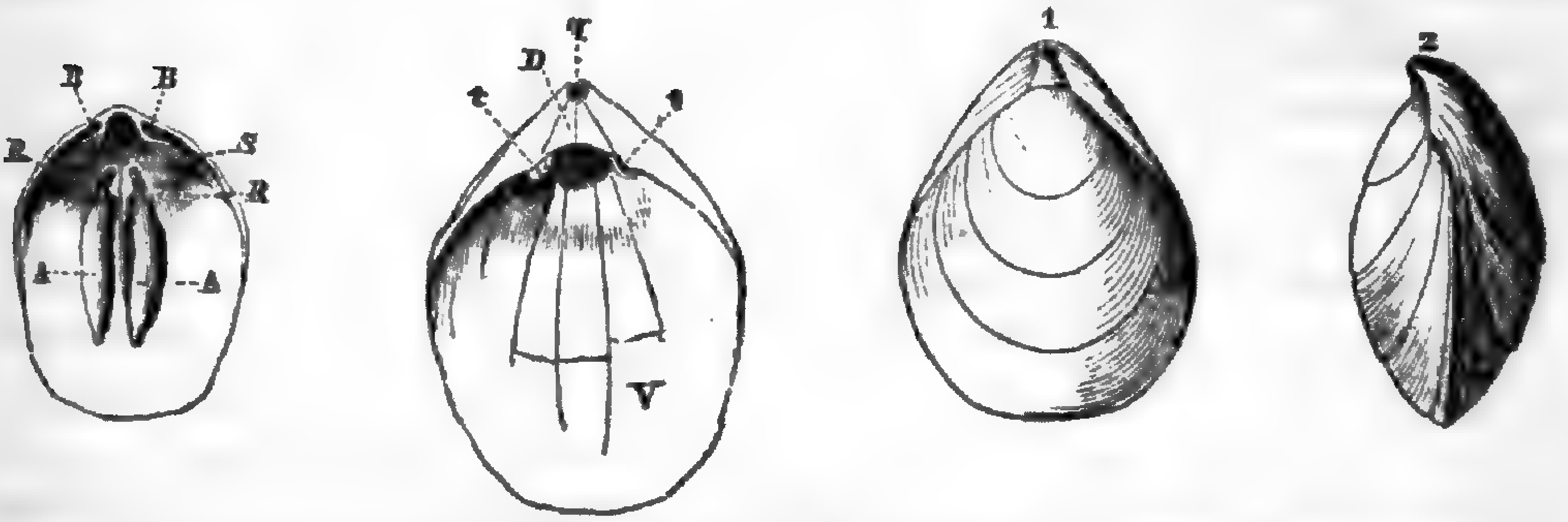


Fig. 1. Dorsal view of *Cryptonella Julia*, showing the loop and horizontal plate. —Fig. 2. Profile view showing one band of the loop with the vertical plate. From drawings, four times enlarged, by Prof. Winchell.—Fig. 3. Front view of the loop. —Figs. 4 and 5. Ventral and dorsal views of the cast of a more oblate form of *C. Julia* enlarged to correspond with figs. 1 and 2.—Figs. 6 and 7. Ventral and dorsal views of *Cryptonella Meta*, from the Schoharie grit.

Fig. 4 is given simply to show the dental lamellæ of the ventral valve; the delicate impressed line in the centre and a fainter one on each side, described by Prof. Winchell, are not shown in the figure. These marks, however, are shown in figs. 6 and 9, and characterize the ventral valves or casts of this valve in all the known species of the genus.

In the *Fifteenth Report on the State Cabinet*, I gave the accompanying fig. 8 of the dorsal valve, and fig. 9 of the interior of a ventral valve. Figures 10 and 11 are dorsal and profile views of *Cryptonella eximia*, from the Lower Helderberg group, the earliest species of the genus known to me.

8. 9. 10. 11.



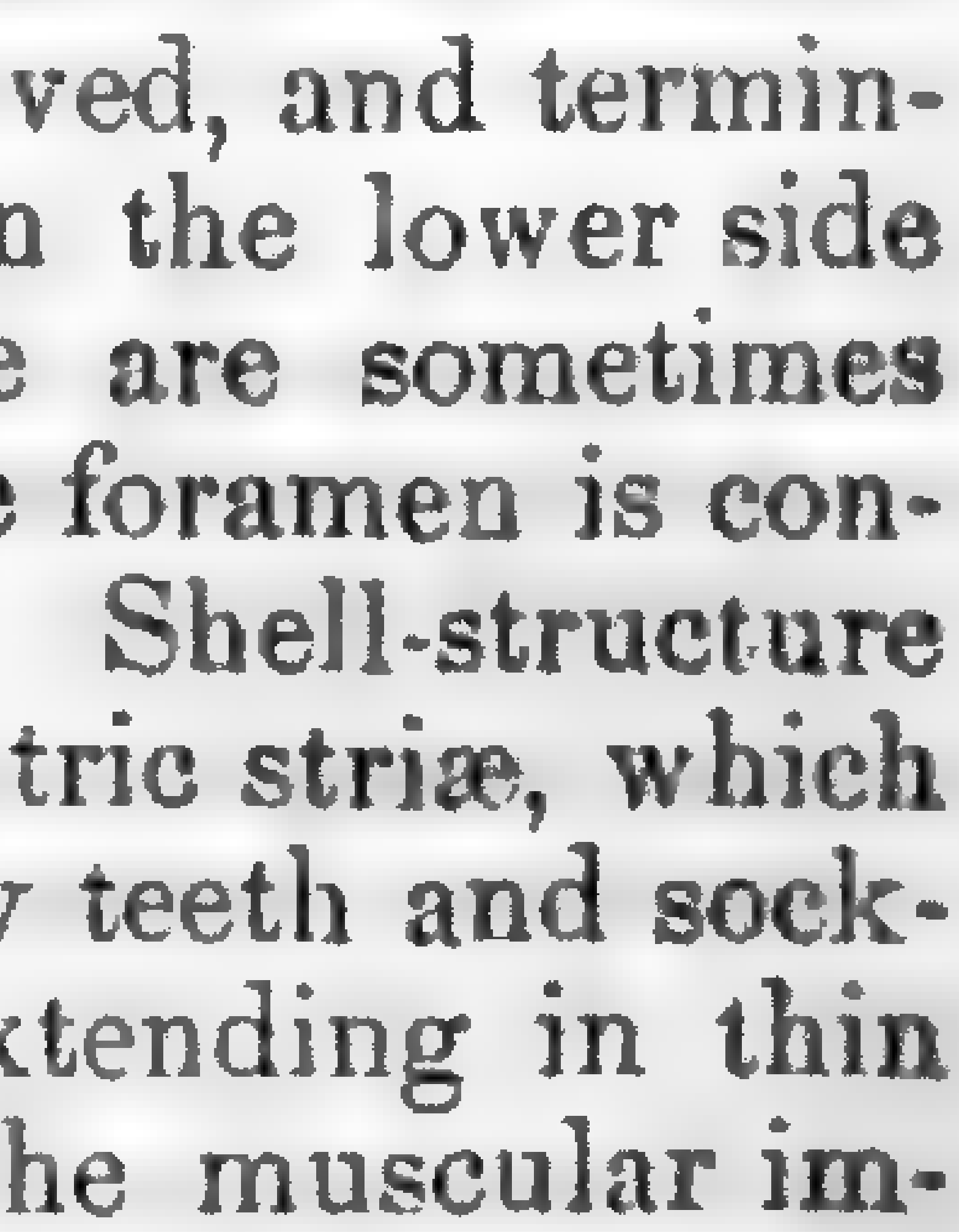
Figs. 8 and 9. Dorsal and ventral views of *Cryptonella* (generic illustrations).—Figs. 10 and 11. Dorsal and profile views of *C. eximia*.

The genus *Cryptonella* may be characterized as follows:

GENUS CRYPTONELLA *Hall*, 1861.—Shells terebratuliform, equilateral, inequivalve, elongate or transverse, ovoid or sublenticular in form, without median fold or sinus, or with these features very slightly developed towards the base of the shell. Ventral valve with the beak extended or incurved, and terminated by a circular foramen which is limited on the lower side by two small triangular deltidial pieces (these are sometimes not visible externally, and the lower side of the foramen is concealed by the umbo of the opposite valve). Shell-structure finely punctate; surface marked by fine concentric striæ, which are sometimes obsolete. Valves articulating by teeth and sockets, the dental lamellæ of the ventral valve extending in thin vertical plates into the cavity of the valve. The muscular impressions of the dorsal valve are strongly marked above, and extend, in two narrow, gradually widening impressions, more than halfway to the base. The ventral valve shows elongated muscular and vascular impressions below the rostral cavity.

In the dorsal valve, the hinge-plates, or bases of the crura, support a slender loop, the two limbs of which are flattened, with the faces vertical; and in its extension forward, the upper margins are inclined towards each other, and, gradually widening, become joined, and thence extending forward, form a single lanceolate plate, which may be more or less attenuate in front. These laminæ of the loop, after becoming thus conjoined and spreading laterally, are abruptly deflected in a vertical plate along the median line, extending into the cavity of the ventral valve, as shown in figure 2, which, while looking upon the dorsal side of the loop, may sometimes

12.



Cryptonella.

be seen projecting backwards between the bands of the loop, as well as extending in front, as shown in fig. 12.

In casts of the ventral valve, we find the marks of two thin dental lamellæ extending to a greater or less distance below the beak. Along the median line in the ventral cast, there is usually a narrow flattened space limited by a slender line; and on each side a less distinct narrow space, limited in the same manner. In the cast of the dorsal valve, there is a median impressed line, and two of less strength on each side of this.

The species of this genus, known to me, are the *Cryptonella* (*Centronella*) *Julia*, and those described as *Terebratula* in the *Thirteenth Report on the State Cabinet*, and which in the *Fourteenth Report* were referred to *Cryptonella*, viz. *Cryptonella* (*T.*) *rectirostra*, *C.* (*T.*) *Lens*, *C.* (*T.*) *planirostra;* and *C. eximia*, of the *Fifteenth Report* as well as a new species from the Schoharie grit.

The *Terebratula Lincklæni*, which has the external characters of *Cryptonella*, and which I have referred to that genus, presents some slight differences in the muscular impressions, which, taken together with its rotund form, are suggestive of true *Terebratula*, to which genus it may possibly belong.

The species of the genus *Centronella* heretofore described have the ventral valve highly convex or subangular in the middle, with the dorsal valve flattened or concave in the middle, or with a median depression, and convex at the sides.

The character of the genus, as given in the descriptions and illustrations of Mr. Billings, are as follows.

GENUS CENTRONELLA, *Billings*,[6] 1859.—"Generic characters: Shells, having the general form of *Terebratula*. Dorsal valve with a loop consisting of two delicate ribbon-like lamellæ, which extend about one-half the length. These lamellæ at first curve gently outwards, and then approach each other gradually, until at their lower extremities they meet at an acute angle; then, becoming united, they are reflected backwards towards the beak in what appears to be a thin flat vertical plate. Near their origin, each bears upon the ventral side a single triangular crural process. Name, from the Greek κεντρον, a spur. This genus is intermediate between *Terebratula* and *Waldheimia*. In the former, the loop is short, not exceeding greatly one-third the length of the shell, and not reflected. In the latter, it extends

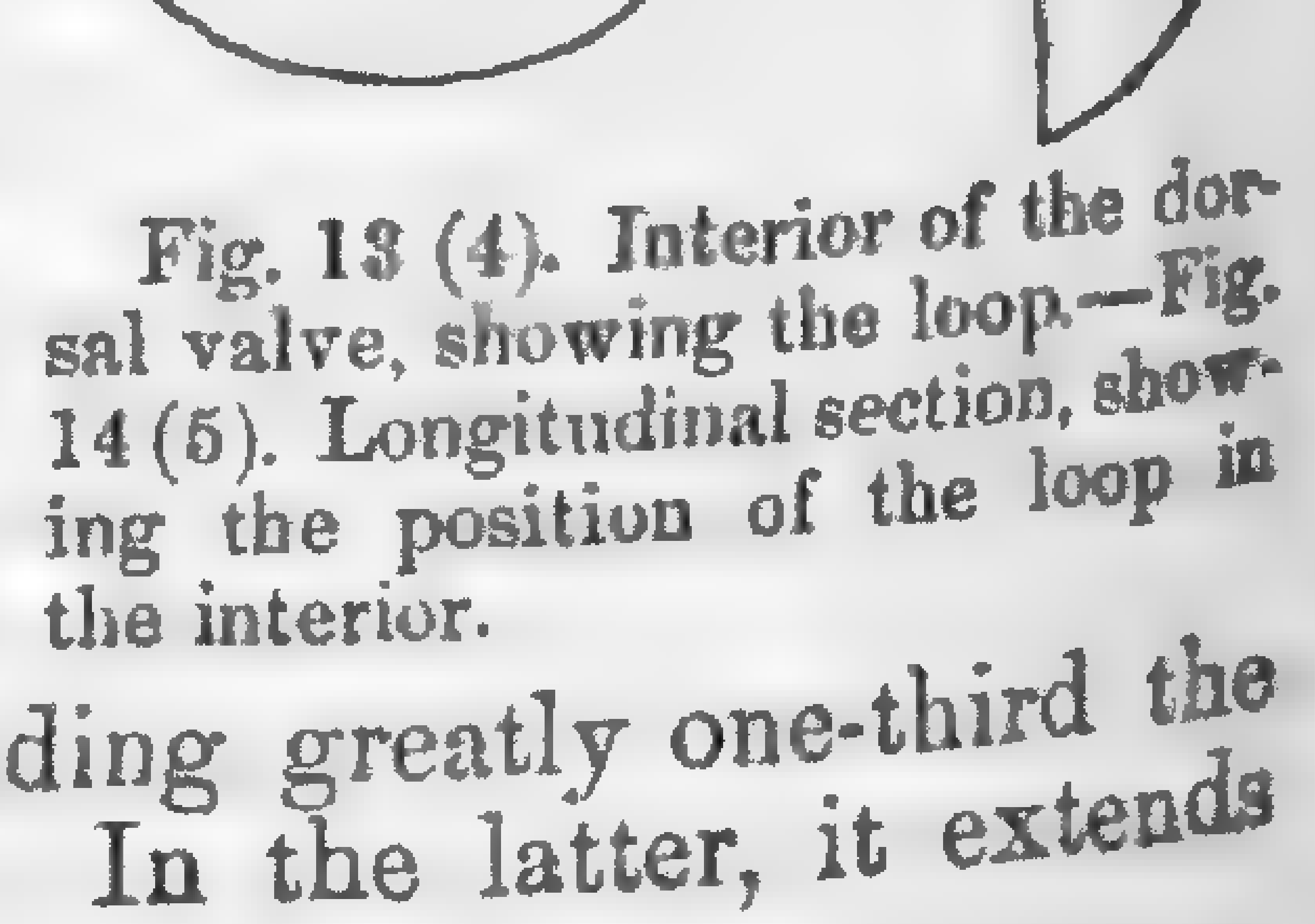


Fig. 13 (4). Interior of the dorsal valve, showing the loop.—Fig. 14 (5). Longitudinal section, showing the position of the loop in the interior.

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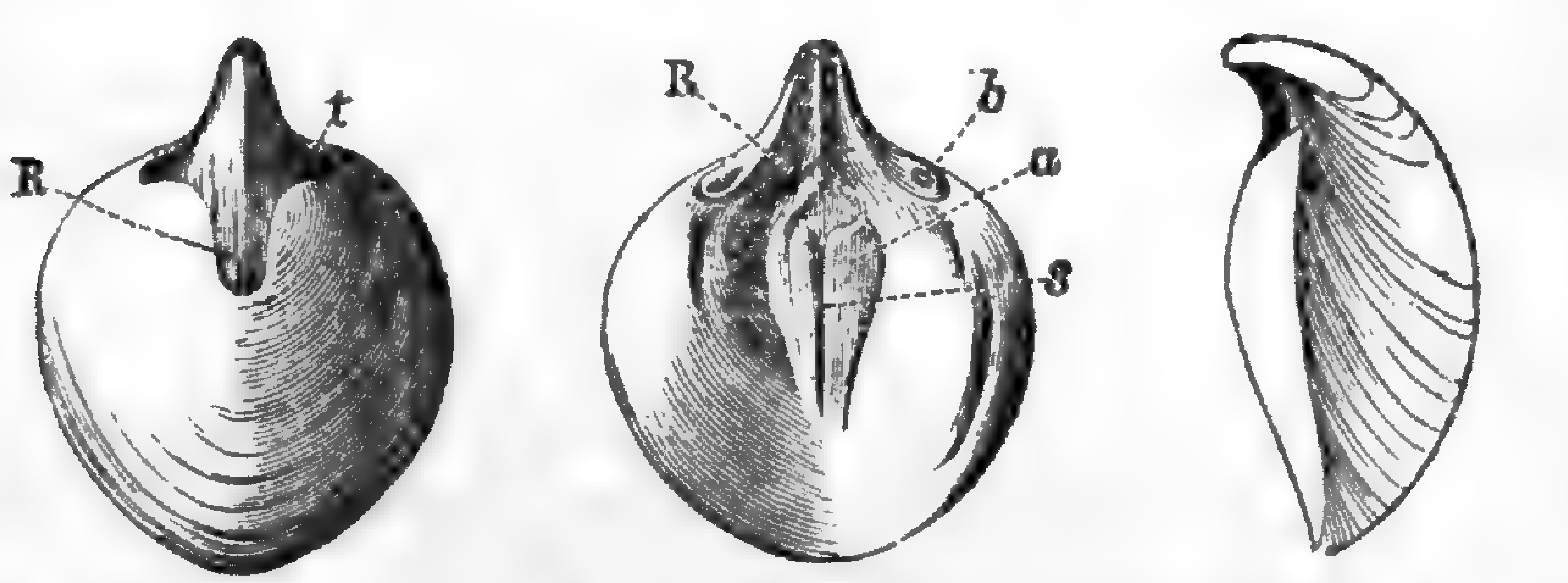
[6] Description and figures copied from the *Canadian Naturalist and Geologist* for April, 1859: the figures enlarged three diameters.

nearly to the front, and is reflected, but the laminæ are not united until after they are folded back."

In *Centronella*, as thus illustrated, we have a simple loop, or the two limbs becoming united at an acute angle at the point of greatest anterior extension, whence they recurve in a thin vertical plate which is not attached at either margin; approaching, in some respects, to *Waldheimia*.

This internal feature is accompanied, in the cast of *C. Glans-fagea*, the typical form of the genus, by other differences which distinguish it from the casts of typical species of *Cryptonella*.



15. 16. 17.

Fig. 15. Ventral view of cast of *Centronella Glans-fagea.*—Fig. 16. Dorsal view of cast of the same.—Fig. 17. Profile view of the same.

In the cast of a ventral valve of *C. Glans-fagea*, fig. 15, we have the filling of a deep rostral cavity; the dental lamellæ have been thick and strong, not extending as thin plates into the cavity of the shell as shown in several species of *Cryptonella*, but having a thick blunt lower termination which leaves no space, or scarcely an appreciable one, to be filled between it and the shell. The spur, or filling of the rostral cavity, is striated; at its base in the centre, on the body of the cast, is a depression; and on each side are fainter striated impressions, indicating the points of muscular attachment.

The interior of the ventral valve of *Centronella impressa*[*] shows similar strong rounded and blunt dental lamellæ, with a deep rostral cavity and muscular markings, which would give a cast similar to that of *C. Glans-fagea*.

The cast of the dorsal valve of *C. Glans-fagea* presents a slightly concave surface, and on each side of the apex two large and deep cavities made by the bases of the crural processes; and between them is a narrow filling of stone. The centre is marked by a double muscular impression, the two parts separated by a narrow groove: above this, and at the base of the crura, are some points marked as if for muscular attachment (see *b*, fig. 16).

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[*] A very distinct species from *C. Hecate* (Billings) of the Oriskany Sandstone, which differs mainly in size from *Centronella* (*Rhynchonella?*) *alveata* (Hall), *Tenth Report on the State Cabinet*, 1857.

The interior of *C. impressa* presents a very strong double process below the beak of the dorsal valve, corresponding to those in *C. Glans-fagea.*

The external form of all the species heretofore referred to *Centronella* is a distinguishing feature, and, when proved to be accompanied by an internal apparatus so different from that of *Cryptonella*, will serve to separate them from all the allied forms.

As before remarked, it has been mainly upon modifications of this internal loop, or the apohysary system, that the separation of most of the genera in the family of *Terebratulidæ* has been made.

In *Cryptonella*, we observe considerable analogy with *Rensselæria*, where the slender bands of the loop expand and unite in

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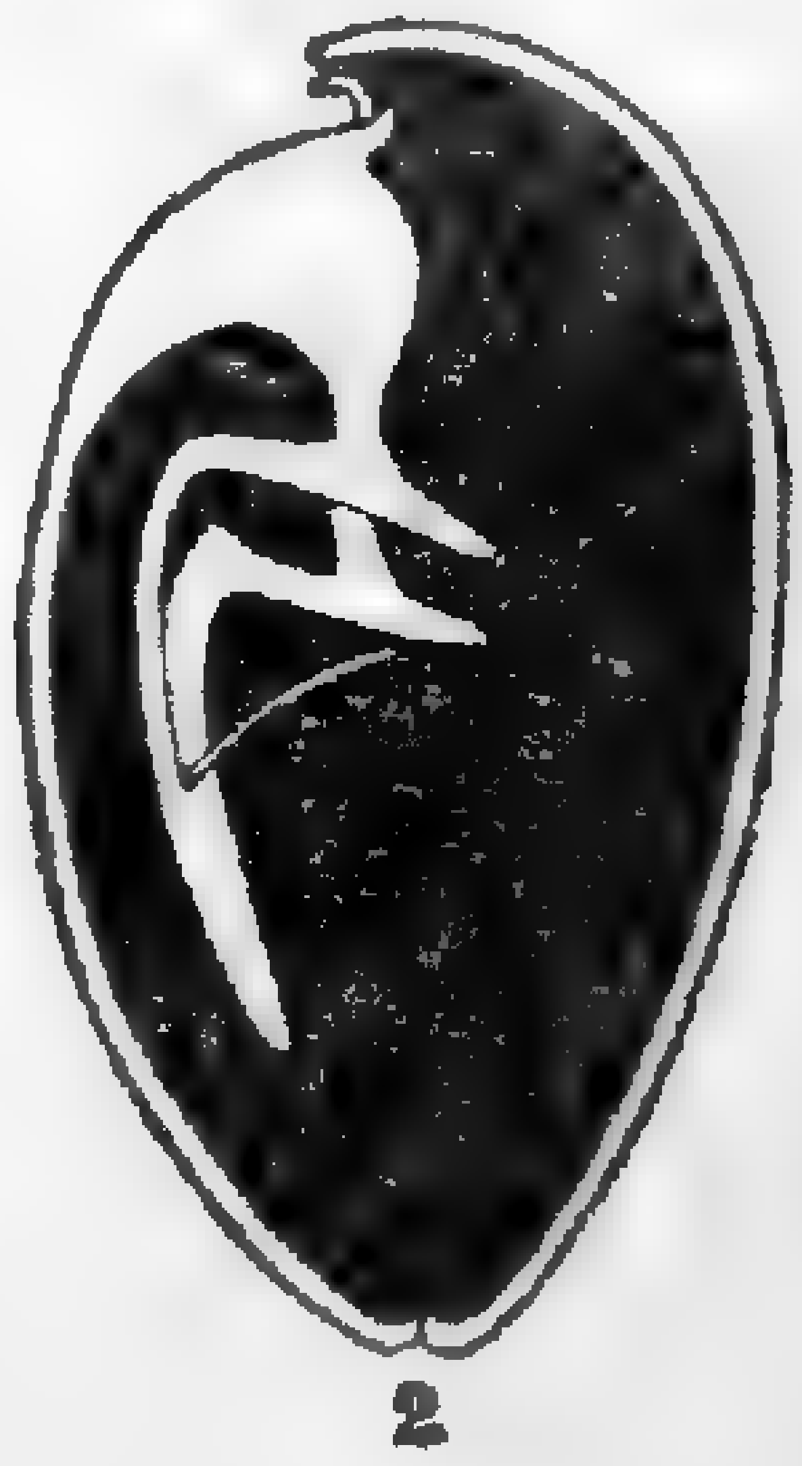

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Fig. 18. Dorsal valve of *Rensselæria Suessana*, showing the internal processes.—Fig. 19. Longitudinal section of the same, showing the relations of the parts.—Fig. 20. Interior of dorsal valve of *R. ovoides.*—Fig. 21. Longitudinal section of the same.

a broad plate, which is obtusely or acutely attenuate in front, and on the ventral side marked by a ridge along the line of junction; from which, at the posterior margin, proceeds a slender process in the ventral cavity. We may readily conceive of this central longitudinal ridge or carina, along the cicatrix of the two parts, being produced into a thin vertical plate, projecting backwards in the line of the process from the base of the conjoined lamellæ in *Rensselœria*, when it would much resemble the median plate of *Cryptonella* (see figures 18, 19, 20 and 21.)

From the data here given, it will be seen that the genus *Cryptonella* is nearly related to *Centronella;* differing in the external form of the typical species, and in some features of the cast.

Since the preceding observations were printed, I have received from Dr. Rominger a figure illustrating the interior of *Centronella Glans-fagea*, as observed by him (fig. 22). Admitting the identity of the species, this figure of the loop is quite different from that given by Mr. Billings for *Centronella Glans-fagea;* and shows essentially the same character as that of *Cryptonella.* Should this internal structure prove to be the true structure of *Centronella*, the minor differences pointed out in the form of the shell and of the cast, between *Centronella Glans-fagea* and authentic *Cryptonella*, are scarcely sufficient to establish generic distinctions.

22.

Centronella Glans-fagea.
Interior showing the loop, from a figure by Dr. C. Rominger.

At a later date however,[*] Mr. Billings has published *Centronella Hecate*, giving, in fig. 99*a* "a specimen with the dorsal valve removed, showing the loop which is covered with minute crystals of silex." In this species, having all the external characters of a congener of *C. Glans-fagea*, no indication is given that any difference had been observed in the character of the loop, from that published in 1859.

Under these circumstances, I hesitate to unite, under a single generic term, these varieties of form with an internal structure so different from that observed in authentic *Cryptonella*, until a reëxamination of the original specimens of Mr. Billings shall confirm his first observations, or show them to correspond with the last named genus.

It is not probable, however, that materials for other genera, or for reference to existing genera, are yet exhausted, among the *Terebratulidœ* of the Upper Silurian and Devonian rocks. While engaged in these investigations, Dr. C. Rominger has kindly sent me a fossil from the Hamilton shales, of Thunder Bay, Michigan, in which the terebratuloid loop is distinctly visible. The form of the shell is ovate, not very unlike *Cryptonella*, but more rotund, the lateral edges more incurved, and the space

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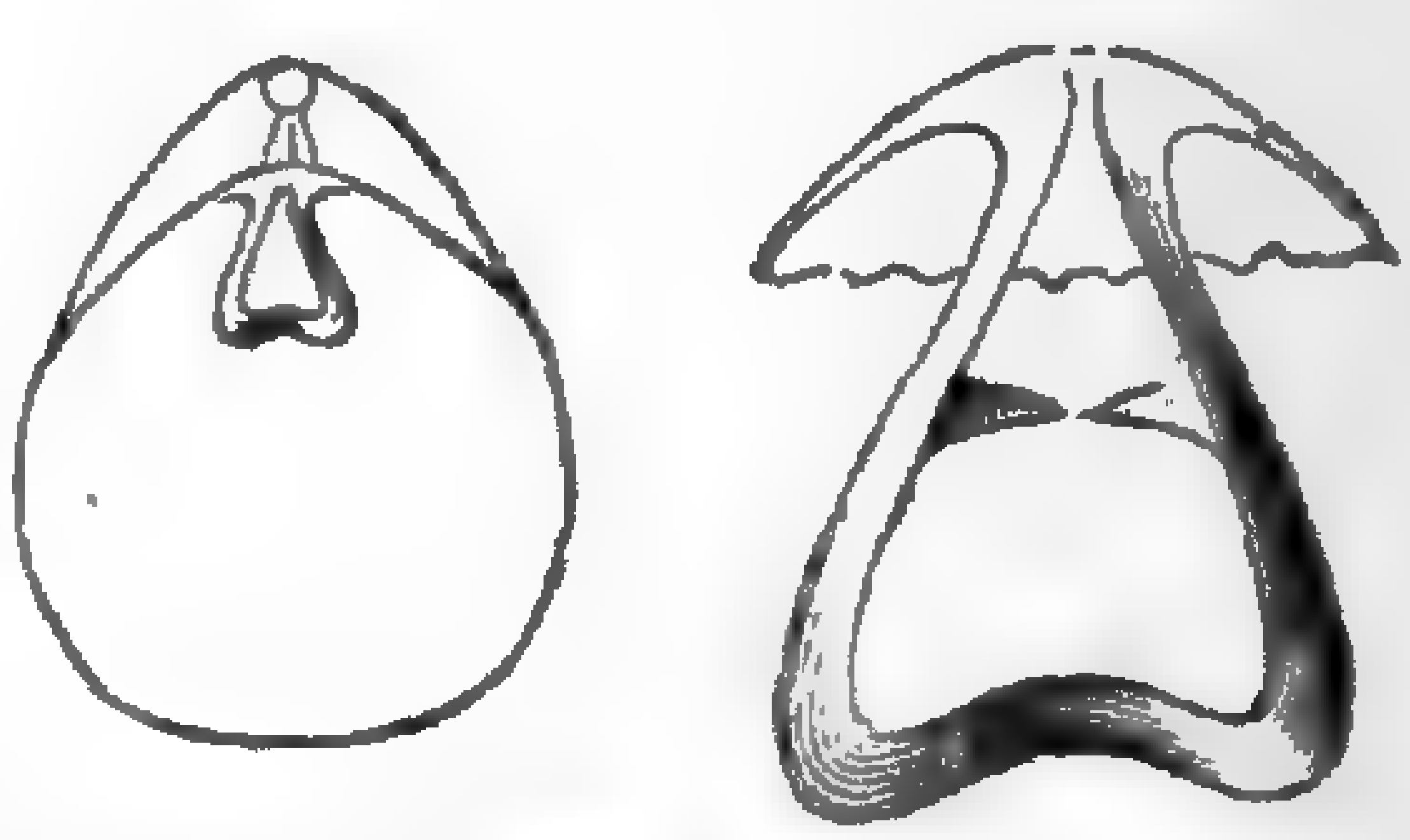
[*] Canadian Journal, May, 1861, p. 272.

below the beak of the ventral valve not so great, nor the deltidial plates so conspicuous as in species of that genus. On a critical examination of the interior, after cutting away the crystalline filling of the shell nearly to the loop, I am unable to find any difference between it and true *Terebratula;* and we have, so far as I know, for the first time the positive determination of this genus in our Devonian rocks. The position and proportions of the loop are shown in fig. 23, which is an outline of the shell from the dorsal side, twice enlarged. Fig. 23*a* is an enlargement of the loop, showing the crural processes.



Figures 23 and 23*a*, Illustrations of *Terebratula Romingeri* Winchell.

At the same time, Dr. Rominger has also sent me specimens of *Terebratula melonica* of Barrande, one of which he has prepared so as to show in a very satisfactory manner the loop in its entire extent. The specimens correspond with those I have received from M. de Verneuil under the same name, and therefore we must regard them as authentic. The external form of *T. melonica* is not unlike some of the less gibbous of *Cryptonella*, and is much less gibbous than the usual forms of *Waldheimia*. The lamellæ are nearly parallel and near together, and the loop is extended four-fifths the entire length of the shell, when it is recurved, and, turning back, extends two-thirds of the distance to the beak of the dorsal valve; and the crural processes are farther from the base of the loop than is represented in the typical figures of *Waldheimia*, and are opposite the extremity of the recurved loop.

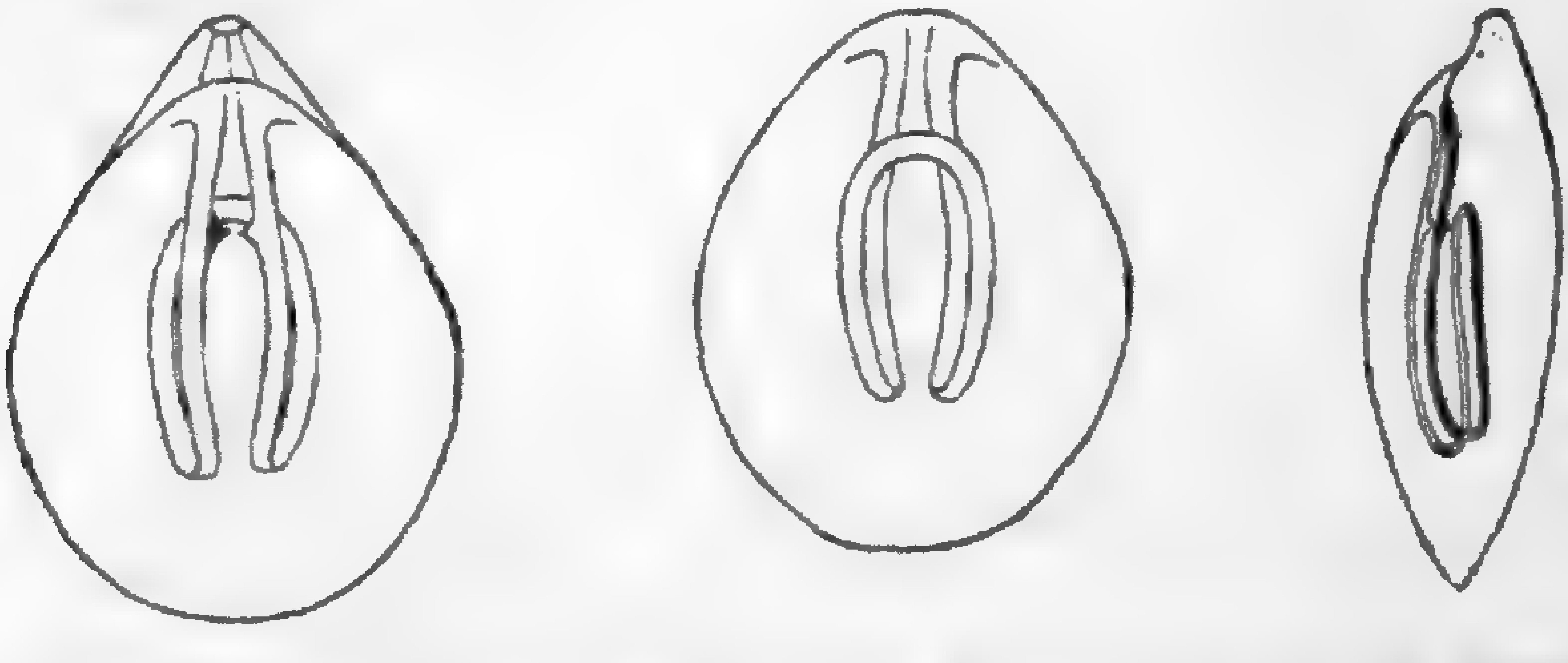


Fig. 24. Dorsal side of *T. melonica*, showing the crural processes directed downwards.—Fig. 25. Ventral side of specimen, looking into the dorsal valves.—Fig. 26. Profile view of same, the figures twice enlarged.

The above figures illustrate all that has been observed in this species.

(*To be continued.*)

ART. XLII.—*Scientific Correspondence.*

I. *Letter on Companion to Sirius, Stellar Spectra and the Spectroscope,* from LEWIS M. RUTHERFURD, dated 175 Second Avenue, New York, March 31, 1863.

Gentlemen:—

1. *Companion to Sirius.*—The position and distance of the companion of Sirius has been measured at my observatory, this season, with the following results. Seventy-nine measures of position, in all, have been made, on six different nights, of which the mean epoch is March 14, 1863; the mean position obtained is 81° 21′ 45″. Thirty-eight measures of distance have been made, the mean result of which is 9″·54. Last year, the position resulting from a mean of forty-eight measures, on six nights, mean epoch March 28, was 84° 58′ 46″, while twenty-eight measures of distance gave 10″·09. From a comparison of these results, it appears that, while the change in distance, 0″·55, is so small that its existence cannot be asserted with confidence, a marked change of position has taken place, amounting to 3° 37′, a quantity so decided that the motion may be taken as fully established: at this rate of motion, assuming it to be circular and in a plane perpendicular to the line of sight, the little star would complete a revolution in about 100 years, or, I believe, twice as long as the period ascribed to the excentric motions in declination of Sirius. I hoped to have been able to compare the direction and quantity of motion detected with the orbit attributed to the opaque body supposed to disturb the great star, but I have been unable to lay my hand upon the papers of Bessel and Peters upon this subject, in time for this letter. I still wonder that Clark's great little star has so long escaped detection; it is a much less difficult object than Mimas, and never fails to show itself in my telescope on any moderately good night. I saw it distinctly in February, with a telescope of nine inches aperture and nine feet focus, made by Mr. Fitz, formerly owned by me, and now belonging to the Hon. Mr. Letsom, British Consul at Montevideo.

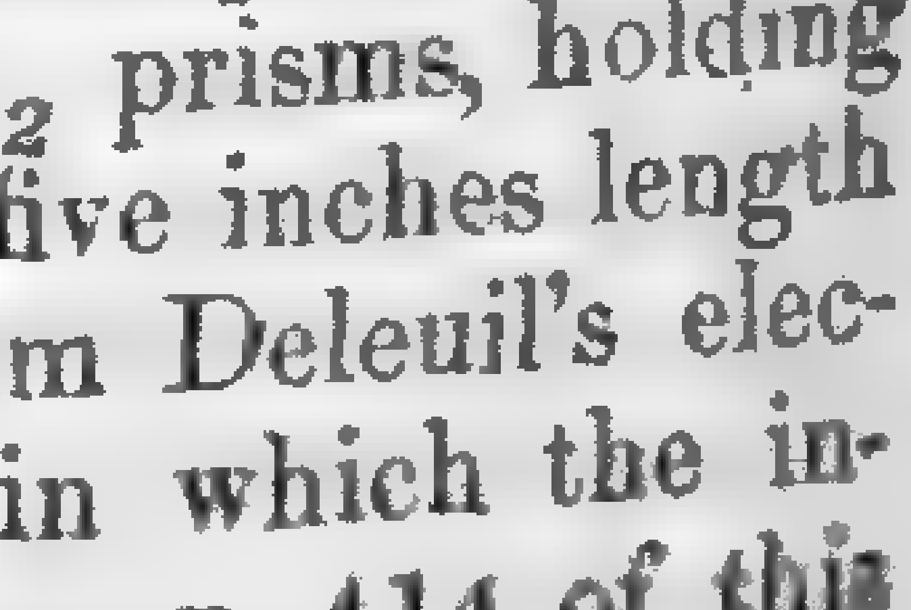
2. *Stellar Spectra.*—Since writing to you in December (p. 71, this volume), I have mounted my astronomical spectroscope in a more firm and convenient manner; I have added a prism, by means of which the spectrum from a spirit lamp is constantly present in the field of view, during the observation of a star: I find this a most useful check, and by means of this comparison I have established the existence in the spectrum of Arcturus of the lines D, E, *b*, and G, and, almost with certainty, found that each line in the spectrum of the star has its counterpart in the solar spectrum.

3. *The Spectroscope.*—I have employed the bad weather, this winter, in the construction of a large spectroscope, telescopes 20 inches focus and 1·6 aperture; the prisms, of which I have so far used but six, are hollow cases of brass cast in one piece, with their faces carefully ground, upon which are cemented plates of glass, originally made for shades for artificial horizons, and consequently nearly plain and parallel; I say nearly, for I have yet to find one square inch of plain and parallel glass; these prisms under certain conditions perform beautifully; the obstacles

to fine performance are two-fold. 1st. I find no specimen of bisulphid of carbon homogeneous in density: upon shaking or disturbing the position of the prism a violent agitation of the image occurs, and in examining it without the eye-piece, after the mode adopted in detecting veins in an object-glass, the whole interior of the prism is seen full of waves and striæ, presenting the appearance of alcohol and water not yet thoroughly mixed; this trouble is cured by time, from a quarter to a half hour being a sufficient rest. 2d. The brass frame is so much more affected by temperature than the glass plates that any great variation is destructive of good definition. This is, I fancy, the cause of the distortion of surface observed by Prof. Rood, rather than the warping effect of the glue. I propose to cure the evil by constructing the frame of solid glass; but, although it is a simple triangular block pierced with an oblong hole, I have not yet found a glass-maker adventurous enough to undertake its construction. I shall persevere, however, for I prefer this remedy to the ingenious plan, adopted by Prof. Rood, of applying additional plates of glass, the surfaces being separated by a thin film of fluid which will not communicate to the outer plate the distortions of the inner: the objections to this plan are that it is complex, the fluid is liable to exude or accumulate in greater thickness at the lower edge of the plates, and, above all, the difficulty of obtaining thin glass with true surfaces.

[The trouble mentioned by Mr. Rutherfurd is probably due to the high coefficient of expansion of CS_2, which renders it so sensitive to changes of temperature that simply handling the prisms will disturb the uniformity of density in the manner noticed by Mr. R. In a large spectroscope constructed by Mr. Alvan Clark of Cambridge or Prof. Cooke, from the plans of the last-named gentleman, eight CS_2 prisms on iron frames are used, with Prof. Rood's plan of glass cover plates. These plates are polished with the greatest care, and give results quite satisfactory. Prof. Cooke has also succeeded in obtaining, from the New England Glass Works, glass triangular frames in one piece with an oval opening, from which Mr. Clark has prepared CS_2 prisms, holding nearly a pint of liquid, and exposing faces of about five inches length by three high; two of these project a spectrum from Deleuil's electric lantern with great intensity, fourteen feet long, in which the inversion of the D line by vapor of sodium (mentioned on p. 414 of this volume) is very effectively shown.—B. S., JR.]

4. *Analysis of the Sodium line D.*—As I said above, my brass prisms under favorable conditions perform admirably; with six of them I am confident that I have seen the line D composed of nine (see figure); this diagram is rude, not founded upon measures, but merely a copy of a sketch made when I first saw the lines; the three on the right of Kirchhoff's central line are not difficult, being readily seen with three prisms of 60°, of bisulphid and one of 45°, of glass (it not being possible to use four of 60° on account of the interference of the telescopes). Of the three in the left compartment, the central one is the most difficult, and all require the best adjustment and light.[1]



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[1] Since writing the above, I have entirely confirmed the correctness of this diagram, having at one time used eleven prisms. — R. April 17th.

The line B is resolved into fourteen fine and close lines, with a beautiful and symmetrical band of finely doubled lines stretching towards A; I think it the most beautiful part of the spectrum. A broad band of fine and close lines adjoins A on the least refrangible side, somewhat resembling the neighborhood of B, and I am confident that A itself is composed of fine lines. In the potash spectrum, I have found some peculiarities which I have not seen mentioned: beginning at the least refrangible end we have the first line A boldly double; a little short of the place of the red lithium line is another pair not quite so wide as the first, which flash but for a moment; close upon the green side of the soda line is a group of four lines, three quite strong and one faint; further on in the green is another group of three lines, and finally the violet line β is double, about as widely separated as A. I have not yet measured the places of these lines, but will send you the results when obtained. The orange strontium column is beautifully resolved into close and fine lines. I am very truly yours,

LEWIS M. RUTHERFURD.

II. *On the origin of the nitrites, &c.*, in a letter to the Editors from Prof. GEO. C. SCHAEFFER, dated Washington, D. C., March 18th, 1863.

Gentlemen: In the last number of your Journal, p. 271, there is a letter from T. Sterry Hunt, F.R.S., on the theory of nitrification depending upon the formation of nitrite of ammonia from water and atmospheric air. This letter requests, as "an important part of the history of this subject, and especially as an explanation of the theory of the reaction," the reproduction, from the "*L. E. and D. Philos. Magazine*, for January, 1863," of the "translation of a note *On the nature of Nitrogen and the theory of Nitrification*," read by Mr. H. "before the French Academy of Sciences, on the 15th of last September."

Mr. Hunt also says, "My object is to claim for myself the new theory of nitrification, which Schönbein seeks to found upon his recent experiments, and which I published nearly two years since."

As an humble worker in the cause of science, I would also ask permission to contribute my mite to the history of this subject.

In the *Annual Report of the Smithsonian Institution* for the year 1861, there is (p. 305) a *Report on Nitrification presented to the Smithsonian Institution in* 1858 [1856][1] by Dr. B. F. Craig, in which the following passage occurs:

"Viewing the subject by the aid of such lights as science affords, the hypothesis which appears to be best in accordance with the facts known, concerning the combination of oxygen and nitrogen, is that propounded by Dr. G. C. Schaeffer, which is based upon that general chemical action by which various bodies assume the elements of water in such a way as to produce salts of ammonia. This action takes place very commonly

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[1] Since this letter was written, the following note has been furnished by Dr. Craig:

"March 29th, 1863.

"The date appended to my paper on Nitrification, which was published in the *Smithsonian Report* for 1861, is a misprint. The real date on the manuscript is 1856. I did not correct the proof, a circumstance which will account for the occurrence of this and a few other typographical errors. B. F. CRAIG."

with those substances which are produced from ammoniacal salts by the *separation* of the elements of water, and may be effected under the influence either of acid or of alkalies, and sometimes by the action of water alone at a high temperature.

"Nitrous oxyd (NO) will generate the nitrate of ammonia by the assumption of the elements of water; for, by the action on it of water and potash at an elevated temperature, ammonia is evolved and nitrate of potash formed, showing that there has been a production of nitrate of ammonia, and a subsequent decomposition of it by the potash. [There are numerous substances which are formed from salts of ammonia by the separation of the elements of water, and which will regenerate the salts by reassuming them. They are known to chemists as amids, anhydrids or nitryls]. Supposing nitrogen to act in the same way, viz: to assimilate four equivalents of water, it will form *nitrite* of ammonia, which, by a well known tendency of the nitrites, will pass into the condition of a nitrate. [The action consists in the assumption of the water by two equivalents, of the nitrous oxyd in one case, and of the nitrogen in the other. In the case of nitrous oxyd it may be represented thus $N_2O_2+H_4O_4=NO_6NH_4$; and in the case of nitrogen $N_2+H_4O_4=NO_4NH_4$]. If potash be present, the nitrite of potash will be produced by decomposition of the ammoniacal salt, and the ammonia set free may itself be nitrified. Without going into theoretical discussions, this hypothesis may be alluded to as one arrived at by legitimate analogies, and which it would be interesting and useful to test by experimental investigations."

The foregoing passage is exactly copied from the Report, with the exception of obvious typographical errors and the incorporation of the foot-notes enclosed in brackets.

As a further contribution to the history of the subject the following reference may be made: In the *Proceedings of the American Association for the Advancement of Science*, Fourth Meeting, held at New Haven, Conn., August, 1850, there will be found on page 206 a paper headed "*On a new test for nitrates.* By Prof. G. C. Schaeffer of Center Coll., Ky., read with comments by T. S. Hunt, Canada Geological Commission." This notice contains in a few lines an erroneous statement of the test, and in several more lines a criticism upon it, to which are appended brief replies of Mr. Hunt and Prof. Silliman, Jr., to this criticism. At page 403 however, there is a copy of the paper as sent *before* the time of meeting, and for the recovery of which, and its insertion, the writer is indebted to the kindnes of Mr. Hunt.

A few quotations from this paper must conclude this intrusion upon your patience.

"*New test for the Nitrites and Nitrates*, &c.—Chemistry has hitherto furnished no distinctive test for the nitrites when presented in small quantities. From the supposed unfrequent occurrence of these salts, the want of such a test has never been felt.

"For several years, I have been engaged in a research which has led me to believe that the nitrites are of far more frequent occurrence than is commonly supposed, and that they have been mistaken for nitrates, as the usual process, with pure sulphuric acid and protosulphate of iron, will give the same reaction with both classes of salts." Among the difficulties encountered is named this one, "the nitrites are generally either destroyed or converted into nitrates with such readiness that it would be almost impossible to concentrate their solutions." After describing the care required in making this test, the following words are found: "With these precautions, I have found this test astonishingly delicate, in fact ranking with those for iron, iodine, &c. Using fused nitre, I have detected the presence of 1 pt. in 617,000 pts. of water; a bystander, wholly ignorant of the nature of the operation, pronouncing as to the color. Yet this salt contained about one-half its weight of undecomposed nitre."

Next follows a description of the conversion of this test into one for the nitrates, after which this remark is made: "In estimating the delicacy of this process, I had used pure rain-water, but before completing the experiments I was obliged to be absent for several days; on my return, I soon found that the water from the same cistern contained so much of nitrates and nitrites that it could no longer be used." "The interval had been marked by the occurrence of frequent and severe thunder showers."

It is very doubtful whether an earlier notice than this, of the presence of nitrites in rain-water, can be produced.

In spite of its unfortunate position in the volume, it seems that the paper just quoted has been republished in this country, in England and on the continent, and, as the much valued *Reports of the Smithsonian Institution* are widely distributed, the verification of the quotations above cited can readily be made.

It is a matter of regret that the want of time and the absence of documentary evidence, soon to be supplied, prevents, at present, the continuation of my contributions to the history of this subject as connected with chemical science; since the result, it is believed, would show another and an earlier origin for these views than any which has yet been assigned to them.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS.

1. *On the Fraunhofer lines visible in the Solar Spectrum.*—Angström has communicated an interesting paper on Fraunhofer's lines, from which we shall extract a few notices relating to particular points not specially mentioned in the more recently published memoir of Kirchhoff. The author begins by referring to a previous memoir of his own, in which he had endeavored to show that a body in a state of glowing heat emits just the same kinds of light and heat which it absorbs under the same circumstances. The conclusions there arrived at were as follows.

The electrical spectrum is composed of two superposed spectra, the one belonging to the metal of the electrodes, the other to the gas through which the spark passes, the two spectra being distinguishable by the difference in appearance. Metallic compounds and metallic sulphids have in their luminous spectra the same lines as each of the bodies which the compound contains, and this affords a ready method of qualitative analysis. In the same paper, the author remarked that Fraunhofer's lines were an inversion of the bright lines in the electrical spectrum, and that an explanation of the lines in the one system would probably furnish an explanation of those of the other, according to the principle laid down in that dissertation. In the present memoir, the author applies the general principle to the case of the sun's atmosphere, and distinctly states that, by determining coincidences between the dark lines in the sun's light and the bright lines in the electric spectra of different metals, we can determine what metals exist in the solar envelope. As Angström's memoir was read before the Royal Academy of Science at Stockholm, Oct. 8, 1861, it appears that the priority of conception, at least, belongs to him, while Kirchhoff has the honor of being the first to demonstrate the truth by direct experiment. Kirchhoff's map of the spectrum extends only from D to a little beyond F; the following statements will therefore interest the chemist. Between G and H there are fifteen strong iron lines, all having their counterparts in the solar spectrum. The two strongest of these lie at about one-fourth and three-fourths of the distance between H and G, and that nearest G is double and contains a calcium line. The third of the lines marked *b*, reckoning towards F, is double, and belongs to both magnesium and iron. Calcium has three strong lines at the violet end of the spectrum, of which two correspond to the H lines, and the third in order forms with one of the iron lines the above-mentioned strong double line. Calcium has also six lines coinciding with lines of the G group, three between G and F, and groups of fine lines at E and between E and G. Aluminum exhibits two strong lines between the two H lines of the solar spectrum and corresponding to two dark lines. Between H and G aluminum probably forms a continuous spectrum. The manganese spectrum exhibits a considerable number of lines. Between G and H two groups of manganese lines coincide with two similar groups of iron lines, and between G and F there are also thirteen manganese lines closely approaching those of iron, and certainly corresponding to dark lines in the solar spectrum. Strontium has two strong lines between H and G which appear to correspond to solar lines, but the strong blue strontium line between G and F has no corresponding line in the solar spectrum. The author assumes further that the line C belongs to hydrogen. An interesting discussion of the theory of thermometric heat concludes Angström's memoir, which, it must be remembered, although first published in English in July, 1862, in reality preceded the important memoir of Kirchhoff.—*L., E. and D. Phil. Mag.*, xxiv, 1, July, 1862.

W. G.

2. *On the violet flame of many Chlorids.*—Gladstone has observed that the majority of the lines in A. Mitscherlich's diagram of the flame of chlorid of copper (given by Miller in 1845) are common to a large number of chlorids if they are sufficiently heated. Thus, in the burning of old ship timber, which of course contains various alkaline and earthy chlorids, the light consists of three groups of lines, the first green and extending to *b*, the second bluish green and blue on either side of F, the third violet from midway between F and G to a little beyond G. These bands may be resolved by the spectroscope into groups of lines which are identical with the lines of chlorid of copper, as shown by ac-

tual angular measurement. The yellow sodium light is wanting. The chlorids of copper, platinum, gold, mercury, nickel, cobalt, zinc, iron, sodium, potassium, and barium, all exhibit the characteristic violet light when sufficiently heated. The explanation of these phenomena is not apparent in the present state of our knowledge.—*L. and E. Phil. Mag.*, xxiv, 417, December, 1862. W. G.

3. *On the Solar Spectrum.*—MERZ has communicated a few notes on the construction of the spectroscope and kindred subjects, which are worthy of attention. The author in the first place gives a *resumé* of the results of Fraunhofer with the spectra of fixed stars, and then quotes very briefly from a memoir of Prof. Donati of Florence, which we have not seen, and which describes the spectra of Sirius, Vega, Procyon, Regulus, Fomalhaut, Castor, Atair, Capra, Arctúrus, Pollux, Aldebaran, Rigel, and Antares. From these observations, it appears probable, according to Merz, that iron plays the chief part in the atmosphere of all these stars. The next notice refers to the use of very large prisms and telescopes for the observation of the spectrum. The author found that a flint glass prism of 60°, with a face 43 lines in breadth, placed in the corresponding section of a beam of parallel rays emerging from a condenser with an aperture of 34 lines, resolved the line D into five lines. A prism with a face of 19 lines resolved D into three lines. When eleven prisms were used, with an angle of about 480°, D was resolved into seven lines. The author expects that great advantage will result from an increase in the size of the prisms and telescopes, and proposes to experiment in that direction.—*Pogg. Ann.*, cxvii, 654, Dec. 1862.

W. G.

[Compare Prof. Rood's article on Merz's results, p. 356 this volume.—*Eds.*]

4. *A new Spectroscope.*—LITTROW has devised a new form of spectroscope, in which only one telescope is necessary, and in which four prisms are made to give the same dispersion as eight with the old arrangement. In this instrument the bundle of rays which diverge from the slit are rendered parallel in the usual manner by an achromatic lens placed at the opposite end of the condensing telescope. The rays then traverse successively four or more flint glass prisms of 60°, then fall upon a mirror which reflects them back so that they again traverse the prisms and fall upon the lens of the condenser. This lens produces an image of the spectrum near the slit, where a prism is placed so as to throw the rays into a lateral ocular. The prisms are so connected that by turning a pinion the whole spectrum can be brought in succession into the field of view, each prism being constantly in the position of minimum deviation for each ray. The apparatus with four prisms costs in Vienna only 420 francs, and gives, according to the inventor, many lines not seen in Kirchhoff's map. An apparatus involving a similar principle has also been described, though very obscurely, by Janssen.[1] The adjustment of the prisms in Littrow's apparatus ought to be adopted in all spectroscopes in which more than one prism is employed.—*Cosmos*, xxi, 650.

W. G.

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[1] Comptes Rendus, June 23d, 1862.

5. *On the Spectra of the Alkaline Metals.*—Wolf and Diacon have studied the spectra of the alkaline metals produced by very high temperatures, and have found that even the light of sodium is not monochromatic. The authors obtained their spectra by passing hydrogen through a slightly bent tube containing potassium, sodium, or a volatile chlorid, and heated to a convenient temperature. The hydrogen, on issuing from the tube, is mixed with oxygen and burned. Under these circumstances, many metallic chlorids give remarkably well defined and long-continuing spectra. Metallic sodium gives in this manner six well-defined lines between C and F, upon a faintly colored ground, which, however, is not continuous, but exhibits two sudden variations in intensity. Potassium gives a magnificent spectrum, in which eleven lines—for the most part already noticed by Debray and Grandeau—are observed. Chlorid of lithium gives four brilliant and characteristic lines. Finally, the chlorids of copper and zinc give very well defined spectra of great intensity.—*Comptes Rendus*, lv, 334. W. G.

6. *Contributions to spectral analysis.*—Böttger has published a few notices relating to the spectral analysis, from which we extract what is new. Selenium gives, according to Böttger, between the yellow and the violet, a very large number of equidistant dark lines. Native selenid of mercury gives the same reaction. When coal-gas, before reaching a Bunsen's burner, is caused to pass through a wash-bottle containing a little chloroform, a flame is obtained which exhibits a beautiful green inner cone, the spectrum of which exhibits two dark blue lines at the extreme end of the violet, three very broad green lines between D and *b*, and a broad blue line between F and G. Chlorid of bismuth produces a great number of bright lines in the red and blue, which, however, last but an instant. Fluor spar gives, in addition to the calcium lines, a beautiful clear blue line, which, according to Böttger, is characteristic of fluorine. Böttger found this line in all the varieties of fluor spar as well as in chemically pure fluorid of calcium, but not in cryolite or fluorid of potassium. The spectrum of cyanogen—long since observed by Draper—is of extraordinary beauty.—*Journal für Prakt. Chemie*, lxxxv, 392. W. G.

7. *On the spectrum of Sodium.*—Fizeau has made the very noteworthy observation that metallic sodium in a state of active combustion gives a *continuous* spectrum in which the line D appears as a *dark* line. Potassium and magnesium do not give continuous spectra under the same circumstances, and Fizeau's observation at present stands entirely isolated, without even an attempt at explanation.—*Comptes Rendus*, liv. W. G.

[Draper's experiments have shown that metals up to a white heat give continuous spectra. At a higher temperature each metal appears to give a discontinuous spectrum or one marked by brilliant lines with intervening dark spaces, as shown by Kirchhoff. Is it not possible that at a still higher temperature the spectra again become continuous, the temperatures at which this takes place being different for each substance? This theory explains the occurrence of more brilliant lines at very high than at lower temperatures, continuity being simply the limit finally reached. If we admit the correctness of this view, Fizeau's experiment may be explained very simply, since the intense light of the body of the flame of burning sodium, which in itself gives a continuous spectrum, passing through the portion of the flame ignited at the edges in contact with the air and of lower temperature, or still more probably through vaporized metallic sodium which has escaped combustion, will reverse the brilliant line D, and thus give a dark line upon a continuous bright spectrum. If this explanation, upon further knowledge of the facts, should prove correct, it will not be necessary, with Kirchhoff, to suppose that the solid body of the sun is ignited or luminous. For the temperature of the photosphere may reasonably be supposed to be highest nearest the surface of the body of the sun, since there the condensation is greatest. Those layers or strata nearest the sun will then give continuous spectra, and the rays from there passing through the outer strata will give spectra containing Fraunhofer's lines, according to the principle laid down by Angström, Kirchhoff, and others. The temperature of burning sodium cannot be determined by calculation, so long as we are ignorant of the specific heat of the oxyd NaO in the form of vapor. We may assume that this specific heat under a constant pressure is not more than one-half of that of water, and we shall obtain the temperature of combustion by dividing the heat of combustion by the specific heat. According to Favre and Silbermann, we have for the heat of combustion the number 3195, which, divided by 0·5, gives for the temperature of combustion 6390° C., which is less than that of hydrogen (=8061° C.) burning also under a constant pressure. But if the specific heat of soda, NaO, in the form of vapor, be taken as one-fourth of that of water, we shall have for the temperature of combustion 12780° C. It appears by no means improbable that the actual temperature is even higher than this.—W. G.]

8. *On the indices of refraction of fluid homologous compounds.*—Landolt has given a very interesting and valuable investigation of the coefficients and indices of refraction and dispersion of the acids of the homologous series $C_{2n}H_{2n}O_4$, of which formic acid is the first term. The author employed a Meyerstein's spectrometer, reading to 10 seconds of arc. The liquids were enclosed in hollow prisms, the refracting angles of which were carefully measured after each cleaning and remounting. The source of light employed was a Geissler's hydrogen tube placed immediately in front of the slit of the spectrometer. The passage of the discharge of a Ruhmkorff's coil gave the three brilliant hydrogen lines α, β, γ, observed and described by Plücker, and for which that physicist found the wave lengths $\lambda_\alpha = 6{\cdot}533$, $\lambda_\beta = 4{\cdot}843$, $\lambda_\gamma = 4{\cdot}339$. The position of these lines is fixed by the wave lengths of Fraunhofer's lines, which are as follows:

λ_B.	λ_C.	λ_D.	λ_E.	λ_F.	λ_G.	λ_H.
6·878	6·564	5·888	5·260	4·843	4·291	3·928

expressed in hundred-thousandths of a centimeter. The employment of the three hydrogen lines, α, β, γ, permits the observations to be made at all times and with the greatest facility and accuracy. Landolt further determined the indices of each substance for a series of temperatures, selecting 20° C. as the normal temperature. The bulb of the thermometer was in each case plunged directly into the liquid; the prism and liquid were heated to 30° C. and allowed to cool slowly, the observations being made from degree to degree. The method of measurement employed was that of least deviation. According to Cauchy, the connection between the wave length and corresponding index of refraction is expressed by the equation

$$\mu = A + \frac{B}{\lambda_2},$$

in which A is the coefficient of refraction, and B the coefficient of dispersion. If the indices μ_α and μ_γ be determined by direct measurement for a given substance, we have the two equations

$$\mu_\alpha = A + \frac{B}{\lambda_\alpha^2}$$

$$\mu_\gamma = A + \frac{B}{\lambda_\gamma^2},$$

from which we find

$$B = \frac{\mu_\gamma - \mu_\alpha}{\frac{1}{\lambda_\gamma^2} - \frac{1}{\lambda_\alpha^2}} \qquad A = \mu_\gamma - \frac{B}{\lambda_\gamma^2}.$$

Thus for water the indices found were

$$\mu_\alpha = 1{\cdot}33120$$
$$\mu_\beta = 1{\cdot}33723$$
$$\mu_\gamma = 1{\cdot}34050.$$

From μ_α and μ_γ and the wave lengths

$$\lambda_\alpha = 6{\cdot}533$$
$$\lambda_\gamma = 4{\cdot}339,$$

we obtain for the constants A and B at 19° C. the values

$$A = 1{\cdot}32386$$
$$B = 0{\cdot}31328.$$

Calculating from these the value of μ_β, we find $\mu_\beta = 1{\cdot}33722$, which agrees very closely with the actual measurement, 1·33723. For the line D the calculated index was 1·33290, the value found by direct measurement also 1·33290. The author gives the values of A and B for each substance at each temperature measured. With these values he also calculates the indices of refraction of each substance at the normal temperature of 20° C. for the seven Fraunhofer's lines B . . . H. The most interesting general results of Landolt's measurements, which begin with formic and end with œnanthylic acid, are as follows. The indices of refraction increase with the number of equivalents of carbon and hydrogen, but by no means uniformly. The indices for all the acids increase in about the same degree as the wave lengths diminish. The curves for the different acids are not equidistant, but, excepting in the case of formic acid, are nearly parallel. The coefficient A also increases irregularly with the carbon and hydrogen. The diminution in A for 1° C. becomes less from acetic acid upward, but the differences are very small. The change in the case of formic acid is less than in any of the others. The coefficient B also increases with the increase of carbon and hydrogen, except in the case of formic acid. Also the elongation of the spectrum, as measured by the difference $\mu_\gamma - \mu_\alpha$, increases with the degree of the acid in the series, excepting in the case of formic acid. The author promises a further discussion of the results of his measurements, as well as an examination of the indices of the homologous alcohols $C_{2n}H_{2n+2}+O_2$.—*Pogg. Ann.*, cxviii, 353. W. G.

II. CHEMISTRY.

1. *On the coloring matters derived from aniline.*—Dr. HOFMANN has published an elegant investigation of the colors derived from anilin, which places the chemical nature of these substances in a clear point of view. Hofmann finds that the red coloring matter, produced by the action of the chlorids of carbon, tin, mercury, and other metals, and of certain oxydizing agents upon anilin, is an organic base which has the formula $C_{40}H_{19}N_3$. This base he terms Rosanilin; in a pure state it is a perfectly colorless crystalline body, slightly soluble in water, and becoming red on exposure to the air. It dissolves in alcohol with a dark red color. The change of color is not accompanied by a change of weight. On distillation, the base yields anilin and a carbonaceous mass. The hydrate is $C_{40}H_{19}N_3, 2HO$. The base is triacid, but forms three classes of salts:

$$C_{40}H_{19}N_3.HCl$$
$$C_{40}H_{19}N_3.2HCl$$
$$C_{40}H_{19}N_3.3HCl.$$

The salts with one equivalent of acid are very stable; they exhibit for the most part a green metallic lustre like the wings of cantharides. They are red by transmitted light, and their solutions have a magnificent red color. The salts with three equivalents of acids are yellowish-brown, both in the mass and in solution. The chlorids $C_{40}H_{19}N_3.HCl$ and $C_{40}H_{19}N_3.3HCl$ unite with bichlorid of platinum to form uncrystallized salts; the triacid chlorid loses acid on heating to 100° C., and becomes indigo-blue, which Hofmann attributes to the formation of an unstable intermediate chlorid. The author describes several crystallized salts of rosanilin; the acetate $C_{40}H_{19}N_3.C_4H_4O_4$ is the most beautiful. The action of nascent hydrogen converts rosanilin into leucanilin, $C_{40}H_{21}N_3$, which is colorless and crystalline, and forms salts containing three equivalents of acid. Oxydizing agents convert leucanilin into rosanilin, so that Hofmann compares the two bases to blue and white indigo.

Hofmann has further examined a beautiful yellow coloring matter which is formed in the oxydation of anilin, and which he terms chrysanilin. This base exists in large quantity in the resinous substance which accompanies rosanilin in all the usual modes of preparation. The base in question appears to have been first prepared by Nicholson, and presents a fine yellow amorphous powder, which is scarcely soluble in water but very soluble in alcohol and ether. The formula of chrysanilin is $C_{40}H_{17}N_3$, and it yields two classes of well crystallized salts, being monacid and biacid. The most remarkable property of this base is the formation of a nitrate so insoluble that chrysanilin is the best known reagent for nitric acid. One gramme of nitrate of potash in one litre of water immediately gives a crystalline precipitate with a solution of chrysanilin. The formulas of the three bases described by Hofmann exhibit a remarkable connection—a sort of homology in which H_2 is the constant difference. Thus we have

Chrysanilin, - - - $C_{40}H_{17}N_3$
Rosanilin, - - - - $C_{40}H_{19}N_3$
Leucanilin, - - - $C_{40}H_{21}N_3$

The conversion of chrysanilin into rosanilin and leucanilin appears possible, but has not yet been effected.

Dr. Hofmann has also examined the beautiful blue coloring matter obtained from crude chinolin by the action of the iodids of methyl, ethyl, &c., and termed cyanin. The iodid of this base has the formula $C_{60}H_{39}N_2I$. Another base homologous with this is found in the commercial cyanin. Its formula is $C_{56}H_{35}N_2I$, and it appears to be derived from pure chinolin, $C_{18}H_7N$, while the first mentioned base is derived from lepidin, $C_{20}H_9N$. The author distinguishes two phases in this reaction. In the first we have the equation

$$C_{20}H_9N+C_{10}H_{11}I=C_{30}H_{20}NI;$$

in the second we have

$$2C_{30}H_{20}NI+KO,HO=C_{60}H_{39}N_2I+KI+2HO.$$

—*Comptes Rendus*, liv, 428, lv, 817, 849. W. G.

ANALYTICAL CHEMISTRY.

2. *On the Analysis of Borates and Fluoborates.*—In solutions which contain only boric acid and alkalies, MARIGNAC (*Fresenius's Zeitschrift für Analytische Chemie, drittes Heft*,) determines the former as follows: The solution is neutralized with chlorhydric acid and chlorid of magnesium, or better, chlorid of magnesium-ammonium is added in such quantity that to one part of boric acid at least two parts of magnesia are present. The liquid is now made ammoniacal and finally is evaporated to dryness in a weighed platinum vessel. Should the addition of ammonia cause a precipitate which does not readily vanish on warming, sal-ammoniac must be put in until the liquid becomes clear. During the evaporation, it is well to add a few drops of ammonia from time to time. When the mass is dry it is heated to redness, then treated with boiling water, the residue is collected on a filter and washed with hot water until the washings are not in the slightest affected by nitrate of silver.

This first residue contains together with excess of magnesia the larger part of the boric acid. A small amount of the latter always goes into solution. The filtrate and washings are treated with ammonia and again evaporated, ignited, and washed as before. The second filtrate and washings are once more treated in the same manner, when great accuracy is required.

The three residues are ignited together in an open crucible as strongly as possible and so long as to decompose the traces of chlorid of magnesium which they may contain. When they are weighed, it only remains to estimate the magnesia in them, to learn by difference the quantity of boric acid. This can be done either by dissolving in an acid and precipitating ammonia-magnesian phosphate or more rapidly by dissolving in a known volume of standard sulphuric acid at a boiling heat and determining the excess, with help of an alkali solution.

Should an insoluble, heavy, gray residue remain on treating with acid, it must be collected and its weight deducted from that of the borate of magnesia. It is platinum.

The subjoined example illustrates the method and demonstrates that alkali-chlorids in large excess have no serious influence on its accuracy. 0·764 grm. of pure borax, containing 0·280 grm. of boric acid were dissolved with 2 grm. of chlorid of sodium and 3·2 grm. of crystallized chlorid of ammonium-magnesium were added.

First residue	= 0·5720	contained boric acid	= 0·2667 grm.
contained magnesia	= 0·3053		
Second residue	= 0·1040	" " "	= 0·0093 "
contained magnesia	= 0·0947		
Third residue	= 0·0645	" " "	= 0·0020 "
contained magnesia	= 0·0625		
		Total,	0·2780

Other determinations gave results of equal accuracy. From insoluble compounds the boric acid is obtained in solution by fusing with thrice their weight of carbonate of soda and exhausting the mass with water. In case of silicates the alkaline solution is digested with chlorid of ammonium to precipitate silica.

When one operates with a fluo-borate the solution of the carbonate of soda fusion is digested with sal-ammoniac to decompose a good share *but not all* the soda-carbonate, and thereupon is precipitated with a neutral or ammoniacal solution of chlorid of calcium. The precipitate of Ca Fl and CaO CO_2 is washed,—a matter easily accomplished—dried, gently ignited, treated with acetic acid, evaporated to dryness and the pure Ca Fl collected, washed and weighed. The filtrate, after removing lime by carbonate and a few drops of oxalate of ammonia, may be treated as before described for the estimation of boric acid. From a mixture of 2·420 grm. of fluor-spar with 0·382 grm. of borax containing 0·190 grm. of fluorine and 0·140 grm. of boric acid, were obtained by this process (except that no fusion was made), 0·1883 grm. of fluorine and 0·1362 grm. of boric acid. In the analysis of borofluorid of potassium a loss of fluorine equal to 1·5 to 1·8 per cent occurred which Marignac thinks might have been avoided by employing a caustic alkali in the fusion. S. W. J.

PHOTOGRAPHY.—

3. *Collodion.*—We translate from *La Moniteur de la Photographie* for February 15th, 1863, the following letter addressed to the editor by A. JEANRENAUD. Mr. Jeanrenaud is a well-known skillful amateur photographer.

"*Mr. Editor*:—If you and several other gentlemen had not requested of me the formula for the collodion I use, I should perhaps never have determined to publish it. In general, each photographer has his own special processes, so that it may be said that there are as many formulas for collodion as there are operators; but, since you judge, from the results I have obtained, that it will be useful to make my formula known to your readers, I do it with the more pleasure, as I hope that those who shall take the pains to try it will have no reason to regret it. This formula is less empirical than it seems, for it is the result of a long series of researches and trials, concerning which it would be useless to dilate. Such as it is, it is *good*, and has given me for several years very constant results; and, I may add, that unlike other collodions, time has upon it no other influence than to improve it, which has determined me always to have a supply a year old on hand.

Formula.

For one litre of collodion,		=	35¼ fluid ounces.
Ether at 62°,	800 grammes,		28½ " "
Alcohol at 40°,	250 "		8·8 " "
Very soluble gun cotton,	8 "		123 grains.
Iodid of cadmium,	9 "		139 "

Upon complete, solution twenty-five drops of pure bromine are added. The color becomes very intense, for there is some iodine set free, and a consequent formation of bromid of cadmium. From this litre I extract 100 grammes—one tenth part of the whole quantity—which I place in a separate flask. Into this 100 grammes are dropped twelve or thirteen drops of highly concentrated liquid ammonia. A very thick golden-yellow precipitate is formed, so thick that it will not mingle with the supernatant liquid even by vigorously shaking the flask. It is not easy to define with chemical exactness the constitution of this precipitate; but what is certain is, that it suffices to add to it a few drops of crystallizable acetic acid to dissolve it and render the collodion perfectly limpid. This last operation with acetic acid is somewhat uncertain, as the quantity varies according to the quality of the alcohol and ammonia used. I now pour back into the first flask the 100 grammes upon which I have just operated, and let the whole stand for fifteen days before using it. During this time the collodion, however red it may be, changes gradually until it attains at last a pale straw-color, which tint it ought to keep. If the collodion is found to be insufficiently iodized (although the proportions above given ought to be quite sufficient), I ought to say that it would not be proper to add the iodid of cadmium directly, or the collodion will become cloudy and cannot be cleared by filtration. It is necessary to dissolve the iodid first in a small quantity of collodion separately, and mix afterwards. In conclusion, the collodion contains iodids, bromids and acetates. It may happen, and it does happen in fact, that it forms in the negative bath small crystals of acetate of silver; I have never had any reason to complain of this, on the contrary I think it is to the reaction which produces them that we must attribute the good qualities of this collodion."

E. E.

III. METALLURGY.

1. *Thallium in furnace products;* by W. T. Roepper, (communicated in a letter to Prof. Geo. J. Brush).—In examining before the spectroscope some of the dust deposited by the tunnel-head flame on the boilers of the Bethlehem Iron Works, a sharp, bright green line flashed up midway between the green calcium and Ba α line, which, judging from Crookes' description, appeared to be the thallium line, a conjecture which Prof. Brush verified by comparison with some of Lamy's chlorid of thallium.

The line appeared at 90° on the scale of the instrument, sodium being at 60° and the red and violet potassium lines respectively at 7° and 226°. In addition to the above lines, the spectra of sodium, potassium, lithium and calcium are distinctly displayed by this dust. Thallium and the alkalies seem to exist in the dust, at least in part, as sulphates, which can be extracted by water. Similar dust from one of the other furnaces along the Lehigh gave the same results; hence it is not unlikely that thallium is a common product of the anthracite furnaces, and is perhaps derived from the pyrites accompanying the coal, though Crookes found the non-cupriferous pyrites to be almost free from this element.[1]

It is only the dust which remains lying on the boilers, or is deposited on the iron doors or shutters of the boiler-chamber, which gives the thallium reaction, while that which has fallen to the floor does not show it. The reason probably is, that it is volatilized by the higher heat of the flame, and escapes through the chimney as soon as it is removed from the comparatively lower temperature of the steam and the outer doors, which seem to act as condensers. I have not been able to detect it in the ashes of anthracite from a common stove, while they beautifully display the sodium, potassium and lithium lines.

Bethlehem, Pa., April 8, 1863.

2. *Bessemer's process for the production of Iron and Steel.*—This method for converting the purer varieties of pig-iron into steel and bar-iron is constantly increasing in favor among European ironmasters.

In a recent communication to the "*Berggeist*," Prof. Tunner states that thousands of cwt. of Bessemer-steel and iron are now annually produced in England and Sweden; that Bessemer-steel is already an article of commerce in Germany; and that large works are also being erected for the employment of this method in France.

Whenever the proper raw-material is used, Bessemer's process gives steel which in all respects is fully equal to the best varieties of cast-steel; and iron of as good quality as the best forge-iron. The loss in converting pig-iron into steel, by this method, is 12 to 15 pr. ct., and in making bar-iron 18 to 22 pr. ct. In 5 to 10 minutes, 15 to 20 cwt. of fluid pig-iron are converted into steel or bar-iron with scarcely any cost for fuel, and without hand labor. The pressure of blast used is from $\frac{1}{2}$ to $1\frac{1}{2}$ atmospheres, and the amount is 800 to 1200 cubic feet of cold air of the ordinary atmospheric density.

Only good charcoal-iron is adapted for conversion by this method, and the reason of the failure of the earlier experiments was the employment of improper and inferior raw-material. Swedish pig-iron is now always used in England for the production of the best sorts of steel and iron. In some of the new iron works attempts have been made to improve the quality of English pig-iron which has been carried to the point of conversion, by adding to it melted Swedish pig-iron; manganese compounds have also been used for the same purpose. But the separation of the

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[1] Mr. Crookes has recently announced that he has found thallium in comparatively large quantities in the deposit from the flues of Mr. Spence's pyrites burners at Manchester.—*Chem. News*, vii, 150.—G. J. B.

deleterious substances associated with carbon in pig-iron still remains an unsolved problem. For the success of this method, a good quality of pig-iron is therefore indispensable, and further a high temperature; this last is attained by converting large quantities of iron in a single operation. In Sweden 15 cwt. for a charge is the minimum quantity used, and if 60 to 100 cwt. be employed the result would be still more favorable. In converting large quantities at one operation, the cost is proportionally diminished, and the product may also be made more uniform.

One great advantage of Bessemer's process is that so much larger quantities of material can be operated upon at one charge than in the ordinary methods of refining, and this quantity is not restricted within narrow limits as in puddling and hearth refining. For the production of the proper temperature, the relative amount of blast to the pig-iron operated upon should be carefully regulated. If too little, the process goes on slowly, and much heat is lost by radiation; on the other hand, if too much blast is used, there is also a loss from the heat carried off by the air which is forced through the iron before it has effected the desired decomposition. The pressure of the blast must, at all events, be greater than that of the column of iron in the furnace, in order that the bath of molten iron shall be thoroughly penetrated and the whole melted mass set in violent agitation. In Sweden the pressure of half an atmosphere has in most cases been found sufficient, while in England a pressure equal to 1½ atmospheres has been used.

Tunner places particular emphasis on the employment of a high pressure with hot blast. He says that if the blast were to be heated to 200–300° C., or perhaps even to 500–600° C., the conversion would unquestionably proceed with great regularity and completeness, and the difficulties in the manufacture of soft bar-iron and steel would be overcome. Further, it is to be borne in mind, that, in order to produce a given variety of steel or iron, the process of conversion must be interrupted whenever the refining has reached the desired point; this last is determined by observing the character of the gases and sparks which escape from the furnace, very much as is the case in hearth refining: practice is of course required to be able to determine this point with accuracy. The fracture of the metal serves as a control in sorting the different qualities. The cost for furnace repairs is much less than was at first anticipated, but the waste product in conversion (equal to 20–30 pr. ct. when the iron is made into bars) demands consideration, especially as no use has yet been found for this more or less impure product. If, however, we take into consideration the length of time that has been necessary to bring the puddling process to its present perfection, while on the other hand Bessemer's process has accomplished so much in so short a time, we have every reason to hope that the day is not far distant when the still remaining difficulties in this process will be reduced to a minimum.—*Polytechnisches Journal*, clxvi, 447. [A wide field is open for the application of Bessemer's process in this country, where pure iron ores, fully equal in quality to those of Sweden and Norway, occur in such abundance.—G. J. B.]

IV. AGRICULTURAL CHEMISTRY.

1. *Atmospheric Nitrite of Ammonia and its Origin.*—E. BOHLIG describes (*Ann. der Ch. u. Ph.*, cxxv, 21–33) the results of long study of this subject, made at the same time as, but independently of, the investigations of Böttger and Schönbein.

Barral found in the rain water collected at the Paris Observatory, during the year ending June, 1852, an average of 151·81 grms. of nitric acid and 41·82 grms. of ammonia per cubic metre. These results have not been received with confidence on account of the deficiencies of the methods at Barral's disposal for the estimation of nitric acid. Boussingault, Bineau, Lawes & Gilbert, and Way found, on the contrary, in all atmospheric waters an excess of ammonia above that required to form nitrate with the nitric acid present, and hence it has been assumed that there exist both nitrate and bicarbonate of ammonia in the atmosphere. Bohlig gives as the result of his researches: 1st, that "normal atmospheric air and normal rain-water never contain bicarbonate of ammonia, but do contain nitrite of ammonia." 2d. "The nitrite of ammonia originates wherever ozone comes in contact with nitrogen, as well as in all cases of combustion in free air." The experiments on which the first of these conclusions is based are purely qualitative in character. According to Bohlig the most sensitive reagent for free ammonia and carbonate of ammonia is chlorid of mercury—a solution containing but $\frac{1}{200000}$ of ammonia giving with this salt a perceptible white turbidity. If 40 cc. of water exempt from ammonia (such is the water of many springs, but distilled water rarely,) is mixed with 5 drops of a solution of corrosive sublimate (1 of salt to 30 of water) and the same quantity of a solution of the purest carbonate of potash (1 of salt to 50 of water), the whole remains perfectly clear for days together in closed vessels. If the solutions are much more concentrated, oxyd of mercury will separate. If water containing ammonia in combination with the stronger acids be tested with corrosive sublimate and carbonate of potash, the same reaction—turbidity from separation of amido-mercuric chlorid—takes place as happens with carbonate of ammonia and sublimate alone, double decomposition occurring between the ammonia salt and carbonate of potash.

Bohlig found, testing the water of each considerable rain for a year, that in no case was any turbidity produced by sublimate alone, while sublimate and carbonate of potash together in all cases gave a turbidity or even a precipitate. Contrary to the statements of the textbooks, Bohlig also found that the first portions of the distillate from rain water were exempt from ammonia. Bohlig thus concludes that the ammonia or carbonate of ammonia found in any case in distilling rain water must have come from admixture of carbonate of lime with the water.

In opposition to these results we have the statement of Boussingault that the water of fogs, in most cases, has a distinct and in some a strong alkaline reaction, (*Agronomie*, ii, 227–8.) Besides it is not easy to understand how the methods employed by Boussingault and Way in the determination of nitric acid should not really have given the amount of nitrous acid (calculated as nitric acid). The former first added carbonate of potash to a litre of the water, then slowly evaporated to a few cubic centimeters and finally estimated the oxydizing effect of the supposed nitric acid by indigo, in connection with strong chlorhydric acid. (*Agronomie*, ii, 299). Way made a pint of the water alkaline with lime, and boiled it down in a long-necked flask to a small bulk, filtered from carbonate of lime, and evaporated in another flask to dryness at a final heat of 350° F. This residue was acted upon by iodid of silver and chlorhydric acid, and the liberated iodine was measured by sulphurous acid. (*Jour. Roy. Ag. Soc. of England*, 1856, xvii, 157.)

Bohlig, in the paper under notice, says, that rain water or a solution of nitrite of ammonia may be boiled a short time, and evaporated to one-third at a gentler heat, without loss of nitrite. The nitrites of lime and potash, in presence of excess of base, are supposed, on all hands, to be fixed at ordinary temperatures. We should expect then that a water containing nitrite of ammonia, when evaporated with carbonate of potash or lime water, would lose carbonate of ammonia, or free ammonia, while the nitrous acid would be completely retained in the residue.

According to Bohlig, nitrite of ammonia in dilute solution, though suffering no chemical change by concentrating to a certain degree, is completely decomposed by further evaporation at or near 212° F. On the other hand, nitrate of ammonia may be boiled to dryness without loss. As, now, rain water always acquires a blue color after a longer or shorter time with acidulated iodid of potassium-starch-paste, while the residue of its evaporation to dryness does not give this reaction, Bohlig concludes that nitrite of ammonia is, while nitrate of ammonia is not, a normal ingredient of atmospheric waters.

From this result, it was warrantable to infer that the atmosphere itself contains no nitrate but only nitrite of ammonia. To examine the atmosphere more directly, Bohlig passed 20 cubic feet of air slowly through a small quantity of pure water. By the above mentioned tests he found no carbonate but some more fixed salt of ammonia, though he could not obtain any reaction for its acid. In imitation of rain, he now caused pure water to fall in a very slender stream upon a long slip of purified paper which hung in the free air and conveyed the water drop by drop into a capsule placed beneath. The water which had thus exposed an enormous surface to the atmosphere contained both ammonia and nitrous acid in such quantity as readily admitted of detection, and the results of numerous trials in this way made in various conditions of the atmosphere, when the sky was clear and when cloudy, after thunder storms and after long gentle rains, were always *qualitatively* the same.

Bohlig does not admit that nitrite of ammonia is formed by the direct union of nitrogen and water in the act of evaporation, as Schönbein believes; but is of the opinion that this compound is simply collected by water from the atmosphere, where it previously existed.

This explanation he conceives to account for the following fact, viz: when spring water that is free from ammonia salts is distilled, the first portions that pass over always render very slightly turbid the mixture of mercuric chlorid and carbonate of potash. When the distillation becomes rapid, this reaction disappears, but recurs again if the fire be slackened and then again urged. Here, the air, that occupies the helm of the still, yields, according to Bohlig, its nitrite of ammonia to the condensing vapors.

Our author says further that the statement of Schönbein, that water and nitrogen unite directly to form nitrite of ammonia, appears doubtful, because the evaporation-experiments of the latter were made with unlimited quantities of air, and no account was taken of the preëxistence in it of the nitrite. But the nitrite always occurs in the atmosphere, though in proportions that vary extraordinarily with meteorological conditions.

In the experiment just described, with the slip of paper, Bohlig often observed that the water evaporated to less than one-sixth its original bulk before giving any reaction for nitrous acid. This happened, for example, after a protracted rain. At other times, when the weather was fine, the water gave the reaction of nitrous acid after once flowing over the paper, even when its quantity was scarcely diminished by evaporation. Schönbein often failed to obtain nitrite, in his own experiments.

Further trials which militate against Schönbein's theory are the following: 50 cc. of pure water were distilled in a rapid stream of air (more than three cubic feet) made free from nitrite of ammonia by passing through oil of vitriol and a long potash tube. The temperature rose from 12° to 100° C. After cooling, the distillate gave no reaction either for ammonia or nitrous acid. This experiment was repeated in the same manner, save that a less quantity of unwashed air was passed through it. Both the distillate and the residue in the retort gave most decided reactions for an ammonia salt, though nitrous acid was not detectable, from the inferior delicacy of the iodine starch test.

Five grms. of carbonate of potash, free from nitrous acid and ammonia, were allowed to *deliquesce* in the air. The liquid thus obtained gave very evident reactions for nitrite of ammonia. From this experiment we might conclude, using Schönbein's logic, that water in the act of *condensation* in presence of nitrogen unites with the latter.

Bohlig describes another highly interesting experiment. Hydrogen, illuminating gas, and alcohol, respectively, were burned in a tall bell-glass connected by its tubulure with several Woulfe's bottles containing pure water, and finally with an aspirator. The combustible was thus consumed in a stream of common air. After several grammes of alcohol (or corresponding quantities of the gases mentioned) were burned, the water of the absorbing vessels was perceptibly *acid* in its reaction, and with the iodid-of-potassium-starch test struck at once a deep-blue color. Ammonia was present only in minute traces, most perceptibly in the water which condensed on the sides of the bell and collected in a capsule placed underneath. This result indicates that the small amount of nitrite of ammonia found in the acid liquid was not produced in the experiment by union of water-vapor and nitrogen, but was simply condensed from the atmosphere.

Bohlig promises further researches, in which the air that feeds the flame shall be first purified from nitrite of ammonia.

It is plain that this whole subject requires thorough experimental revision. The facts now in our possession are certainly not sufficient to warrant the assumption that nitrite of ammonia is formed from nitrogen and water; while at the same time some of Schönbein's experiments are scarcely explainable on any other hypothesis. S. W. J.

2. *The Nitrogen Question.*—Liebig,[1] Nicklès,[2] and others regard the theory of Schönbein with enthusiastic favor, since in their view it relieves the "nitrogen question" of agricultural chemistry of all embarrassment, and demonstrates that the atmosphere is to plants a source as abundant as unfailing of combined or assimilable nitrogen.

We must emphatically dissent from any such conclusion, for two reasons: 1st. It is not *proved* that there is in the atmosphere more assimilable nitrogen than corresponds to what has already been determined, in a manner that we must at present regard as entirely trustworthy, by Way and Boussingault. Lawes and Gilbert, at Rothamstead, England, collected all the waters of rain, snow, dew and fog that could be gathered during the years 1855–6. Way analyzed these waters, and found in them, for 1855, 7·11 lbs. of ammonia and 2·98 lbs. of nitric (nitrous?) acid, for 1856, 9·53 lbs. of ammonia and 2·80 lbs. nitric acid—amounts corresponding to 6·63 and 8·31 lbs. of nitrogen, respectively, for an acre of surface. 2d. It is not *proved* that any nitrogen is made assimilable—converted into nitrite—by the act of evaporation. Until solid facts have been accumulated to a considerable extent, especially until quantitative investigations really demonstrate that combined nitrogen is much more abundant than appears from the researches of Way and Boussingault, we are not warranted in making such positive deductions from the results of Schönbein, interesting and valuable as they are. S. W. J.

V. MINERALOGY AND GEOLOGY.

1. *On the composition of Columbite.*—H. Rose considers this mineral to be essentially a compound of hypocolumbic acid with protoxyd of iron and manganese. It is, however, difficult to deduce a rational composition from many of the analyses of the columbite from Bodenmais and Connecticut. The specimens from these localities vary exceedingly in their densities, their powder varies in color, and by careful observation it can be seen that they are more or less decomposed. The crystals are not unfrequently traversed by rifts and seams, and, on being broken, the fractured surfaces are often found coated with a thin layer of impure hypocolumbic acid, which last can be easily separated from the mineral. It would appear that columbite is partially decomposed by the action of water and the atmosphere, and that a portion of the iron and manganese is removed as carbonate; another portion of the iron is converted into the magnetic oxyd, which gives the pulverized mineral a black color, while the color of the powder of the undecomposed mineral is cherry-red. The specimens having the highest specific gravity are those which are the most decomposed. The specimens of columbite from Greenland and from the Ilmen Mountains retain their original properties: they have a lower density than the specimens from Bodenmais and Connecticut, and their density is always constant; their powder is cherry-red, never black. It is only from the analysis of these unaltered specimens that we

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[1] Chemistry applied to Agriculture, 7th edition.

[2] This Journal, [2], xxxv, 283.

can arrive at a correct interpretation of the true composition of this mineral.

Nine analyses of the columbite from Bodenmais have been made in Rose's laboratory by Rose, Afdéef, Jacobson, Chandler, Warren and Finkener. The specimens examined showed the different densities 6·39, 6·078, 5·976, 5·971, 5·860, 5·701, and 5·698. Those with the highest densities had a black powder, while in the lighter specimens the powder was more of a chocolate-brown or cherry-red color. The oxygen ratios between the bases and the hypocolumbic acid in the analyses were: 1 : 4·07, 1 : 3·95, 1 : 3·7, 1 : 3·87, 1 : 3·56, 1 : 3·53, 1 : 3·4, 1 : 3·34, and 1 : 3·16.

The specimens of columbite from Connecticut showed less alteration than those from Bodenmais. Among them, however, were some specimens with a high specific gravity and having a black powder. Four analyses by Rose, Schlieper, Chandler and Oesten, on specimens having the densities 6·048, 5·583, 5·708, 5·483, showed the same peculiarities in regard to streak and powder as observed in the Bodenmais mineral. The oxygen ratios were 1 : 3·63, 1 : 3·48, 1 : 3·13 and 1 : 3·1. The specimens which contained the largest amount of hypocolumbic acid had the highest density, and had also a black powder.

Rose observes that the columbite occurring in the Greenland cryolite is unquestionably the purest yet found. The crystals have suffered no decomposition, and all the specimens have therefore the same specific gravity. Selected fragments gave this density as 5·374 to 5·376, in powder 5·4; the powder had a light cherry-red color. Two analyses by Oesten, and one by Finkener gave the oxygen ratio of bases to acid as 1 : 3·08, 1 : 3·14 and 1 : 3·11. The columbite from the Ilmen Mts. is also extremely pure. Different specimens have the same specific gravity, G.=5·461—5·447. An analysis of this columbite by Oesten shows it to contain a small amount of oxyd of uranium; this is not found in columbite from other localities. The Ural columbite does not contain any yttria or magnesia, as was formerly supposed. The relation of the oxygen of the bases to the acid is as 1 : 3·06.

From these analyses, Rose concludes that in the purer varieties of columbite—those which have suffered no alteration or decomposition—the oxygen of the hypocolumbic acid is three times that of the oxygen of the protoxyd of iron and manganese, that is, the relation of oxygen of the acid to that of the bases is as 3 : 1. An analogous relation exists in wolfram, the ratio between the tungstic acid and the bases being 3 : 1, and the bases also consist of protoxyd of iron and manganese.—*Jour. prakt. Chem.*, lxxxv, 438. G. J. B.

2. *Kischtimite, a new mineral.*—T. Korovaeff describes, under the name *Kischtim-Parisit*, a new mineral from the gold-washings of the Borsowka river in the district of Kischtim in the Ural Mountains (*Jour. prakt. Chem.*, lxxxv, 442). The mineral was not crystallized; color dark brownish-yellow, streak much lighter; fracture sub-conchoidal; lustre between greasy and vitreous; friable, and in small pieces transparent. G.=4·784. B.B., at a moderate temperature loses its lustre, becomes of a dull, opaque, opaline yellow color; at a high temperature it glows, and on cooling has a high lustre, and a brick-red color. In the closed tube

gives off water and becomes darker colored. Soluble in the fluxes: with borax in the outer flame gives a yellow glass, in the inner flame faint yellow, which on cooling becomes colorless; with salt of phosphorus gives the same reactions, except that both beads are colorless on cooling. The powder moistened with sulphuric acid gives off fluohydric acid. Dissolved in chlorhydric acid, with the evolution of carbonic acid, and traces of chlorine. The acid solution gave no precipitate with sulphydric acid gas; in the neutral solution sulphid of ammonium gave a colorless voluminous precipitate, insoluble in caustic potash, but soluble in excess of carbonate of ammonia, thus indicating the presence of the oxyds of the cerium metals. The filtrate from the sulphid of ammonium precipitate left no residue on evaporation and ignition, showing the absence of alkalies and alkaline earths. Three analyses gave:

	$\ddot{\text{C}}$	$\dot{\text{H}}$	La	Ce	Fl	O (loss)
1.	17·19	2·20	37·46	26·78	6·12	
2.	19·65		35·66	28·84	5·97	
3.	19·80		——	——	6·96	
Mean,	17·19	2·20	36·56	27·81	6·35	9·69

From this, Korovaeff deduces the formula $6\dot{\text{La}}\ddot{\text{C}}+(\ddot{\overline{\text{Ce}}}+\text{Ce}_2\text{Fl}_3+2\dot{\text{H}})$ or $3\dot{\text{La}}\ddot{\text{C}}+\text{Ce}_2(\text{Fl},\text{O})^3+\dot{\text{H}}$, which on calculation equals $\ddot{\text{C}}$ 17·28, $\dot{\text{H}}$ 2·40, La 37·67, Ce 25·23, Fl 7·52, O 9·60=100·00.

In physical characters, except crystallization, the mineral very closely approaches the *parisite* from Musso, described and analyzed by Bunsen. The Kischtim mineral, however, contains no lime, and on treatment with chlorhydric acid evolves chlorine, indicating the presence of sesquioxyd of cerium. Its specific gravity also differs materially from parisite, the latter being 4·35, while the Kischtim mineral is 4·784. We suggest the name *Kischtimite* as preferable to the double name *Kischtim-Parisit* for this new species. G. J. B.

3. *Catalogue of the Miocene Shells of the Atlantic Slope;* by. T. A. CONRAD.—In the last number of the *Proceedings of the Academy of Natural Sciences* of Philadelphia (Dec., 1862, pp. 559–582), Mr. Conrad has given us a Catalogue which must prove an invaluable assistance, not only to palæontologists but to those students of recent zoology who make the shells of our coast a subject of study. The notices of our Miocene shells previously published, particularly those of Mr. Conrad himself, are so numerous and scattered, that to collect and index them,—a necessary preliminary to their investigation,—would be by far too extended a work for every one interested therein to undertake for himself. It is a subject for congratulation that this work is now done for all, by one so competent and so well acquainted with our Tertiary Faunæ as the distinguished author of the "Catalogue."

Mr. Conrad states that the Miocene of our Atlantic slope extends from New Jersey to South Carolina, and he includes in it the so-called "Pliocene" of the latter State. The newer Pliocene or Pleistocene of the coast rests immediately upon the Miocene, and there is no intermingling of extinct forms between these two formations. About 580 species of shells are found in the Miocene, the proportion of Conchifers to Gasteropods being 1 : 1·14. Mr. C. thinks that the proportion of recent species generally acknowledged to occur in this formation should be greatly reduced, and he rejects from the list no less than 18 which were formerly supposed to be identical with recent forms. He even doubts whether any of them are identical; those that possibly are so being only 30 in number, most of which he has not as yet had an opportunity of comparing with their recent analogues or co-species. The *Natica heros* and *N. duplicata* of our coast have fossil analogues so closely resembling them that he can find no essential difference between them. We would suggest that, in making these comparisons, specimens from the intermediate Pleistocene deposits should also be examined. If a few of the denizens of that ancient Miocene sea have really survived to the present epoch, we might expect them to have undergone some slight change during so great a lapse of time. A comparison with those examples which lived at an intermediate epoch would go far toward settling this question.

A few words on the nomenclature employed by Mr. Conrad will not be out of place here. He has followed the authors of "The Genera of Recent Mollusca" in restoring the "generic" names of Klein, and giving them the preference over the more recent, but well established names of authors whose works were, until very lately, universally accepted. Against this we must enter our protest. The generic nomenclature of the Mollusca is in a state of extreme confusion, and unless we can find some principle to guide us in selection among the older names of these groups of species, we can never reach a firm basis. The true principle seems to be sufficiently plain, and has, with few exceptions, been generally followed.

The system of nomenclature proposed by Linnæus, the convenience of which has been proved by an hundred years of usage, has become the *law*, and it follows that no names should be adopted as generic which were not given in accordance with this law, and by those who understood that they were naming *genera*, in the Linnæan sense. We would not, indeed, join those who consider that we cannot go behind a particular edition of the "*Systema Naturæ*," nor would we exclude from use the names proposed by all authors who were not strictly binomial in their specific nomenclature. An author may name a genus, and give its type, without describing any species whatever under it. But it is essential that an author should acknowledge genera as understood by Linnæus, and also that they are composed of species in the Linnæan sense. But Klein, who was an avowed enemy of the Linnæan school, made use of an entirely different system in his "*Tentamen Methodi Ostracologicæ.*" His "species" avowedly include several species of the Linnæan kind, each designated by a "phrase" according to the general usage among pre-Linnæan authors. Witness, for instance, on p. 114 of his work above named, where we find,—"Genus I, *Patella integra.* Species I, *Striata.* 1. *Indica, major, striis planis,*" etc. 2. "*Cypria, striis crassis,*" etc., and so on, including 22 species under the "species *Striata,*" until we come to "Species II, *Reticulata* seu *clathrata*" with 7 species; "Species III, *Virgata* vel *circinnata,*" with 4 species; "Species IV, *Lævis,*" with 5, and so on. Klein's *species* in fact correspond more nearly with Linnæan *genera.* Again, very many of his generic names are composed of two words, and the most enthusiastic of his modern followers do not claim priority for these, with the exception of H. and A. Adams, who take sometimes the first word of the binomial phrase for the generic name to be established! To this objection it is answered that wherever Klein's names are (accidentally) uninomial, they must be adopted. But if this method of settling the question be allowed, we shall have all writers who are affected with the prevailing rage for change, searching through every forgotten and almost extinct work at all relating to natural history, which has appeared since the invention of printing, seizing upon every case in which an author *happened* to designate a group of animals by a single name, and adding this to our already overburdened synonymy, to the suppression of the name last in vogue. And further, when we have got to the date of the invention of printing, there will be some who will insist that the distribution of a certain number of copies of a manuscript constitutes publication, and so go back to the still older names given by writers who flourished during and before the Middle Ages! Naturalists, averse to the more severe studies in the realm of nature herself, will become archæologists, and cheaply earn reputation by seeking for prior names to replace those which have become well known.

We have thus dwelt upon Klein's case because it is one of importance, not only as a type of many, but on account of the great number (about 170) of "generic" names which he proposed, a large number of which the authors of the Moerch and Adams school are now endeavoring to revive, and nearly all of which are liable to be pressed upon us with as much reason as the first lot has been.

But to drop the question of simple nomenclature, we may, in conclusion, express the lively satisfaction with which we have examined the generic distribution of our Miocene shells by the author of the "*Catalogue.*" Numbers of species formerly huddled together in old generic groups are here separated and given their proper distinct place in the system, and the names proposed for the new genera are for the most part very appropriate. We are now enabled satisfactorily to compare our Miocene fauna with that of Europe, and with that of the actual epoch on our own coast.
W. S.

4. *Geology of Vermont.*—Announcement has been issued by A. D. Hager of Proctorsville, Vt., that the Geological Report of Vermont in quarto will hereafter be disposed of by him at six dollars a copy. The edition is nearly exhausted.

VI. BOTANY AND ZOOLOGY.

1. *A new character in the Fruit of Oaks.—Note sur un Nouveau Caractère observè dans le Fruit des Chênes et sur la meilleure division à adopter pour le Genre Quercus*, is the title of a short article contributed by Mr. Alph. DeCandolle to the *Bibliothèque Universelle* for October, 1862. It is well known to botanists that Mr. DeCandolle has been assiduously engaged in the elaboration of the order *Cupuliferæ* for the Prodromus, and has had before him the authentic types of almost every published species, and an amount of materials as to many of them which, so far as dried specimens may serve, leaves little to be asked. The present paper has a purely botanical interest, and, having been already reproduced in the *Edinburgh Journal of Science*, need only be briefly

noticed here. The new character unexpectedly brought to light is that of the position in the acorn of the five atrophied ovules as respects the seed, or kernel, which results from the fertilization of the sixth ovule, the only one which ever matures. DeCandolle shows that the aborted ovules do not disappear as the fruit grows, but persist, just as they are well known to do in the Horse-chestnut and Buckeye, and that they may be found in the ripe acorn upon examination. It appears that the ovules in this genus are by no means always suspended from the summit of the cells, as generally thought, indeed, that they are ascending from the base or near it in the common European Oak, and persist there in the acorn; while, however, they are found above the seed in four of the five natural sections under which DeCandolle arranges the species. But in the great section *Lepidobalanus*, which comprises all the Oaks of the northern parts of the world, except one of California, these ovules are situated sometimes at the base, rarely about the middle, and sometimes near the summit of the seed. Moreover, all the Oaks which mature their fruit the first year bear their atrophied ovules at the base of the seed, or at least below its middle. Oaks of biennial maturation are divided in this respect, some having these ovules below, others above; but most of the North American species appear to be in the latter category.

This character of annual or biennial maturation, which DeCandolle thinks has been neglected for half a century [surely not in this country, where it has been familiar, both popularly and scientifically, ever since the time of the elder Michaux], was taken up by the acute and excellent Gay in the Old World, who showed that two Cork Oaks had been confounded under the name of *Quercus Suber*, one with annual, the other with biennial maturation of the fruit. This character, being of easy application to herbarium specimens of any goodness, as well as obvious in the living tree, would naturally be much relied on in classification. But, as in the case of the two Cork Oaks, so in general, it is not coördinated with other important differences, and therefore it serves merely to distinguish related species, or to subdivide conveniently that portion of the *Lepidobalanus* group in which the ovules are inferior.

DeCandolle notices a peculiarity in the embryo of our Live Oak (*Q. virens*), viz.: that its cotyledons are perfectly united into one homogeneous substance, while nothing of the sort appears in its near relative *Q. Ilex* of the Old World. He wishes the germination of the Live Oak to be examined in this respect, apparently to determine whether the mass consists of two united cotyledons or of a single cylindrical one. *A priori*, we could have little doubt; but we solicit fresh acorns of the coming season, or germinating ones the present year from some southern posts. A. G.

2. *Species, considered as to Variation, Geographical Distribution, and Succession.—Etude sur l'Espèce, à l'occasion d'une Revision de la Famille des Cupulifers, par* M. ALPH. DECANDOLLE.—This is the title of a second paper by Mr. DeCandolle growing out of his study of the Oaks. It was published in the November number of the *Bibliothèque Universelle*, and separately issued as a pamphlet. A less inspiring task could hardly be assigned to a botanist than the systematic elaboration of the genus *Quercus* and its allies. The vast materials assembled under DeCandolle's hands, while disheartening for their bulk, offered small hope of novelty. The subject was both extremely trite and extremely difficult.

Happily it occurred to DeCandolle that an interest might be imparted to an onerous undertaking, and a work of necessity be turned to good account for science, by studying the Oaks in view of the question of *Species.*

What this term *Species* means, or should mean, in natural history, what the limits of species, *inter se* or chronologically, or in geographical distribution, their modifications, actual or probable, their origin, and their destiny,—these are questions which surge up from time to time; and now and then in the progress of science they come to assume a new and hopeful interest. Botany and Zoology, Geology, and what our author, feeling the want of a new term, proposes to name *Epiontology,*[1] all lead up to and converge into this class of questions, while recent theories shape and point the discussion. So we look with eager interest to see what light the study of Oaks, by a very careful, experienced, and conservative botanist, particularly conservant with the geographical relations of plants, may throw upon the subject.

The course of investigation in this instance does not differ from that ordinarily pursued by working botanists; nor, indeed, are the theoretical conclusions other than those to which a similar study of other orders might not have equally led. The Oaks afford a very good occasion for the discussion of questions which press upon our attention, and perhaps they offer peculiarly good materials on account of the number of fossil species.

Preconceived notions about species being laid aside, the specimens in hand were distributed, according to their obvious resemblances, into groups of apparently identical or nearly identical forms, which were severally examined and compared. Where specimens were few, as from countries little explored, the work was easy, but the conclusions, as will be seen, of small value. The fewer the materials, the smaller the likelihood of forms intermediate between any two, and—what does not appear being treated upon the old law-maxim as non-existent—species are readily enough defined. Where, however, specimens abound, as in the case of the Oaks of Europe, of the Orient, and of the United States, of which the specimens amounted to hundreds, collected at different ages, in varied localities, by botanists of all sorts of views and predilections,—here alone were data fit to draw useful conclusions from. Here, as DeCandolle remarks, he had every advantage, being furnished with materials more complete than any one person could have procured from his own herborizations, more varied than if he had observed a hundred times over the same forms in the same district, and more impartial than if they had all been amassed by one person with his own ideas or predispositions. So that vast herbaria, into which contributions from every source have flowed for years, furnish the best possible data,—at least are far better than any practicable amount of personal herborization,—for the comparative study of related forms occurring over wide tracts of territory. But as the mate-

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[1] A name which, at the close of his article, DeCandolle proposes for *the study of the succession of organized beings*, to comprehend, therefore, palæontology and all included under what is called geographical botany and zoology,—the whole forming a science parallel to geology,—the latter devoted to the history of unorganized bodies, the former, to that of organized beings, as respects origin, distribution, and succession. We are not satisfied with the word, notwithstanding the precedent of *palæontology;* since *ontology*, the science of being, has an established meaning as referring to mental existence,—i. e., is a synonym or a department of metaphysics.

rials increase, so do the difficulties. Forms, which appeared totally distinct, approach or blend through indermediate gradations; characters, stable in a limited number of instances or in a limited district, prove unstable occasionally, or when observed over a wider area; and the practical question is forced upon the investigator,—what here is probably fixed and specific, and what is variant, pertaining to individual, variety or race?

In the examination of these rich materials, certain characters were found to vary upon the same branch, or upon the same tree, sometimes according to age or development, sometimes irrespective of such relations or of any assignable reasons. Such characters, of course, are not specific, although many of them are such as would have been expected to be constant in the same species, and are such as generally enter into specific definitions. Variations of this sort, DeCandolle, with his usual painstaking, classifies and tabulates, and even expresses numerically their frequency in certain species. The results are brought well to view in a systematic enumeration,—

(1.) Of characters which *frequently* vary upon the same branch: over a dozen such are mentioned.

(2.) Of those which *sometimes* vary upon the same branch: a smaller number of these are mentioned.

(3.) Those so rare that they might be called monstrosities.

Then he enumerates characters, ten in number, which he has never found to vary on the same branch, and which, therefore, may better claim to be employed as specific. But, as among them he includes the duration of the leaves, the size of the cupule, and the form and size of its scales, which are by no means wholly uniform in different trees of the same species, even these characters must be taken with allowance. In fact, having first brought together, as groups of the lowest order, those forms which varied upon the same stock, he next had to combine similarly various forms which, though not found associated upon the same branch, were thoroughly blended by intermediate degrees.

> "The lower groups (varieties or races) being thus constituted, I have given the rank of *species* to the groups next above these, which differ in other respects, i. e., either in characters which were not found united upon certain individuals, or in those which do not show transitions from one individual to another. For the Oaks of regions sufficiently known, the species thus formed rest upon satisfactory bases, of which the proof can be furnished. It is quite otherwise with those which are represented in our herbaria by single or few specimens. These are *provisional species*,—species which may hereafter fall to the rank of simple varieties. I have not been inclined to prejudge such questions; indeed, in this regard, I am not disposed to follow those authors whose tendency is, as they say, to reunite species. I never reunite them without proof in each particular case; while the botanists to whom I refer do so on the ground of analogous variations or transitions occurring in the same genus or in the same family. For example, resting on the fact that *Quercus Ilex*, *Q. coccifera*, *Q. acutifolia*, &c., have the leaves sometimes entire and sometimes toothed upon the same branch, or present transitions from one tree to another, I might readily have united my *Q. Tlapuxahuensis* to *Q. Sartorii* of Liebmann, since these two differ only in their entire or their toothed leaves. From the fact that the length of the peduncle varies in *Q. Robur* and many other Oaks, I might have combined *Q. Seemannii* Liebm., with *Q. salicifolia* Née. I have not admitted these inductions, but have demanded visible proof in each particular case. Many

species are thus left as provisional; but in proceeding thus, the progress of the science will be more regular, and the synonymy less dependent upon the caprice or the theoretical opinions of each author."

This is safe and to a certain degree judicious, no doubt, as respects published species. Once admitted, they may stand until they are put down by evidence, direct or circumstantial. Surely a species may rightfully be condemned on good circumstantial evidence. But what course does DeCandolle pursue in the case—of every-day occurrence to most working botanists having to elaborate collections from countries not so well explored as Europe—when the forms in question, or one of the two, are as yet unnamed? Does he introduce as a new species every form which he cannot connect by ocular proof with a near relative, from which it differs only in particulars which he sees are inconstant in better known species of the same group? We suppose not. But if so, little improvement for the future upon the state of things revealed in the following parapraph can be expected.

"In the actual state of our knowledge, after having seen nearly all the original specimens, and in some species as many as 200 representatives from different localities, I estimate that, out of the 300 species of *Cupuliferæ* which will be enumerated in the Prodromus, two-thirds at least are *provisional* species. In general, when we consider what a multitude of species were described from a single specimen, or from the forms of a single locality, of a single country, or are badly described, it is difficult to believe that above one-third of the actual species in botanical works will remain unchanged."

Such being the results of the *want* of adequate knowledge, how is it likely to be when our knowledge is largely increased? The judgment of so practiced a botanist as DeCandolle is important in this regard, and it accords with that of other botanists of equal experience.

"They are mistaken," he pointedly asserts, "who repeat that the greater part of our species are clearly limited, and that the doubtful species are in a feeble minority. This seemed to be true, so long as a genus was imperfectly known, and its species were founded upon few specimens, that is to say, were provisional. Just as we come to know them better, intermediate forms flow in, and doubts as to specific limits augment."

DeCandolle insists, indeed, in this connection, that the higher the rank of the groups, the more definite their limitation, or, in other terms, the fewer the ambiguous or doubtful forms; that genera are more strictly limited than species, tribes than genera, orders than tribes, &c. We are not convinced of this. Often where it has appeared to be so, advancing discovery has brought intermediate forms to light, perplexing to the systematist. "They are mistaken," we think more than one systematic botanist will say, "who repeat that the greater part of our natural orders and tribes are absolutely limited," however we may agree that we will limit them. Provisional genera we suppose are proportionally hardly less common than provisional species; and hundreds of genera are kept up on considerations of general propriety or general convenience, although well known to shade off into adjacent ones by complete gradations. Somewhat of this greater fixity of higher groups, therefore, is rather apparent than real. On the other hand, that varieties should be less definite than species, follows from the very terms employed. They are ranked as varieties, rather than species, just because of their less definiteness.

Singular as it may appear, we have heard it denied that spontaneous varieties occur. DeCandolle makes the important announcement that, in the Oak genus, the best known species are just those which present the greatest number of spontaneous varieties and sub-varieties. The maximum is found in *Q. Robur*, with twenty-eight varieties, all spontaneous. Of *Q. Lusitanica* eleven varieties are enumerated, of *Q. Calliprinos* ten, of *Q. coccifera* eight, &c. And he significantly adds that "these very species which offer such numerous modifications are themselves ordinarily surrounded by other forms, provisionally called species, because of the absence of known transitions or variations, but to which some of these will probably have to be joined hereafter." The inference is natural, if not inevitable, that the difference between such species and such varieties is only one of degree, either as to amount of divergence, or of hereditary fixity, or as to the frequency or rarity, at the present time, of intermediate forms.

This brings us to the second section of DeCandolle's article, in which he passes on, from the observation of the present forms and affinities of Cupuliferous plants, to the consideration of their probable history and origin. Suffice it to say, that he frankly accepts the inferences derived from the whole course of observation, and even contemplates with satisfaction a probable historical connexion between congeneric species. He accepts and, by various considerations drawn from the geographical distribution of European *Cupuliferæ*, fortifies the conclusion—long ago arrived at by Edward Forbes—that the present species, and even some of their varieties, date back to about the close of the Tertiary epoch, since which time they have been subject to frequent and great changes of habitation or limitation, but without appreciable change of specific form or character; that is, without profounder changes than those within which a species at the present time is known to vary. Moreover, he is careful to state that he is far from concluding that the time of the appearance of a species in Europe at all indicates the time of its origin. Looking back still further into the Tertiary epoch, of which the vegetable remains indicate many analogous, but few, if any, identical forms, he concludes, with Heer and others, that specific changes of form, as well as changes of station, are to be presumed. And finally, that "the theory of a succession of forms through the deviation of anterior forms is the most natural hypothesis, and the most accordant with the known facts in palæontology, geographical botany and zoology, of anatomical structure and classification: but direct proof of it is wanting, and moreover, if true, it must have taken place very slowly; so slowly indeed, that its effects are discernable only after a lapse of time far longer than our historic epoch."

In contemplating the present state of the species of *Cupuliferæ* in Europe, DeCandolle comes to the conclusion that, while the Beech is increasing, and extending its limits southward and westward (at the expense of *Coniferæ* and Birches), the Common Oak, to some extent, and the Turkey oak decidedly, are diminishing and retreating, and this wholly irrespective of man's agency. This is inferred of the Turkey Oak from the great gaps found in its present geographical area, which are otherwise inexplicable, and which he regards as plain indications of a partial extinction. Community of descent of all the individuals of species is of course implied in these and all similar reasonings.

An obvious result of such partial extinction is clearly enough brought to view. The European Oaks (like the American species) greatly tend to vary,—that is, they manifest an active disposition to produce new forms. Every form tends to become hereditary, and so to pass from the state of mere variation to that of race; and of these competing incipient races some only will survive. *Quercus Robur* offers a familiar illustration of the manner in which one form may in the course of time become separated into two or more distinct ones.

To Linnæus this Common Oak of Europe was all of one species. But of late years the greater number of European botanists have regarded it as including three species, *Q. pedunculata*, *Q. sessiliflora*, and *Q. pubescens*. DeCandolle looks with satisfaction to the independent conclusion which he reached from a long and patient study of the forms (and which Webb, Gay, Bentham and others had equally reached), that the view of Linnæus was correct, inasmuch as it goes to show that the idea and the practical application of the term *species* have remained unchanged during the century which has elapsed since the publication of the *Species Plantarum*. But the idea remaining unchanged, the facts might appear under a different aspect, and the conclusion be different, under a slight and very supposable change of circumstances. Of the twenty-eight spontaneous varieties of *Q. Robur*, which DeCandolle recognizes, all but six, he remarks, fall naturally under the three sub-species, *pedunculata*, *sessiliflora*, and *pubescens*, and are therefore forms grouped around these as centres; and, moreover, the few connecting forms are by no means the most common. Were these to die out, it is clear that the three forms which have already been so frequently taken for species, would be what the group of four or five provisionally admitted species which closely surround *Q. Robur* (see p. 435) now are. The best example of such a case, as having in all probability occurred, through geographical segregation and partial extinction, is that of the Cedar, thus separated into the Deodar, the Lebanon, and the Atlantic Cedars,—a case admirably worked out by Dr. Hooker two or three years ago.[2]

A special advantage of the *Cupuliferæ* for determining the probable antiquity of existing species in Europe, DeCandolle finds in the size and character of their fruits. However it may be with other plants (and he comes to the conclusion generally that marine currents and all other means of distant transport have played only a very small part in the actual dispersion of species), the transport of acorns and chestnuts by natural causes across an arm of the sea in a condition to germinate, and much more the spontaneous establishment of a forest of Oaks or Chestnuts in this way, DeCandolle conceives to be fairly impossible in itself, and contrary to all experience. From such considerations, i. e., from the actual dispersion of the existing species, with occasional aid from Post-tertiary deposits, it is thought to be shown that the principal *Cupuliferæ* of the Old World attained their actual extension before the present separation of Sicily, Sardinia and Corsica, or of Britain, from the European continent.

This view once adopted, and this course once entered upon, has to be pursued farther. *Quercus Robur* of Europe with its bevy of admitted

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[2] Nat. Hist. Review, Jan., 1862. See this Journal, [2], xxxiv, 148.

derivatives, and its attending species only provisionally admitted to that rank, is very closely related to certain species of Eastern Asia, and of Oregon and California,—so closely that "a view of the specimens by no means forbids the idea that they have all originated from *Q. Robur*, or have originated, with the latter, from one or more preceding forms so like the present ones that a naturalist could hardly know whether to call them species or varieties." Moreover, there are fossil leaves from diluvian deposits in Italy, figured by Gaudin, which are hardly distinguishable from those of *Q. Robur* on the one hand, and from those of *Q. Douglasii*, &c., of California, on the other. No such leaves are found in any Tertiary deposit in Europe; but such are found of that age, it appears, in Northwest America, where their remote descendants still flourish. So that the probable genealogy of *Q. Robur*, traceable in Europe up to the commencement of the present epoch, looks eastward and far into the past on far distant shores.

Q. Ilex, the Evergreen Oak of Southern Europe and Northern Africa, reveals a similar archæology; but its presence in Algeria leads DeCandolle to regard it as a much more ancient denizen of Europe than *Q. Robur;* and a Tertiary Oak, *Q. ilicoides*, from a very old Miocene bed in Switzerland, is thought to be one of its ancestral forms. This high antiquity once established, it follows almost of course that the very nearly related species in Central Asia, in Japan, in California, and even our own Live Oak with its Mexican relatives, may probably enough be regarded as early offshoots from the same stock with *Q. Ilex.*

In brief,—not to continue these abstracts and remarks, and without reference to Darwin's particular theory (which DeCandolle at the close very fairly considers),—if existing species, or many of them, are as ancient as they are now generally thought to be, and were subject to the physical and geographical changes (among them the coming and the going of the Glacial epoch) which this antiquity implies; if in former times they were as liable to variation as they now are; and if the individuals of the same species may claim a common local origin, then we cannot wonder that "the theory of a succession of forms by deviations of anterior forms" should be regarded as "the most natural hypothesis," nor at the general advance made towards its acceptance in some form or other.

The question being, not, how plants and animals originated, but, how came the existing animals and plants to be just where they are and what they are? it is plain that naturalists interested in such inquiries are mostly looking for the answer in one direction. The general drift of opinion, or at least of expectation, is exemplified by this essay of DeCandolle; and the set and force of the current are seen by noticing how it carries along naturalists of widely different views and prepossessions—some faster and farther than others,—but all in one way. The tendency is, we may say, to extend the law of continuity, or something analogous to it, from inorganic to organic nature, and in the latter to connect the present with the past in some sort of material connection. The generalization may indeed be expressed so as not to assert that the connection is genetic, as in Mr. Wallace's formula: "Every species has come into existence coincident both in time and space with preëxisting closely allied species." Edward Forbes, who may be called the originator of this whole line of inquiry, long ago expressed a similar view. But the only material sequence we know, or can clearly conceive, in plants and animals, is that from parent to progeny; and, as DeCandolle implies, the origin of species and that of races can hardly be much unlike, nor governed by other than the same laws, whatever these may be.

The progress of opinion upon this subject in one generation is not badly represented by that of DeCandolle himself, who is by no means prone to adopt new views without much consideration. In an elementary treatise published in the year 1835, he adopted and, if we rightly remember, vigorously maintained, Schouw's idea of the double or multiple origin of species, at least of some species,—a view which has been carried out to its ultimate development only perhaps by Agassiz, in the denial of any necessary genetic connection among the individuals of the same species, or of any original localization more restricted than the area now occupied by the species. But in 1855, in his *Géographie Botanique*, the multiple hypothesis, although in principle not abandoned, is seen to lose its point, in view of the probable high antiquity of existing species. The actual vegetation of the world being now regarded as a continuation, through numerous geological, geographical, and more recently historical, changes, of anterior vegetations, the actual distribution of plants is seen to be a consequence of preceding conditions, and geological considerations, and these alone may be expected to explain all the facts, many of them so curious and extraordinary, of the actual geographical distribution of the species. In the present essay, not only the distribution but the origin of congeneric species is regarded as something derivative; whether derived by slow and very gradual changes in the course of ages, according to Darwin, or by a sudden, inexplicable change of their Tertiary ancestors, as conceived by Heer, DeCandolle hazards no opinion. It may, however, be inferred that he looks upon 'natural selection' (which he rather underrates) as a real, but insufficient, cause; while some curious remarks (pp. 57–58), upon the number of monstrosities annually produced, and the possibility of their enduring, may be regarded as favorable to Heer's view.

As an index to the progress of opinion in the direction referred to, it will be interesting to compare Sir Charles Lyell's well known chapters of 20 or 30 years ago, in which the permanence of species was ably maintained, with his treatment of the same subject in a work just issued in England, which, however, has not yet reached us.

A belief in the derivation of species may be maintained along with a conviction of great persistence of specific characters. This is the idea of the excellent Swiss vegetable palæontologist, Heer, who imagines a sudden change of specific type at certain periods, and perhaps is that of Pictet. Falconer adheres to somewhat similar views in his elaborate paper on Elephants, living and fossil, in the *Natural History Review* for January last. Noting that "there is clear evidence of the true Mammoth having existed in America long after the period of the northern drift, when the surface of the country had settled down into its present form," and also in Europe so late as to have been a cotemporary of the Irish Elk, and on the other hand that it existed in England so far back as before the deposition of the boulder Clay; also that four well-defined species of fossil Elephant are known to have existed in Europe; that "a vast number of the remains of three of these species have been exhumed over a large area in Europe; and, even in the geological sense, an enormous interval of time has elapsed between the formation of the most ancient and the most recent of these deposits, quite sufficient to test the persistence of specific characters in an Elephant," he presents the question: "Do then the successive Elephants occurring in these strata show any signs of a passage from the older form into the newer?"

To which the reply is: "If there is one fact which is impressed on the conviction of the observer with more force than any other, it is the persistence and uniformity of the characters of the molar teeth in the earliest known Mammoth and his most modern successor .... Assuming the observation to be correct, what strong proof does it not afford of the persistence and constancy, throughout vast intervals of time, of the distinctive characters of those organs which are most concerned in the existence and habits of the species? If we cast a glance back on the long vista of physical changes which our planet has undergone since the Neozoic Epoch, we can nowhere detect signs of a revolution more sudden and pronounced, or more important in its results, than the intercalation and sudden disappearance of the glacial period. Yet the 'dicyclotherian' Mammoth lived before it, and passed through the ordeal of all the hard extremities it involved, bearing his organs of locomotion and digestion all but unchanged. Taking the group of four European fossil species above enumerated, do they show any signs in the successive deposits of a transition from the one form into the other? Here again the result of my observation, in so far as it has extended over the European area, is, that the specific characters of the molars are constant in each, within a moderate range of variation, and that we nowhere meet with intermediate forms." .... Dr. Falconer continues, (p. 80):

"The inferences which I draw from these facts are not opposed to one of the leading propositions of Darwin's theory. With him, I have no faith in the opinion that the Mammoth and other extinct Elephants made their appearance suddenly, after the type in which their fossil remains are presented to us. The most rational view seems to be, that they are in some shape the modified descendants of earlier progenitors. But if the asserted facts be correct, they seem clearly to indicate that the older elephants of Europe, such as *E. meridionalis* and *E. antiquus*, were not the stocks from which the later species, *E. primigenius* and *E. Africanus* sprung, and that we must look elsewhere for their origin. The nearest affinity, and that a very close one, of the European *E. meridionalis* is with the Miocene *E. planifrons* of India; and of *E. primigenius*, with the existing India species.

"Another reflexion is equally strong in my mind,—that the means which have been adduced to explain the origin of the species by 'Natural Selection,' or a process of variation from external influences, are inadequate to account for the phenomena. The law of phyllotaxis, which governs the evolution of leaves around the axis of a plant, is as nearly constant in its manifestation as any of the physical laws connected with the material world. Each instance, however different from another, can be shown to be a term of some series of continued fractions. When this is coupled with the geometrical law governing the evolution of form, so manifest in some departments of the animal kingdom, e. g., the spiral shells of the Mollusca, it is difficult to believe that there is not, in nature, a deeper-seated and innnate principle, to the operation of which Natural Selection is merely an adjunct. The whole range of the Mammalia, fossil and recent, cannot furnish a species which has had a wider geographical distribution, and passed through a longer term of time, and through more extreme changes of climatal conditions, than the Mammoth. If species are so unstable, and so susceptible of mutation through such influences, why does that extinct form stand out so signally a monument of stability? By his admirable researches and earnest writings, Darwin has, beyond all his cotemporaries, given an impulse to the philosophical investigation of the most backward and obscure branch of the biological sciences of his day; he has laid the foundations of a great edifice; but he need not be surprised, if, in the progress of erection, the superstructure is altered by his successors, like the Duomo of Milan from the Roman to a different style of architecture."

Entertaining ourselves the opinion that something more than natural selection is requisite to account for the orderly production and succession of species, we offer two incidental remarks upon the above extract.

First, we find in it,—in the phrase "Natural Selection, or a process of variation from external influences,"—an example of the very common confusion of two distinct things, viz., *variation* and *natural selection*. The former has never yet been shown to have its cause in "external influences," nor to occur at random. As we have elsewhere insisted, if not inexplicable, it has never been explained; all we can yet say is, that plants and animals are prone to vary, and that some conditions favor variation. Perhaps in this Dr. Falconer may yet find what he seeks: for "it is difficult to believe that there is not in [its] nature, a deeper-seated and innate principle, to the operation of which Natural Selection is merely an adjunct." The latter, which is the *ensemble* of the external influences, including the competition of the individuals themselves, picks out certain variations as they arise, but in no proper sense can be said to originate them.

Secondly, although we are not quite sure how Dr. Falconer intends to apply the law of phyllotaxis to illustrate his idea, we fancy that a pertinent illustration may be drawn from it, in this way. There are two *species* of phyllotaxis, perfectly distinct, and, we suppose, not mathematically reducible the one to the other,—viz. 1, that of alternate leaves, with its varieties; and, 2, that of verticillate leaves, of which opposite leaves present the simplest case. That, although generally constant, a change from one variety of alternate phyllotaxis to another should occur on the same axis, or on successive axes, is not surprising, the different sorts being terms of a regular series,—although indeed we have not the least idea as to how the change from the one to the other comes to pass. But it is interesting, and in this connection perhaps instructive, to remark that, while some dicotyledonous plants hold to the verticillate, i. e., opposite-leaved phyllotaxis throughout, a larger number—through the operation of some deep-seated and innate principle, which we cannot fathom,—change abruptly into the other species at the second or third node, and change back again in the flower, or else effect a synthesis of the two species in a manner which is puzzling to understand. Here is a change from one fixed law to another, as unaccountable, if not as great, as from one specific form to another.

An elaborate paper on the vegetation of the Tertiary period in the southeast of France, by Count Gaston de Saporta, published in the *Ann.*

Sci. Nat. in 1862, vol. xvi, pp. 309–344,—which we have not space to analyze,—is worthy of attention from the general inquirer, on account of its analysis of the Tertiary flora into its separate types, Cretaceous, Austral, Tropical, and Boreal, each of which has its separate and different history, —and for the announcement that "the *hiatus*, which, in the idea of most geologists, intervened between the close of the Cretaceous and the beginning of the Tertiary, appears to have had no existence, so far as concerns the vegetation; that in general it was not by means of a total overthrow, followed by a complete new emission of species, that the flora has been renewed at each successive period; and that while the plants of Southern Europe inherited from the Cretaceous period more or less rapidly disappeared, as also the austral forms, and later the tropical types (except the Laurel, the Myrtle, and the Chamærops humilis), the boreal types, coming later, survived all the others, and now compose, either in Europe, or in the north of Asia, or in North America, the basis of the actual arborescent vegetation. Especially "a very considerable number of forms nearly identical with Tertiary forms now exist in America, where they have found, more easily than in our [European] soil—less vast and less extended southward—refuge from ulterior revolutions." The extinction of species is attributed to two kinds of causes; the one material or physical, whether slow or rapid; the other inherent in the nature of organic beings, incessant, but slow, in a manner latent, but somehow assigning to the species, as to the individuals, a limited period of existence, and, in some equally mysterious but wholly natural way, connected with the development of organic types:—"By *type* meaning a collection of vegetable forms constructed upon the same plan of organization, of which they reproduce the essential lineaments with certain secondary modifications, and which appear to run back to a common point of departure."

In this community of types, no less than in the community of certain existing species, Saporta recognizes a prolonged material union between North America and Europe in former times. Most naturalists and geologists reason in the same way,—some more cautiously than others,—yet perhaps most of them seem not to perceive how far such inferences imply the doctrine of the common origin of related species.

For obvious reasons such doctrines are likely to find more favor with botanists than with zoologists. But with both the advance in this direction is seen to have been rapid and great; yet to us not unexpected. We note, also, an evident disposition, notwithstanding some endeavors to the contrary, to allow derivative hypotheses to stand or fall upon their own merits,—to have indeed upon philosophical grounds certain presumptions in their favor,—and to be, perhaps, quite as capable of being turned to good account as to bad account in natural theology.[3]

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[3] What the Rev. Principal Tulloch remarks in respect to the philosophy of miracles has a pertinent application here. We quote at second hand:

"The stoutest advocates of interference can mean nothing more than that the Supreme Will has so moved the hidden springs of nature that a new issue arises on given circumstances. The ordinary issue is supplanted by a higher issue. The essential facts before us are a certain set of phenomena, and a Higher Will moving them. How moving them? is a question for human definition; the answer to which does not and cannot affect the Divine meaning of the change. Yet when we reflect that this Higher Will is everywhere reason and wisdom, it seems a juster as well as a more comprehensive view to regard it as operating by subordination and evolution, rather than by interference or violation."

Among the leading naturalists, indeed, such views—taken in the widest sense—have one and, so far as we are now aware, only one thoroughgoing and thoroughly consistent opponent, viz.: Mr. Agassiz.

Most naturalists take into their very conception of a species, explicitly or by implication, the notion of a material connection resulting from the descent of the individuals composing it from a common stock, of local origin. Mr. Agassiz wholly eliminates community of descent from his idea of species, and even conceives a species to have been as numerous in individuals and as wide spread over space, or as segregated in discontinuous spaces, from the first as at a later period.

The station which it inhabits, therefore, is with other naturalists in no wise essential to the species, and may not have been the region of its origin. In Mr. Agassiz's view the habitat is supposed to mark the origin, and to be a part of the character of the species. The habitat is not merely the place where it is, but a part of what it is.

Most naturalists recognize varieties of species; and many, like DeCandolle, have come to conclude that varieties of the highest grade, or races, so far partake of the characteristics of species, and are so far governed by the same laws, that it is often very difficult to draw a clear and certain distinction between the two. Mr. Agassiz will not allow that varieties or races exist in nature, apart from man's agency.

Most naturalists believe that the origin of species is supernatural, their dispersion or particular geographical area, natural, and their extinction, when they disappear, also the result of physical causes. In the view of Mr. Agassiz, if rightly understood, all three are equally independent of physical cause and effect, are equally supernatural.

In comparing preceding periods with the present and with each other, most naturalists and palæontologists now appear to recognize a certain number of species as having survived from one epoch to the next, or even through more than one formation, especially from the Tertiary into the Post-tertiary period, and from that to the present age. Mr. Agassiz is understood to believe in total extinctions and total new creations at each successive epoch, and even to recognize no existing species as ever contemporary with extinct ones, except in the case of recent exterminations.

These peculiar views, if sustained, will effectually dispose of every form of derivative hypothesis.

Returning for a moment to DeCandolle's article, we are disposed to notice his criticism of Linnæus's 'definition' of the term *species* (*Phil. Bot.*, No. 157): *Species tot numeramus quot diversæ formæ in principio sunt creatæ*,—which he declares illogical, inapplicable, and the worst that has been propounded. "So, to determine if a form is specific, it is necessary to go back to its origin, which is impossible. A definition by a character which can never be verified is no definition at all."

Now, as Linnæus practically applied the idea of species with a sagacity which has never been surpassed, and rarely equalled, and indeed may be said to have fixed its received meaning in natural history, it may well be inferred that in the phrase above-cited he did not so much undertake to frame a logical *definition*, as to set forth the *idea* which, in his opinion, lay at the foundation of species. On which basis A. L. Jussieu did construct a logical definition :—" nunc rectius definitur perennis individuorum similium successio continuata generatione renascentium." The fundamental idea of species, we would still maintain, is that of a chain, of which genetically-connected individuals are the links. That, in the practical recognition of species, the essential characteristic has to be *inferred*, is no great objection,—the general fact that like engenders like being an induction from a vast number of instances, and the only assumption being that of the uniformity of nature. The idea of gravitation, that of the atomic constitution of matter, and the like, equally have to be verified inferentially. If we still hold to the idea of Linnæus, and of Agassiz, that existing species were created independently, and essentially all at once at the beginning of the present era, we could not better the propositions of Linnæus and of Jussieu. If, on the other hand, the time has come in which we may accept, with DeCandolle, their successive origination, at the commencement of the present era or before, and even by derivation from other forms, then the '*in principio*' of Linnæus will refer to that time, whenever it was, and his proposition be as sound and wise as ever.

In his *Géographie Botanique* (ii, 1068–1077) DeCandolle discusses this subject at length, and in the same interest. Remarking that of the two great facts of species, viz: *likeness among the individuals*, and *genealogical connection*, zoologists have generally preferred the latter,[*] while botanists have been divided in opinion, he pronounces for the former as the essential thing, in the following argumentative statement:

> "Quant à moi, j'ai été conduit, dans ma definition de l'espèce, à mettre décidément la ressemblance au-dessus des caractères de succession. Ce n'est pas seulement à cause des circonstances propres au règne végétal, dont je m'occupe exclusivement; ce n'est pas non plus afin de sortir ma définition des théories et de la rendre le plus possible utile aux naturalistes descripteurs et nomenclateurs, c'est aussi par un motif philosophique. En toute chose il faut aller au fond des questions, quand on le peut. Or, pourquoi la reproduction est-elle possible, habituelle, féconde indefiniment, entre des êtres organisés que nous dirons de la même espèce? Parce qu'ils se ressemblent et uniquement à cause de cela. Lorsque deux especes ne peuvent, ou, s'il s'agit d'animaux supérieurs, ne peuvent et ne veulent se croiser, c'est qu'elles sont très differentes. Si l'on obtient des croisements, c'est que les individus sont analogues; si ces croisements donnent des produits féconds, c'est que les individus étaient plus analogues; si ces produits eux-mêmes sont féconds, c'est que la ressemblance était plus grande; s'ils sont fécond habituellement et indéfiniment, c'est que la ressemblance intérieure et extérieure était très grande. Ainsi le degré de ressemblance est le fond; la reproduction en est seulement la manifestation et la mesure, et il est logique de placer la cause au-dessus de l'effet."

We are not at all convinced. We still hold that genealogical connection, rather than mutual resemblance is the fundamental thing,—first on the ground of fact, and then from the philosophy of the case. Practically, no botanist can say what amount of dissimilarity is compatible with unity of species; in wild plants it is sometimes very great, in cultivated races, often enormous. DeCandolle himself informs us that the different variations which the same Oak tree exhibits are significant indications of a disposition to set up separate varieties, which becoming hereditary may

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[*] Particularly citing Flourens: "La ressemblance n'est qu' une condition secondaire; la condition essentielle est la descendance: ce n'est pas la ressemblance, c'est la succession des individus, qui fait l'espèce."

constitute a race; he evidently looks upon the extreme forms, say of *Quercus Robur*, as having thus originated; and on this ground, inferred from transitional forms, and not from their mutual resemblance, as we suppose, he includes them in that species. This will be more apparent should the discovery of the transitions, which he leads us to expect, hereafter cause the four provisional species which attend *Q. Robur* to be merged in that species. It may rightly be replied that this conclusion would be arrived at from the likeness step by step in the series of forms; but the cause of the likeness here is obvious. And this brings in our '*motif philosophique.*'

Not to insist that the likeness is after all the variable, not the constant, element,—to learn which is the essential thing, resemblance among the individuals or their genetic connection, we have only to ask which can be the cause of the other.

In hermaphrodite plants (the normal case), and even as the question is ingeniously put by DeCandolle in the above extract, the former surely cannot be the *cause* of the latter, though it may, in case of crossing, offer *occasion.* But, on the ground of the most fundamental of all things in the constitution of plants and animals, "the fact incapable of farther analysis, that individuals reproduce their like, that characteristics are inheritable,"[5] the likeness is a direct natural consequence of the genetic succession,—and it is logical to place the cause above the effect.

We are equally disposed to combat a proposition of DeCandolle's about genera, elaborately argued in the *Géographie Botanique*, and incidentally re-affirmed in his present article, viz., that genera are more natural than species, and are more correctly distinguished by people in general, as is shown by vernacular names. But we have no space left in which to present some evidence to the contrary.

Here we must abruptly close our long exposition of a paper which, from the scientific position, ability, and impartiality of its author, is likely at this time to produce a marked impression. We would also direct attention to an earlier article in the same important periodical (viz: in the *Bibl. Univ.* for May, 1862), on the European Flora and the Configuration of Continents in the Tertiary Epoch, a most interesting abstract of, and commentary on, the introductory part of Heer's *Flora Tertiaria Helvetiæ*, as reëdited and translated into French by Gaudin, with additions by the author. A. G.

3. *Flora Capensis;* by Dr. Harvey and Dr. Sonder; vol. ii, 1861–62. The second volume of this excellent work extends from the *Leguminosæ* to the *Loramthaceæ* inclusive, that is, it concludes the Polypetalous orders. Almost half the volume is devoted to the *Leguminosæ*, elaborated by Dr. Harvey, and much the greater part of the other half is occupied by the *Bruniaceæ*, by Dr. Sonder (who assigns no definite character to separate them from *Hamamelideæ*), the *Crassulaceæ*, by Dr. Harvey, the *Mesembryaceæ* by Dr. Sonder (*Mesembryanthemum* counting 300 species, including 7 not sufficiently known), and the *Umbelliferæ*, by Dr. Sonder. *Montinia* is transferred by Dr. Harvey from the *Onagraceæ* to the *Saxifragaceæ*. The close affinity of the latter order to *Rosaceæ* is recognized by placing it and its immediate allies next after *Rosaceæ* in the series.

A. G.

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[5] See this Journal, vol. xxix, [2], March, 1860, p. 165, for the enunciation of this obvious principle.

4. *Flora of Canada.—Flore Canadienne, ou Descriptions de toutes les Plantes des Forêts, Champs, Jardins et Eaux du Canada,* &c.—Par l'Abbé L. PROVANCHER, Curé de Portneuf. Quebec: Joseph Darveau, 1862. 2 vols, 8vo. pp. 842.—It is pleasant to find that Botany is attracting so much attention in Lower Canada as to call into existence a Canadian Flora in the French language; and it is much to the credit of the Abbé Provancher, for zeal and enterprize, that he should have produced such a work as this, in so good a form and so neatly printed. It is of course substantially a compilation; and the author is evidently a neophyte, of limited acquaintance with the plants around him; but he makes a fair beginning, in a work which may for the present very well serve the educational end in view. The critical Flora of Canada and the other Provinces is yet to be written, and will be of a different order.

The wood cuts, "over 400 in number," which illustrate the orders, and which here appear in such novel guise with their French environment, are every one taken from Gray's Botanical Text Book, except five of the Ferns from the Manual,—a preference which speaks more for the good taste of the Abbé than does the omission to mention the source.

A. G.

5. *The Tendrils of Virginia Creeper terminating in flat expansions or disks,* by means of which this climber readily ascends smooth trunks and walls, appear to have attracted Mr. Des Moulin's attention, at Bordeaux, as a great curiosity. They are described at length by him in the *Transactions of the Linnæan Society* of that city. Before publishing, however, he had become aware that this peculiarity was described in the *Manual of Botany of Northern States* in 1856. We can give him earlier dates; i. e., *Torrey & Gray, Flora of N. America,* i, 245 (1838); and the venerable Dr. Darlington's *Flora Cestrica,* 2d ed., p. 153 (1837). Probably there is still earlier mention of it; as the fact has been familiar to us from boyhood. These disks are figured in *First Lessons in Botany,* p. 38. We may add that on the same plant may often be seen these disk-bearing tendrils and others which act in the ordinary manner. Although we have never seen aërial rootlets also, to verify the character "caule radicando-scandente" in Michaux, yet these are mentioned by Dr. Darlington, who is generally very correct, and are not unlikely to appear under favorable conditions, as they do in the Southern Muscadine Grape. A. G.

6. *Vites Boreali-Americanæ,* par. E. DURAND, *de l'Académie des Sciences Naturelles de Philadelphie,* etc. *Memoire précédé d'une Introduction* par M. CH. DES MOULINS, etc.—In response to demands from the French Society for Acclimatisation, and from Mr. Des Moulins on the part of the naturalists and vine-growers of Bordeaux, the excellent Mr. Durand of Philadelphia, along with other practical information, communicated a condensed but very careful monograph of the North American species of Vitis. This monograph,—a most laudable attempt to illustrate an extremely difficult group of species,—is published in the *Actes de la Société Linnéene de Bordeaux,* vol. xxiv, issued at the close of the last year, greatly amplified in bulk by the garrulous introduction, intercalations and notes of its French editor. Seven pages of this introduction are devoted mainly to a criticism of the two words by which the present

writer distinguished the genus *Ampelopsis*, viz.: "disk none." The substance of the whole is, that Mr. Des Moulins admits that no disk is to be found in the flower of *Ampelopsis*, but thinks that he finds under the forming fruit something which, if it developed, would become a disk: then stating, in effect, that the disk in *Ampelideæ* is nothing more than a development of the common receptacle of the flower (to which we have no present occasion to object), he insists that this disk equally exists "*plus ou moins fort*," in *Ampelopsis* where it is not *developed* at all. A reëxamination enables us to say that Mr. Sprague's figures in the *Genera Am. Bor. Ill.*, ii, pl. 162 are correct, and that there is no disk at all developed in *Ampelopsis*. Such are the facts. If now it be argued that this genus should be united to *Vitis* in spite of this difference, we could not well object, knowing how variable the disk is in different species of *Vitis* (including *Cissus*), and that a Brazilian species of the latter is hardly distinguishable from our Virginia Creeper except in its strongly developed disk. Bentham and Hooker fil., we observe, have recently made this reduction; but still upon an unfounded hypothetical basis. They write: "*Ampelopsis* .... exhibet discum cum ovario omnino confluentem;"—a view which we can no more confirm by observation than we can that of Des Moulins; but it has the immense advantage of being stated in fewer words than the latter requires of pages. A. G.

7. *Vegetable Productions of the Feejee Islands.*—A "Blue Book," entitled "*Correspondence relative to the Fiji Islands*," May, 1862, gives a full and official account of the arrangement between the British Consul, Mr. Pritchard, and *Ebenezer Thakombau*, claiming to be king of the Fiji Islands, for the cession of the latter to the British crown, and of the appointment of Col. Smythe as a commission to visit these islands and to report whether the acquisition would be desirable,—whereupon the commissioner visited the islands, accompanied by Dr. B. Seemann, who was instructed to explore and report upon their vegetable productions and resources. Col. Smythe very sensibly reported that Thakombua, although perhaps the most influential of the independent chiefs, had no claim to the title of king of Fiji, and that it was inexpedient to accept his offer. What most interests us is the appendix, containing Dr. Seemann's elaborate Report on the Vegetable Productions and Resources of the Vitian or Fijian Islands. This treats, 1, of the climate, soil, and flora in general of these islands, and, 2, of the Colonial Produce, so-called, such as sugar, coffee, tamarinds and tobacco, which they may be expected to yield, as also certain oils and fats, farinas, and spices. 3. The staple food of the people. This "is the same all over Polynesia, being derived, with the total exclusion of all grain and pulse, from the yam, the taro, the banana, the plantain, the bread fruit, and the cocoa-nut; but the bulk of it is furnished in the different countries by only one of these plants. In the Hawaian group the taro takes the lead, whilst the cocoa-nut is looked upon as a delicacy, from which the women were formerly altogether cut off. In some of the smaller coral islands the inhabitants live almost entirely upon cocoa-nuts. The Samoans place the bread-fruit at the head of the list. Again, the Fijians think more of the yam than of the others, though all grow in their islands in the greatest perfection, and in an endless number of varieties." Of edible fruits there is a long list, the bread-fruit

and bananas being the most important, and the account of the *Ivi*, (*Inocarpus edulis*), is the most interesting, now that its botanical relationship has been detected by Mr. Bentham. 4. *Cannibal vegetables*, the vegetables eaten with human flesh,—formerly an important part of Fijian dietetics, and not yet entirely obsolete,—form the subject of a separate section. Human flesh, it appears, is extremely difficult to digest, and, perhaps on this account, was eaten with the leaves of three vegetables which were thought to assist the process, viz: of *Trophis anthropophagorum* and *Solanum anthropophagorum* of Seemann, and of *Omalanthus pedicellatus*, Benth., an Euphorbiaceous plant. 5. *National Beverages.* Like the other Polynesians, they prepare an intoxicating drink from the root of *Piper methysticum.* "In order to prepare the beverage, it is necessary to reduce the roots to minute particles, which, according to regular Polynesian usage, is done by chewing,—a task, in Fiji, devolving upon lads who have sound teeth, and who occupy a certain social rank towards the man for whom they perform the office.... Some Fijians make it a point to chew as great a quantity as possible in one mouthful; and there is a man of this sort at Veratra, famous all over the group, who is able within three hours' time to chew a single mouthful sufficient to intoxicate fifty persons." Although the Fijians drink the natural liquor of young cocoa-nuts, they were not acquainted, nor were any Polynesians acquainted, with the art of extracting and fermenting toddy from the cocoa-nut palm. From which it is inferred, that, if the Polynesians are of Malayan origin, they must have left the cradle of their race before the extraction of toddy from the cocoa-nut tree, or even the tree itself, was known there. Indeed, this palm itself is thought to have made its way by the drifting of its fruits across the Pacific from east to west, through the Polynesian Islands, and to have reached Ceylon within what may be called historical times. 6. *Vegetable Poisons.* Under this head is an interesting account of the kau-karo (literally Itch-wood), the *Oncocarpus Vitiensis* A. Gray, which acts like the Poison Rhus of North America and of Japan, only with tenfold virulence. Indeed, a drop of the juice, falling upon the hand of one of Dr. Seemann's companions, "instantly produced a pain equal to that produced by contact with a red-hot poker." The *Excœcaria Agallocha*, known through the East, is equally virulent with its ally the Manchineel tree. The smoke of the burning wood is used by the Fijians to cure leprosy,—a terribly severe, but sometimes an effectual, remedy. 7. *Medicinal Plants.* None of real importance are brought to light. 8. *Scents and Perfumes.* These are used for scenting the cocoa-nut oil which the natives profusely apply to the hair and to the naked body. Besides that obtained from several flowers, from the fruit of *Parinarium laurinum* and of *Eugenia* (*Jambosa*) *neurocalyx* A. Gray, and from the bark of a species of *Cinnamomum*, the most famous is that yielded by the Sandalwood of the islands, which, formerly abundant at Sandalwood Bay, is now almost annihilated. 9. *Materials for Clothing.* The *tapa*, made of the bark of the Paper Mulberry, mainly furnished what scanty clothing was needed, until the introduction of cheap cotton cloth by traders. Successive sections discourse of *Fibres used for cordage*; of *Cotton*, several sorts of which have been introduced and run wild in these islands, and the better sorts are now cultivated with success; of *Timber*, the most important being a kind of kowrie-pine or *Dammara*, and *Calophyllum inophyllum.* The wood of the latter, abundant by the sea-side, is used for canoes and boats, while its seed yields an important oil, but the most valued wood is that of *Afzelia bijuga* A. Gr., which is almost indestructible. *Palms, Sacred Groves, Ornamental Plants,* &c., occupy the remaining sections.

Having submitted his economical report, Dr. Seemann is now turning his attention to the scientific botany of the Feejee Islands, where he made a collection second in extent and interest only to that of the U. S. Exploring Expedition under Commodore Wilkes. The *Flora Vitiensis* which he has announced as in preparation, is to be a royal quarto volume of about 400 pages of letter press, and 100 colored plates by Mr. Fitch,—to be published by Lovell Reeve and Co. In form and extent it will therefore equal his well known Botany of the Voyage of the Herald; and it can not fail to be interesting and important.

A *Synopsis Plantarum Vitiensium*, or List of the Fijian Plants at present known, has just been issued by Dr. Seemann, corrected up to date. We note that he has overlooked Mr. Sullivant's folio, of the *Musci* of Wilkes' Expedition, in which fifteen mosses not in his list are enumerated or described from these islands, and six of them are figured. The *Lichenes* by Mr. Tuckerman, the *Algæ* by Prof. Harvey and the late Prof. Bailey, and the few *Fungi*, by Messrs. Curtis and Berkeley, also published, but sparingly diffused, may also add something to the list. A. G.

8. *New Edition of Gray's Manual of the Botany of the Northern United States.*—We copy the *Advertisement to the revised edition*, 1863. —"The additions and alterations of the Revised Edition of this work, now issued, are mainly the following:

"1. The addition of an entirely new part, entitled GARDEN BOTANY, AN INTRODUCTION TO A KNOWLEDGE OF THE COMMON CULTIVATED PLANTS: see pp. xxix–lxxxix. By this, the common exotics, no less than the wild plants, are made available for botanical classes, which will be a great convenience in many cases. Most of these cultivated plants are everywhere common, and generally at hand for botanical illustration; and it is desirable that they should be scientifically known and rightly named. And there is no great difficulty in studying them, if *double* flowers, and those which are otherwise in a monstrous or unnatural condition, be avoided, at least by beginners. It is obviously absurd and highly inconvenient to mix in the cultivated with the wild plants in such a work as this. But a separate account of the common exotics, annexed and subsidiary to the *Botany of the Northern United States*, especially in the School Edition, will doubtless be popular and useful. Directions for the use of the *Garden Botany* will be found on p. xvii and p. xxix.

"2. The ANALYTICAL KEY, p. xvii, upon which the pupil so greatly depends, has been altogether revised, much simplified, adapted to the *Garden Botany* as well as to the *Botany of the Northern States*, and printed in a larger type.

"3. Numerous corrections in particulars have been made throughout the body of the work, whenever the required alterations could well be effected upon the stereotype plates. Many others, suggested by acute and obliging correspondents, or by my own observation, are necessarily deferred until the work can be recomposed.

"4. The plants which have been newly detected within our limits, and one or two which were before accidentally omitted, are enumerated and characterized in the ADDENDA, p. xc.

"5. Eight plates have been added, crowded with figures, illustrating all the genera (66 in number) of Grasses. They are wholly original, having been drawn from nature and engraved by Mr. Sprague. They will be of great assistance in the study of this large, difficult, and important family.

"The flattering success which the *Manual* has met with stimulates the author's endeavors towards its continued improvement;—in regard to which he still solicits aid from his correspondents."

9. *Botanical Necrology*, 1862.—Of the three botanists of Holland who all died in the earlier weeks of the year 1862, viz.: *Blume*, *Van den Bosch*, and *De Vriese*, a brief record was made in this Journal for May last.

Prof. M. N. Blytt, of the University of Christiania, the most distinguished Norwegian botanist, died on the 26th of July last, aged 70 years. He had amassed vast materials for the illustration of Scandinavian botany, and had commenced the publication of his *Norges Flora*, the first volume of which appeared in 1861.

Wm. Borrer, Esq., of Henfield in Sussex, England, one of the venerable cotemporaries and botanical friends of Sir James E. Smith, and whose name has long been intimately associated with English botany, died on the 10th of February, 1862, in the 81st year of his age.

Dr. James Townshend Mackay, the author of the *Flora Hibernica*, long the director of the Botanic Garden of Trinity College, Dublin, died five days later, viz: on the 15th of February, at an age little less venerable than that attained by Mr. Borrer.

Dr. D. G. von Kieser, the late President of the Imperial German Society of Naturalists, and who has been Professor of Medicine at the University of Jena ever since 1812, died on the 11th of October, aged 83 years. He is to be honorably mentioned among the botanists, on account of two early essays on the anatomy and physiology of plants, one of which, in the year 1812, took the prize offered by the Haarlem Academy; and for his *Elements of the Anatomy of Plants*, the earliest German treatise of modern times, published in 1815.

Dr. Joachim Steetz, of Hamburg, died on the 24th of March, 1862, in the 57th year of his age. He was a medical practitioner, who devoted his leisure hours with assiduity and much success to systematic botany, and especially, in his later years, to the *Compositæ.*

Mr. John Tweedie, a Scotch gardener, who visited Buenos Ayres to make botanical collections on the LaPlata, the Parana, and the Uruguay, &c., more than thirty years ago, and became so fond of the country that he made it his home, died at Santa Catalina, near Buenos Ayres, on the first of April, 1862, at the age of 87. To him we are mainly indebted for the original of the Verbenas which adorn our parterres, and for many other ornamental cultivated plants.

Turning now to our home circle, we have to record the honored names of four of the older cultivators of our science who have been removed from our thin ranks within the last few months:—

Benjamin D. Greene, Esq., of Boston, died on the 14th of October last, at the age of 69 years. He was born in 1793, was graduated at Harvard University in the year 1812; he first pursued legal studies, partly in the then celebrated school at Litchfield, Connecticut, and was duly admitted to the Bar in Boston. He then took up the study of medicine, and completed his medical course in the schools of Scotland and Paris, taking his medical degree at Edinburgh in the year 1821. The large advantages of such a training having been enjoyed, Mr. Greene did not engage in the practice of either profession. An ample inheritance, which rendered professional exertion unnecessary, conspiring with a remarkably quiet and contemplative disposition, and a refined taste, led him to devote his time to literary culture and to scientific pursuits. His fondness for botany, which early developed, was stimulated by personal intercourse with various European botanists, and especially with his surviving friend, the now venerable Sir Wm. Hooker, then Professor in the University of Glasgow, to whom he naturally became much attached, and by whom he was highly appreciated.

In botany, as in everything else, Mr. Greene sought to be silently useful. He never himself published any of his discoveries or observations. The few species to which his name is annexed were given to the world at second-hand. But his collections were extensive, his original observations numerous and accurate, and both were freely placed at the disposal of working botanists. He early saw that the great obstacles to the advantageous prosecution of botanical investigations in this country, and especially in New England, were the want of books and the want of authentic collections; and these desiderata he endeavored, so far as he could, to supply. He gathered a choice botanical library, he encouraged explorations, and he subscribed to all the large purchasable North American collections,—beginning with those of Drummond in the Southern United States and in the then Mexican province of Texas. These, being distributed under numbers, among the principal herbaria of the world, and named or referred to in monographs or other botanical works, were of prime importance as standards of comparison. Such collections and such books as Mr. Greene brought together were just the apparatus most needed at that time in this country; and now, when our wants are somewhat better supplied, we should not forget the essential service which they have rendered, nor the disinterested kindness with which their most amiable and excellent owner always placed them at the disposal of those who could advantageously use them. Mr. Greene's botanical library and collections have been, by gift and by bequest, consigned to the Boston Society of Natural History, of which he was one of the founders and the first President,—and by which they will be preserved for the benefit of future New England botanists, by whom his memory should ever be gratefully cherished. The genus *Greenea*, established by Wight and Arnott upon two rare Rubiaceous shrubs of India, barely anticipated a similar dedication by his old friend Mr. Nuttall, of a curious Grass of Arkansas and Texas, and will perpetuate his name in the annals of the science which he lovingly cultivated.

Dr. Asahel Clapp, of New Albany, Indiana, died on the 17th of December last, as has already been announced in the current volume of this Journal (p. 306). We are not informed of the particulars of his life, nor of his exact age, but we suppose he had nearly or quite reached his three-score years and ten. His only botanical publication is one of merit and importance, viz., *A Synopsis or Systematic Catalogue of the Medicinal Plants of the United States*, which forms an 8vo volume of

222 pages. It was presented to the American Medical Association in May, 1852, and published during that year, at Philadelphia. A rare plant of the order *Compositæ*, which inhabits the southern borders of Texas, was dedicated to Dr. Clapp in the Botany of the Mexican Boundary Survey.

Dr. Melines C. Leavenworth, as already announced in this Journal, died in the vicinity of New Orleans, in December last, while acting as Surgeon to the 12th Connecticut regiment, at the age of probably above three score years. It is to be desired that some one acquainted with them would put upon record the incidents of his life. He was formerly and for many years a surgeon in the United States Army; from which, however, he retired about twenty years ago. While in the army, and at frontier posts in Arkansas, Louisiana, and Florida, he indulged his strong botanical tastes, and did useful service, by observing and collecting the plants within his reach, which he communicated to Dr. Torrey along with copious notes. These were the more important as his dried specimens were seldom neatly preserved. The pages of the *Flora of North America*, upon which his name so often occurs, testify to his zeal and success as a botanical explorer and pioneer. His ardent love of botany—fostered, we believe, by the late Dr. Tully—must have early developed; for as much as forty years ago he discovered "four new plants from Alabama," which he described in the seventh volume of this Journal, in 1824. Among the many rare plants which he detected, a very peculiar one—the *Amphianthus pusillus* of Torrey—which he found in the upper part of Georgia, is so very scarce and local that it has never been met with since. A pretty and strikingly marked Cruciferous genus, one species of which (if indeed distinct from the other) was discovered by Dr. Leavenworth, dedicated to him by Dr. Torrey, commemorates his botanical services;—which services, indeed, were continued to the last. For no sooner had he landed with his regiment upon our southern coast than he zealously began to collect the plants he met with, and to note their peculiarities. Although his scientific acquirements and insight were not great, his zeal and devotion to botany were thorough and genuine. A. G.

Dr. Charles Wilkins Short died at Louisville, Ky., March 7, aged 69 years. A notice of his life will appear in our next issue.

ZOOLOGY—

10. *Evidence as to Man's place in Nature;* by THOMAS HENRY HUXLEY, Fellow of the Royal Society. 160 pp. 8vo. London: Williams and Norgate.—The able zoologist, Prof. Huxley, discusses in the first chapter of his work, "The Natural History of the Man-like Apes," or the Orangs, Gibbons, Gorillas and Chimpanzees; in the second. "the Relations of Man to the lower animals;" and in the third, the "Fossil remains of Man." The second topic is that towards which all the rest of the work points; and the conclusion of the whole is, that man belongs structurally to the same order with the *Quadrumana*, and constitutes among the *Primates* (as the order is called, after Linnæus), the family of *Anthropini;* and further, that "if man be separated by no greater structural barrier from the brutes than they are from one another, then it seems to follow that if any process of physical causation can be discovered, by which the genera and families of ordinary animals have been

produced, that process of causation is amply sufficient to account for the origin of Man;" and, finally, that the theory of Mr. Darwin is "the only one that has any scientific existence," and is, probably, the true one, or at least, "if not precisely true, the hypothesis is as near an approximation to the truth as, for example, the Copernican hypothesis was to the true theory of the planetary motions" (p. 107).

The main argument of the work has been met by the writer in his article (this volume, p. 65), on the Classification of Mammals. It is there shown, that Man stands apart from all other Mammals, on the basis of a characteristic of profound zoological value. The characteristic referred to is this:—that, in Man, the fore-limbs are withdrawn completely from the *locomotive* series, and transferred to the *cephalic;* and, thus, a very large anterior portion of the body is turned over to the service of the head, while the posterior or gastric portion is reduced to its minimum. This condition of extreme *cephalization* in the system is of the very highest significance, and places Man alone. Man's erect structure is a part of its expression. The nature of the feet in Man,—they being made simply for supporting the body, and not, as in the Quadrumana, for clinging or grasping—is a concomitant feature of his erectness; and such also is the position of the cerebellum wholly beneath the cerebrum, mentioned in Professor Owen's characteristics of Man. For the argument on the subject, we refer to the article mentioned.

The uses of the fore-limbs in man are, first, the *inferior*, depending on the demands of the appetite satisfied through the mouth (uses that are united to the locomotive in the Apes and some other quadrupeds); second, the *superior*, depending on the demands of Man's higher nature.

This higher nature, it may be added, we regard as a spiritual one, in which the brute has no share, and to the possession of which no development-process could elevate him. The raising of the fore-limbs from the ground, for esthetic, intellectual, and spiritual service, was in direct harmony with such a spiritual endowment. Man exhibits his exclusive possession of such an element, not merely in having the power of speech, but more fundamentally in being the only species capable of reaching towards a knowledge of himself, of nature, and of God;—the only one, therefore, capable of conscious obedience, or disobedience, of any moral law, and the only one subject to degradation through the appetites and a moral nature. His power of indefinite progress, his thoughts and desires that look onward even beyond time, his recognition of spiritual existence and of a Divinity above, all evince a nature that partakes of the infinite and divine. Man is linked to the *past* through the system of *life*, of which he is the last, the completing, creation. But, unlike other species of that closing system of the *past* (significantly the *Zoic* era of geological history), he, through his *spiritual* nature, is far more intimately connected with the opening *future.*

Whatever the point of view, then, we see reason wholly to dissent from the sentiment with which Prof. Huxley concludes his chapter "on the relations of Man to the lower animals" (p. 112): "Our reverence for the nobility of manhood will not be lessened by the knowledge, that Man is, in substance and in structure, one with the brutes; for he alone possesses the marvellous endowment of intelligible and rational speech, whereby, in the secular period of his existence, he has slowly accumulated and organized the experience which is almost wholly lost with the cessation of every individual life in other animals; so that now he stands raised upon it, as on a mountain top, far above the level of his humble fellows, and transfigured from his grosser nature by reflecting, here and there, a ray from the infinite source of truth." It is possible to conceive that a being with such mental endowments as Man possesses, and with even the throat of a gorilla, might originate an intelligible language; but it is incomprehensible how the gift of speech could develop man's mental qualities in a brute, however long the time allowed. Moreover, it is a natural question, why there are not Man-apes in the present age of the world, representing the various stages of transition, and filling up the *hiatus*, admitted to be large, if such a process of development is part of the general system of nature. We think this question a fair one, notwithstanding the reply which may be made, that the more developable individuals long since passed out of the Ape-stage, leaving behind only the unimprovable ones. The resemblances between the skeletons of Man and the Apes, and between ova generally, mentioned by Prof. Huxley, may, to the uninitiated in science, appear to make the transition by development feasible: yet they are of no weight as argument, since the question is as to the *fact* whether, under nature's laws, such a transition has taken place as the gradual change of an Ape into a Man, or, whether Apes were made to be, and remain, Apes. In the Ape, the great muscle of the foot, the *flexor longus pollicis*, divides and sends a branch to three or more of the toes, while in Man, it passes to the great toe alone: Is it a *fact* that this, and the many structural differences of the foot and other parts of the body, were brought about by gradual development in a progressive Ape?

Between the lowest and highest types of men, there are all possible intermediate shadings as to grades of intellect, size of brain, and form of features. The range of grades, thus passing into one another through small individual differences, is very wide among the several diverse tribes of negroes in Africa; it is very wide in the present population of Europe, and even in Britain alone. For these and other reasons, we may believe in the unity of origin of the human race. But with regard to Man and the Man-apes, no evidence has been pointed out, derived from Man, or the Apes, proving either the fact, or the probability, or the possibility, of a common origin. The direct evidence, on which the Darwinian hypothesis rests, comes from lower departments of life, and is acknowledged by its advocates to be exceedingly scanty and imperfect: they would say—and rightly—that facts have but just begun to be collected. But on this general subject, it is not our purpose now to enter.

The few discoveries of ancient skulls of inferior capacity, made recently in Europe, indicate the condition of some of the early tribes on *that* continent, or, at least, of some individuals in those tribes, and are of great archæological interest. The skulls are not inferior to those of some of the lowest of living men; and Prof. Huxley remarks respecting them, that they do not seem to him "to take us appreciably nearer to the lower pithecoid form," that is, to that of the Man-apes.

Should similar discoveries be made all over the globe, proving a former condition of the race much inferior to the present, such a phase in its history is one that would have been a necessary consequence of man's nature, however large his skull or brain when created. For, as Prof. Guyot has observed, a first race, very limited in language and knowledge, without arts, and possessing, in full force, man's natural selfishness, unbridled appetites, and evil propensities, would have entered at once upon a course of degradation; and, before many centuries had passed, the whole population, unless some part or all had been restrained or guided by superhuman agency, would have sunk to its lowest limit of moral and physical debasement. It is not too much to expect that the fact of a general physical debasement may be ultimately proved by the discoveries now in progress. J. D. D.

11. *On the question whether Diatoms live on the sea-bottom at great depths;* by WM. STIMPSON, M.D.—In a paper on the Diatomaceæ found in mud collected at great depths from the bottom of the sea off the coast of Kamtschatka, in soundings made by the North Pacific Expedition under Com. Rodgers (see *this Journal*, [2], xxi, 284), the late lamented Professor Bailey made the following remark. "The perfect conditions of the organisms in these soundings, and the fact that some of them retain their soft parts, indicate that they were very recently in a living condition, but it does not follow that they were living when collected at such immense depths." My attention has recently been called to this subject by the perusal of an account of the recent discoveries of animal life in various forms at depths vastly greater than had been previously suspected; for instance, at 1400 fathoms by Torell, at 1000 and 1500 fathoms by Milne-Edwards, and at 3000 fathoms by Dr. Wallich. The question of the nature of the food of these abysmal animals is one of great interest, and I wish to place on record, in advance of the publication of the report of the expedition, the results of my examination of the specimens alluded to by Prof. Bailey, when they were freshly taken from the water.

In the sounding taken at the depth of 2700 fathoms, in lat. 56° 46′ N., long. 168° 18′ E., Lieut. Brooke used, for the armature of his lead, three quills, each about three inches in length, fastened together, and placed in such a position that when the lead struck the bottom the quills would be forced perpendicularly into it, and thus become filled with mud from a stratum a few inches below the general surface of the sea-bottom. The experiment was successful; the quills coming up compactly filled with mud of the usual character occurring at such depths in such latitudes. One of the quills having been submitted to me for microscopic examination, was carefully wiped and cut in two at the *middle*, in order to secure for examination a specimen, as nearly as possible free from any chance admixture from the water near the surface. In this specimen I found an abundance of diatoms, some of which, apparently *Coscinodisci*, appeared to me to be undoubtedly living, judging from their fresh appearance and the colors of their internal cell contents.

It is exceedingly doubtful whether sufficient light can penetrate to so great a depth to afford the stimulus which these vegetable organisms are suppose to require for their existence and multiplication. On the other hand, it is by no means certain that some amount of light does not so penetrate, and, if we deny the existence of vegetable life in these abysses, it will be difficult to account for the existence there of animals, which must, ultimately, derive their sustenance from the vegetable kingdom. The supply which they might obtain from the dead bodies of those organisms which die at the surface, and slowly sink through two or three miles of water to the bottom, seems totally insufficient, for Dr. Wallich has proved that the animals, starfishes for instance, not only exist at those depths, but exist in great numbers. We would call the attention of those who may have an opportunity of obtaining specimens of the bottom at great depths, to the great importance of a microscopic examination of these specimens as soon as taken from the sea. Fresh water should, of course, be used in spreading the mud upon the slide.

12. *On the "genus Diplothyra."*—Having received from Mr. Sanderson Smith, of New York, a fine series of the shell recently described by Mr. Tryon in the *Proceedings of the Philadelphia Academy*, as a new genus and species of Pholadidæ, "*Diplothyra Smithii*," I have satisfied myself that Mr. Tryon is wrong in considering the accessory valve as double, and that the shell in question is a true *Martesia*. It is, in fact, very closely allied to *M. cuneiformis*, which often presents an accessory valve of precisely the same character. WM. STIMPSON.

13. *On Part II. of Prof. G. Jan's Prodromo della Iconografia Generale degli Ofidi ;* by E. D. COPE.—Among the constantly appearing contributions to Herpetology, few are more valuable than those upon the serpents, issued by Prof. G. JAN, director of the Museum at Milan. This value is however dependent rather upon the number of new forms made known, and the beautiful plates illustrating the work, than upon unusual merit in the diagnoses, or in recognition of cotemporary labors.

The second part, which has come to our hands through the kind attention of Prof. Jan, treats of the *Calamaridæ*. It is not our intention to discuss the classification of the suborder of the *Asinea*,[1] but we will remark that we doubt whether any herpetologist can characterize with precision more than three subordinate groups—viz., *Boidæ*, *Achrochordidæ* and *Colubridæ*.[2] The subdivisions of the last are so completely interwoven and gradually connected, that no author has yet presented us with characters by which we can isolate them in a natural manner. It has therefore seemed best that the term "family" should be restricted to the three groups here mentioned. It is true that among *Colubridæ* the types are as varied as are the relations of these "families," and it may be said that the simplicity of ophidian structure has deprived us of the means of defining groups, whose equivalents are elsewhere much more tangible. Admitting this to be the case,—how nearly equivalent are zoological groups anywhere, and how uniform is zoological rank? Until it can be shown that this rank is not to be expressed by the formula x^{n-1}, we are justified in retaining the varied divisions of *Colubridæ* as *subfamilies*, and in calling *Achrochordus* the type of a *family*, though it exhibit but a little greater degree of differentiation than some of the former.

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[1] Eurystomatous serpents with an unabbreviated os maxillare. The other suborders of the Ophidia, as accepted by the writer, are, on the one hand, the Proteroglypha and Salenoglypha, and on the other, Tortricina (Tortricidæ and Uropeltidæ) and Scolecophidia (Typhlopidæ).

[2] Formerly called subfamilies by the writer.

Prof. Jan adopts the name *Calamaridæ*, after Günther, and includes twenty-three genera. As the work is not intended to be a general ophiology, many genera as well as species are omitted. With great propriety he places here the *Platypteryx* and *Stenognathus* of Duméril, which are associated with *Dipsas* in the *Erpétologie Générale.* He adds to those previously known the genera *Pseudorhabdium* (near *Calamaria*), *Adelphicus* (near *Rhabdosoma*), and *Elapotinus* (near *Elapomorphus*), all with ungrooved teeth. He describes twenty-one species, which are new to herpetology. A few others, presumed to be new, have really been previously described, which is not a matter of surprise when we consider the scattered condition of herpetological literature.

Prof. Jan separates from *Rhabdosoma* those Mexican species which possess two pairs of geneïal plates, which is probably a judicious change. If the *Catostoma chalybeum* of Wagler belongs to this group, that author's name will pertain to it rather than to *Rhabdosoma*, as has been urged.[3] In the work before us, however, it is referred to *Elapoides* of Boie, a genus with keeled scales. If Wagler's statement, "squamæ lævissimæ," is correct of the *chalybæum* as it is of the *semidoliatum* (though Günther says "scales keeled"[4]), this reference can hardly be accepted—still less that of *Colobognathus* of Peters, which is abundantly characterized by its deficient dentition and want of temporal plates.

The genus called *Carphophis*, which follows *Elapoides*, was first established under the name *Carphophiops* in d'Orbigny's *Dict. Univ. d'Hist. Nat.*, on the *Coluber amœnus* of Say. This species was called *vermiformis*, while the name *amœnus* was retained for that since called *Helenæ* by Kennicott. Under the impression that the two represented distinct genera, the *Helenæ* was called *Carphophis* in the same work, and following on the same page. As the true application of the name *vermiformis* could not have been ascertained at the time of its publication, *Carphophis* must be retained, though erroneously characterized, and established upon a species different from the afterwards accepted type.

Prof. Jan is in error in identifying *Virginia Harperti*[5] with the *V. Valeriæ* on p. 24. He also employs the name *Conocephalus* for the genus *Haldea*, which we have shown to be inapplicable.[6] So *Ninia* is the older name for *Streptophorus*, and should be employed in its stead. *Aspidura carinata* (p. 29) is the *Haplocercus Ceylonensis* of Günther, published in 1858. *Elapops Petersi* is *E. plumbeater*[7] of three years earlier date. In the genus *Homalosoma* we find *Contia* of Baird and Girard included. I have already alluded to the range of this genus over both continents;[8] it embraces in the Old World the *coronelloides* and *melanocephala* of Prof. Jan's enumeration, with the *Coronella modesta* of Martin. *Psilosoma* Jan, will probably be accepted as a well established genus.

The genus *Elapomorphus* has received many accessions, within a few years, through the labors of Duméril, Günther, Reinhardt and Peters. As adopted in the Prodromus, it embraces four or five distinct genera. Prof. Duméril early[9] alluded to the very peculiar dentition of his *E. Ga-*

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[3] Monatsberichte Preuss. Acad. 1859, p. 275; Pr. A. N. S. Phila., 1860, p. 339.

[4] Günther, Proc. Z. S. Lond., 1860, June.

[5] Pr. A. N. S. Phil., 1862, p. 249.

[6] Pr. A. N. S. Phil., 1860, p. 76.

[7] Loc. cit., 1860, p. 566.

[8] Loc. cit., 1862, p. 339.

[9] Rev. Mag. Zool., 1856, p. 468.

bonensis, and he has since made it the type of a genus *Miodon*, which was anticipated by *Urobelus* of Reinhardt. The very anterior position of the grooved tooth, which has but three solid ones in front of it, suggests the yet undiscovered point of transition from *Asinea* to the *Proteroglypha*. *Microsoma* Jan, is an *Elapid* of the same region, possessing many of the peculiarities of *Urobelus*.

There are probably three, certainly two, genera of this group in South America besides Jan's *Elapomojus;* they are *Apostolepis*, *Elapomorphus verus*, and *Phalotris*,[10] corresponding to the sections marked by asterisks in the table on p. 42.

Homulocranium was referred to *Tantilla* of Bd. & Girard on the ground of priority of the latter in 1861;[11] of this, Prof. Jan does not seem to be aware. He describes an *H. Wagneri*, said to have been brought from Florida, which probably does not belong to the genus on account of its entire anal scutum. *Elapotinus*, described as new, and allied to *Elapomorphus*, is also near to *Tantilla* as far as the characters given enable us to decide. The posterior superior maxillaries are not grooved; if other differences exist, we are not informed of them.

Under the head of *Probletorhinidæ*, Prof. Jan unites a number of genera of singular aspect, and undoubted affinity, which mostly inhabit Mexico and Southwestern United States. We have already recognized this group and published a table of the genera in the *Philadelphia Proceedings* for 1861, (p. 302) and are much gratified at this confirmation of the view there expressed. We will now give an artificial synopsis of this group, with the additions and modifications which new material suggests.[12] The African *Ligonirostra* (*Temnorhynchus* Smith, preoccupied in Coleoptera), must be placed near *Prosymna* Gray. *Chilorhina* De Fil. is *Sympholis* Cope, of prior date. Dr. Jan's demonstration of the position of *Ficimia* Gray is as interesting as unexpected; *Amblymetopon* of Günther has never been properly separated from it, if a difference exists. We will accept for the present *Exorhina* Jan, but his *Oxyrhina* is *Chionactis* Cope (long ago characterized by Hallowell), and *Achirhina* is *Toluca* Kenn., also of prior date. Then there must be added *Conopsis*, and perhaps *Brachyurophis* of Günther,[13] *Sonora* Baird & Girard, and *Gyalopium* and *Chilomeniscus* of the writer.

I. *Internasal plates wanting.*

Rostral plate in contact with frontal, - - - -	*Ficimia.*
Rostral plate not in contact with frontal,	
Loreal none, anal divided, - - - - -	*Conopsis.*
Loreal present,	
Anal divided, nasal separate, - - - -	*Exorhina.*
Anal entire, nasal confluent with first upper labial, -	*Sympholis.*

II. *Internasals confluent with nasals.*

Dentition glyphodont, - - - - - -	*Stenorhina.*
Dentition isodont, muzzle shovel-like, - - - -	*Chilomeniscus.*

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[10] Pr. A. N. S. Phil., 1861, p. 524. [11] L. c., p. 74.

[12] Farther accessions of material will probably suggest the union of some of the genera.

[13] Ann. Mag. Nat. Hist. 1863, p. 21.

III. *Internasals separate from nasals.*

Two internasals.
  Two prefrontals.
    Nasal and first superior labial confluent; rostral recurved, - *Gyalopium.*
    Nasal and labial separate.
      No loreal, one nasal.
        Dentition glyphodont, - - - - - - *Brachyurophis.*
        Dentition isodont, - - - - - - - - *Toluca.*
      Loreal present.
        Two nasals, - - - - - - - - *Sonora.*
        One nasal, - - - - - - - - - *Chionactis.*
  One prefrontal, - - - - - - - - - - *Ligonirostra.*
One internasal, one prefrontal, - - - - - *Prosymna.*

We have, on a former occasion,[14] alluded to the close connection of this group with the *Coronellinæ*, through *Cemophora* and allied forms; our author perceives exactly the same affinity, but renames the genus just mentioned, *Stasiotes*. *Ficimia* and, as Günther remarks, *Brachyurophis*, are probably related to *Rhinostoma;* the latter is no doubt connected to the beautiful *Heterodon semicinctus*, by Dr. Peters' *Simophis*. *Heterodon d'Orbignyi* connects the red-ringed species with our northern type; thus we are led from *Sonora semiannulata* to *Heterodon platyrhinus!* Ours is indeed no "Ariadne's thread" if we are led to such results. But we have perhaps only lost the clue.

We have only to remark, regarding Prof. Jan's species of this group, that *Chilorhina Villarsii* is *Sympholis lippiens*, and that *Stenorhina quinquelineata* is not a variety of, but a very distinct species from, the *ventralis*—or *Degenhardtii*, as Jan agrees with Peters in calling it.

Thus it appears that Prof. Jan's work, like that of most others, is not free from oversights, many of which are not so excusable as some, which may have been occasioned by nearly simultaneous publications.

14. *Note on the "Glass Coral" of Japan*, (in a letter to Prof. SILLIMAN, Jr., from WILLIAM STIMPSON, dated Smithsonian Institution, Feb. 6, 1863.)

"The 'glass-coral' to which you refer is the *Hyalonema mirabilis* of Gray, which is found in the seas of Japan, and is one of the most beautiful of marine objects. It forms the subject of an elaborate monograph by Brandt, illustrated by four folio plates. This author divides it, on insufficient grounds, into two genera and several species. We have a few specimens in the museum of the Smithsonian Institution. They consist of groups of silicious fibres resembling spun glass, closely wound together in a spiral manner so as to form cylinders of a foot or more in length and the thickness of the little finger. In the centre of the bundle, particularly toward the base, we find a fibrous substance somewhat resembling cotton or rather asbestos, which is composed of very fine fibres, silicious like the larger ones. The cylinders are encrusted by various marine growths, i. e. a Zoanthus, a sponge, and a sea weed;—and to one of them the egg of a shark (*Scyllium?*) was attached by its tendrils. The Zoanthus is so uniformly found upon specimens, and encrusts them so regularly, that both Brandt and Gray do not hesitate to consider the glass-coral as the axis of a polyp related to the Gorgoniæ. Leuckart combats this idea and considers the polyp to be a parasite, while the

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[14] Proc. Acad. Phil., 1860, 241.

silicious fibres themselves belong to a sponge allied to the curious *Euplectella* figured by Prof. Owen in the *Transactions of the Linnæan Society*, vol. xxii, pl. xxi. An examination of these figures and the accompanying description will convince the most skeptical of the correctness of Leuckart's view. The cotton-like substance which I have mentioned above as found in the centre of the cylindrical bundles may perhaps give some indications of the character of the sponge to which these curious spiculæ belong, but the sponge usually seen encrusting the bundles is in all probability *not* the true one, as is supposed by some; and the *Zoanthus*, we cannot even consider as a parasite. For, in the Smithsonian specimens, to which my attention was first called by Mr. Verrill, we see abundant evidence that these so-called parasitic growths are the result of the ingenuity of the Japanese curiosity-mongers from whom the specimens are obtained, of which ingenuity we have also instances in the "mermaids" and other artifacts brought from Japan. In the first place the unnatural grouping of the bundles, figured by Brandt and seen in one of the Smithsonian specimens, is effected by means of a gum resembling gum tragacanth. The group thus formed is inserted into a crevice of a fragment of coral so nicely as to have the appearance of growing attached. Some agglutinating substance is also used for the attachment of the zoanthoid polyp, the sponge, and the sea-weed, for upon scraping these off at various points, we found *beneath* each of them *silken threads tied around the bundle of fibres for the purpose of keeping them together!* The nicety with which this is done is wonderful, and the deception is perfect. We should judge that the Japanese must have considerable knowledge of the lower animals, to be able to produce factitious congeries, so nearly agreeing with nature and so well calculated to deceive even practiced naturalists."

[The numerous auditories who have listened to the instructive and entertaining lectures of Dr. Macgowan upon Japan will be amused to learn that the curious glassy zoophyte which the Doctor exhibited turns out (quite unconsciously to the learned lecturer) to be another proof of the skill of that cunning people in manufacturing factitious objects in natural history so curiously as to deceive even skillful naturalists.

The genus *Hyalonema* and the species *H. Sieboldi* will be found described in Dana's Zoophytes, pp. 641, 642. The glassy fibres of *H. mirabilis*, when heated alone in a glass tube, decrepitate and fly into numerous minute spiculæ, splitting longitudinally, and emitting an animal odor without becoming colored. These fibres are pure silica. They do not gelatinize in hot chlorhydric acid, and no trace of lime could be detected in them by the spectroscope. They polarize light only very imperfectly, either in cross section or transversely. The rings of growth are beautifully seen in section, and as many as seventy can be counted arranged about a center which is excentric to the cylinder.—S.]

15. *Prodromus of the History, Structure, and Physiology of the order Lucernariæ;* by Prof. HENRY JAMES CLARK, of Harvard University, Cambridge, Mass. (*Journal of the Boston Society of Natural History*, March, 1863, pp. 531–567).—In the earlier pages of this number of the Journal, (p. 346, article XXXIV,) it may be seen that the Lucernarians are

ranked as a distinct order of Acalephæ. The principal feature in the prodromus, to which we would here call attention, is the division of the order Lucernariæ into two families. The first family, *Cleistocarpidæ* includes such Lucernarians as the genera *Carduella, Depastrum,* &c.; and the second family, *Eleutherocarpidæ*, embraces the earliest described *Lucernariæ, L. quadricornis, L. octoradiata, L. campanulata*, &c., which are divided into three genera. Out of the eleven species of the order, the author has collected himself, or obtained from other sources, no less than eight, leaving only three, of which one is doubtful, to be added to his collection. The author's description, of the above-mentioned eight species, shows that he has studied them with the closest anatomical detail, and has drawn up the diagnoses as much from the internal as from the external characters; in fact we should say that the whole structure of these animals is epitomized in the prodromus. The geographical distribution of three of these species,—*Manania auricula* (*Lucernaria auricula* Fabricius), *Haliclystus auricula* (*L. auricula* Rathke, non Fabricius) and *L. quadricornis*,—is interesting, from the fact that they are common to the shores of Europe and America; and we are led to believe that more of the others, which are of the rarest sort, will be yet found to extend across the Atlantic. This view is in accordance with the opinions of most of the leading zoologists, both of this country and Europe, in regard to the other animals of the North Atlantic fauna. Of the rest of the eleven species comprised in the order, five are European and two are American. The latter two are entirely new to science.

VII. ASTRONOMY AND METEOROLOGY.

1. *Re-discovery of Panopea, Asteroid* (70).—Panopea was re-discovered by R. Luther at Bilk, Oct. 21, 1862. According to an observation of Oct. 28th, the error of Duner's ephemeris was $-8^{m}\ 13^{s}$ in A. R. and $-1^{\circ}\ 19'$ in Dec.

2. *Elements of Asteroid* (76).—The following elements of Freya, Asteroid (76), have been computed by D'Arrest of Copenhagen.

Epoch 1862, Oct. 24·5, Greenwich m. t.

$$\begin{array}{rcl} M & = & 321^{\circ}\ 37'\ 44''{\cdot}94 \\ \begin{array}{r}\pi\\ \Omega\\ i\end{array} & \begin{array}{c}=\\=\\=\end{array} & \left.\begin{array}{r}67\ \ 10\ \ 17\ {\cdot}9\\ 212\ \ 29\ \ 32\ {\cdot}5\\ 2\ \ 13\ \ \ 3\ {\cdot}0\end{array}\right\}\text{ Mean equinox 1862·0.} \\ \varphi & = & 1\ \ 43\ \ 52\ {\cdot}4 \\ \log.\ a & = & 0{\cdot}503649 \\ \mu & = & 623{\cdot}066 \end{array}$$

3. *Discovery of Asteroid* (77).—On the 12th of November, 1862, a new planet was discovered by Dr. C. H. F. Peters, at Hamilton College Observatory. It was near Feronia, and was between the 11th and 12th magnitudes.

4. *Comet* III, 1862.—This comet was discovered on the morning of Nov. 28, by Professor Respighi, at Bologna, and three days later by Dr. Bruhns at Leipsic. The following elements have been communicated by R. Engelmann of Leipsic.

T = 1862, Dec. 28·18262.
π = 125° 9′ 42″·6
☊ = 355 44 57 ·9
i = 42 22 52 ·5
log. q = 9·904475
Motion retrograde.

5. *Comet* I, 1863.—This comet was discovered by Dr. Bruhns of Leipsic, on the morning of Dec. 2d. The following elements have been computed by F. Tiejen of Berlin.

T = 1863, Feb. 3·52928 Berlin m. t.
π = 191° 23′ 12″·2
☊ = 116 55 28 ·0
i = 85 21 42 ·8
(Apparent equinox, 1862, Dec. 6·0.)
log. q = 9·9002165
Motion direct.

6. *Star Shower in December*, 1565.—In a *Sagenbuch der Lausitz* by Karl Haupt, published in the *Neues Lausitzisches Magazin* (Görlitz, 1862), among *Wunderzeichen am Himmel*, gathered from old Lusatian chronicles, is the following:

"On the 3d of December, 1565, there fell at Sorau fire from heaven like flakes of snow."—*Magnus, (Joh. Lam.) Historische Beschreibung von Sorau.* Leipz., 1710. 4to.

7. *Shooting Stars seen in England in* 1862.—The usual displays of shooting stars this year (1862), as seen near Manchester, have not been as well marked as usual; that of August 10th–11th, perhaps less so than for the last few years, but the weather was not very favorable. That of Nov. 9th–10th[1] was not in the least marked, either as regards the numbers or radiant. But the more newly determined period for Dec. 10th–12th has been exceedingly well defined, and the radiant point, both for the last year and for the present one, perfectly referable to a part of the heavens halfway between β Aurigæ and α Geminorum.—*R. P. Greg in Phil. Mag.*

8. *Auroral arch of April* 9th, 1863.—On the evening of April 9th, there was noticed at New Haven some appearance of an auroral light between 7½ and 8 o'clock. About 9 o'clock, white columns rose both from the eastern and western horizon, and shot up towards the meridian, their tops inclining from a vertical direction about fifteen degrees towards the south. A line of shorter columns connected the two columns just mentioned, in such a manner as to form a tolerably regular arch, spanning the heavens, and passing exactly over the Dipper. This arch was evidently formed of short streamers parallel to each other. Most of them were from 10° to 15° in length, and for some time presented the appearance of a row of comet's tails all parallel to each other. By 9½ o'clock, the eastern portion had very much faded, but the column in the west was intensely bright, and of a white color. It extended to Castor, and passed centrally over a star about midway between the two horns of the Bull. At 10 o'clock, the column in the east had disappeared entirely, while that in the west had very much faded, but extended up nearly or quite to the meridian. During the entire evening, there was noticed a

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[1] This, it will be observed, is not the proper anniversary of the November shower.

very strong auroral glow above the northern horizon, with the usual dark segment beneath it.

The following notice of this aurora appeared in the *Newburyport Daily Herald* of April 10th, with the signature P., presumed to denote Dr. Henry C. Perkins.

"An auroral arch of intense brightness spanned the heavens last evening as the bell was ringing for 9 o'clock, equalled only during our remembrance by that of Aug., 1827. Starting from a point just above the horizon, not far from due East, it enveloped the star in the right knee of Bootes, passed amid the stars in the Sickle, or the head and neck of Leo, thence enveloping Castor and Pollux, covering the space between the feet of the Twins, swerving thence a little to the northwest between the heads of Orion and Taurus, until it faded from view.

The arch was about 8° in width, remarkably well defined, though not so sharply so as that in 1827. It gradually moved to the South at the rate of about 8° or 10° in 20 minutes, when it broke up into wisps of light strikingly resembling those seen in the tail of Donati's comet, and so beautifully and truly represented in Prof. Bond's drawing of that body.—P."

[Correspondents are requested to send in their observations on this auroral arch, which was probably seen over sufficient area to furnish data for approximate estimates of its height.]

VIII. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *National Academy of Sciences.*—Hon. Henry Wilson of Massachusetts, in the Senate of the United States, at the last session of Congress, brought forward and secured the unanimous passage of the following bill entitled,

"A Bill to incorporate the National Academy of Sciences.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That LOUIS AGASSIZ, Massachusetts; J. H. ALEXANDER, Maryland; S. ALEXANDER, New Jersey; A. D. BACHE, at large; F. A. P. BARNARD, at large; J. G. BARNARD, United States army, Massachusetts; W. H. C. BARTLETT, United States Mil. Acad., Missouri; U. A. BOYDEN, Massachusetts; ALEXIS CASWELL, Rhode Island; WILLIAM CHAUVENET, Missouri; J. H. C. COFFIN, United States Naval Academy, Maine; J. A. DAHLGREN, United States navy, Pennsylvania; J. D. DANA, Connecticut; CHARLES H. DAVIS, United States navy, Massachusetts; GEORGE ENGELMANN, St. Louis, Missouri; J. F. FRAZER, Pennsylvania; WOLCOTT GIBBS, New York; J. M. GILLISS, United States Naval Observatory, Kentucky; A. A. GOULD, Massachusetts; B. A. GOULD, Massachusetts; ASA GRAY, Massachusetts; A. GUYOT, New Jersey; JAMES HALL, New York; JOSEPH HENRY, at large; J. E. HILGARD, at large, Illinois; EDWARD HITCHCOCK, Massachusetts; J. S. HUBBARD, United States naval observatory, Connecticut; A. A. HUMPHEYS, United States army, Pennsylvania; J. L. LECONTE, United States army, Pennsylvania; J. LIEDY, Pennsylvania; J. P. LESLEY, Pennsylvania; M. F. LONGSTRETH, Pennsylvania; D. H. MAHAN, United States Military Academy, Virginia; J. S. NEWBERRY, Ohio; H. A. NEWTON, Connecticut; BENJAMIN PEIRCE, Massachusetts; JOHN RODGERS, United States navy, Indiana; FAIRMAN ROGERS, Pennsylvania; R. E. ROGERS, Pennsylvania; W. B. ROGERS, Massachusetts; L. M. RUTHERFURD, New York; JOSEPH SAXTON, at large; BENJAMIN SILLIMAN, Connecticut; BENJAMIN SILLIMAN, Jr., Connecticut; THEODORE STRONG, New Jersey; JOHN TORREY, New York; J. G. TOTTEN, United States army, Connecticut; JOSEPH WINLOCK, United States Nautical Almanac, Kentucky; JEFFRIES WYMAN, Massachusetts; J. D. WHITNEY, California, their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

"SEC. 2. *And be it further enacted,* That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

"SEC. 3. *And be it further enacted*, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any department of the government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports, to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the government of the United States."

Agreeably to an invitation from Mr. Wilson, a majority of the corporators named in this Act met on the 22d of April, at 11 A. M. in the Chapel of the University of the city of New York, for the purpose of organizing the National Academy of Sciences. The body was called to order, with a few appropriate remarks, by Mr. Wilson, who was present by the request of a large number of members. A temporary organization was secured by the choice of Joseph Henry of Washington and Alexis Caswell of Brown University as Chairman and Secretary, *pro tempore.* A committee of nine persons, of whom Prof. Caswell was chairman, was appointed to prepare and report Rules for governing the Academy, agreeably to the powers vested in them by Section 2d of the Act of Incorporation, adopted by Congress and approved by the President of the United States on the 4th of March, 1863.

Agreeably to the laws thus enacted (which lay over to January next for final consideration), the Academy is divided into two classes, viz.:[1]

1st. The Class of Mathematics and Physics.

2d. The Class of Natural History.

The corporate members elect under which of these two classes and in which section of that class they will inscribe their names. The classes are subdivided thus:—

A. *Class of Mathematics and Physics.*—SECTIONS: 1, Mathematics; 2, Physics; 3, Astronomy, Geography, and Geodesy; 4, Mechanics; 5, Chemistry.

B. *Class of Natural History.*—SECTIONS: 1, Mineralogy and Geology; 2, Zoology; 3, Botany; 4, Anatomy and Physiology; 5, Ethnology.

While each member chooses his own position, he may also be elected an honorary member of any section by the members thereof, and the Academy retains the power of transferring a member from one Section to another.

There may be fifty foreign associates, who take no part in the business of the Academy, but have the privilege of attending its sessions, reading and communicating papers and of receiving a copy of the publications of the Academy.

The officers of the Academy are a President, a vice President, a Foreign Secretary, a home Secretary, and a Treasurer, all of whom are elected for a term of six years.

There is also a chairman and secretary to each class elected annually at each January meeting. The officers of the Academy, and chairman of the classes, together with four members to be annually elected by the Academy, constitute a Council for the transaction of such business as is assigned to them by law or by the Academy.

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[1] As these Rules are subject to change prior to their final adoption in January, there is an obvious impropriety in publishing them in detail, at present, but so much of their provisions as concern the general organization of the Academy, and as are not likely to be materially altered, we give in this notice.—EDS.

The powers of the President, (or in case of his absence or disability, the Vice-President,) are, to preside at the meetings of the Academy, name (unless otherwise provided for by law) committees of members, referring business, experimental enquiries, investigations or preliminary inquiries required by the Government of the United States or its branches, to members specially conversant with the subject; and, with the Council, to direct the general business of the Academy. The duties of the other officers present nothing beyond what is usual in all similar organizations.

The Academy holds two stated meetings in each year, one in January and one in August. The January meeting is to be held always in Washington on the 3d day of January, (or when that day is a Sunday, on the 4th), but the August meeting will be held at such place as the Academy at any previous meeting may designate, and on the 3d Wednesday of the month. The scientific meetings of the Academy are to be open or public, the business meetings closed. Communications by persons not members of the Academy are to be presented and read by a member who makes himself responsible only for the general propriety of the paper and not for opinions expressed by the author.

Propositions for researches, experiments, observations, investigations or reports, shall originate with the Classes to which the subjects are appropriate, and then be submitted to the Academy for discussion, and approval or rejection, excepting propositions from the Government of the United States, or any of its branches, which shall be acted on by the President, who will in such case report, if necessary, at once to the Government, and also to the Academy at the next stated meeting. The judgment of the Academy is to be at all times at the disposition of the Government upon any matter of Science or Art within the limits of the subjects embraced by it. The President of the Academy is competent, in special cases, to call in the aid, upon committees, of experts, or men of remarkable attainments not members of the Academy.

The Annual Report to be presented to both Houses of Congress, is to be prepared by the President of the Academy, and before its presentation is to be submitted, first to the Council, and then to the Academy at the January meeting. The abstract of a memoir may however be sent by any member to the Home Secretary, to be printed and circulated among the members during the recess of the Academy.

These are the most important features of the organic law of the National Academy of Sciences. An election was held under the rules when the following officers were chosen almost unanimously:

President,	ALEXANDER DALLAS BACHE,	Washington, D. C.
Vice-President,	JAMES D. DANA,	New Haven, Conn.
Foreign Secretary,	LOUIS AGASSIZ,	Cambridge, Mass.
Home Secretary,	WOLCOTT GIBBS,	New York.
Treasurer,	FAIRMAN ROGERS,	Philadelphia.

OFFICERS OF THE CLASSES.

Class A. Mathematics and Physics.

Chairman,	B. PEIRCE,	Cambridge, Mass.
Secretary,	B. A. GOULD,	Cambridge, "

Class B. Natural History.

Chairman,	B. SILLIMAN,	New Haven, Ct.
Secretary,	J. S. NEWBERRY,	Ohio.

After the completion of the organization, each member present, agreeably to the requirements of the organic law, took the oath of allegiance prescribed by the Senate of the United States for its own members, and in addition thereto took an oath faithfully to discharge the duties of a member of the National Academy of Sciences to the best of his ability.

Born in the midst of a great political revolution, the National Academy of Sciences, created by the supreme law of the land, stands pledged to the power which has called it into being, and to the world to discharge its duties with fidelity. The members of the Academy named in the Act had before them simply to accept or to decline the trust reposed in them, by no choice of theirs. So far as they have accepted their position, we feel justified in saying it is with a conviction that there were many not named on the list who might most properly have been there, and with the assurance that so far as any honor may attach to membership, it will be shared much more largely by those who shall hereafter be called by the suffrages of the Academy to fill such vacancies as must occur, than by the corporators who are named in the law.

The National Academy of Sciences does not take the place of, or necessarily interfere with, the American Association for the Advancement of Science, as many persons seem to have supposed.

IX. BOOK NOTICES.

1. *The National Almanac and Annual Record for the year* 1863. Philadelphia: G. W. Childs, 1863. 12mo. pp. 698.—This work succeeds the well known *American Almanac* so long issued at Boston, and which attained an enviable reputation as a reliable record of cosmical facts and the repository of a large amount of information, statistical, political, educational, scientific and general. Mr. Childs has taken up the task relinquished by Mr. Sawyer, and with a degree of fullness surpassing the original. The articles of scientific value in this volume are Meteorology, Tide tables for Coast of U. S., Coast Survey, and Smithsonian Institution, which are excellent. In the same category should be mentioned a valuable paper on the changes in the relative position (in population and growth) of the several States from 1790 to 1860, by Prof. Wm. M. Gillespie, who has exhibited this subject graphically by the method so common in tabulating scientific results by curves. With the active aid of Profs. Bache and Henry of Washington, Profs. Coppée and Gillespie, Dr. Pollock and others, the reliable character of the *National Almanac* is secured, while, as we are informed, the spirited editor retains the best talent, in all departments, before given to the *American Almanac.*

2. *The Geological Evidences of the Antiquity of Man*, with remarks on "theories of the origin of species by variation;" by Sir CHARLES LYELL, F.R.S. pp. 520, 8vo. London. Reprinted by G. W. Childs, Philadelphia.

3. ABBÉ MOIGNO's new Journal, called *Les Mondes Revue Hebdomadaire des Sciences, et les applications aux arts et a l'industrie*, appeared first on the 12th of February of this year, and has reached us regularly each week since. It replaces *Cosmos*, from which Abbé Moigno has withdrawn, for reasons of a personal nature growing out of his relations to the proprietor, which he fully sets forth in a *Prologue* of 6 or 7 pages.

Les Mondes is an extremely lively Journal of 28 pages, with a supplement on pure Science of 16 pages each week. It aims to notice the progress of all science, pure and applied, whether French or foreign.

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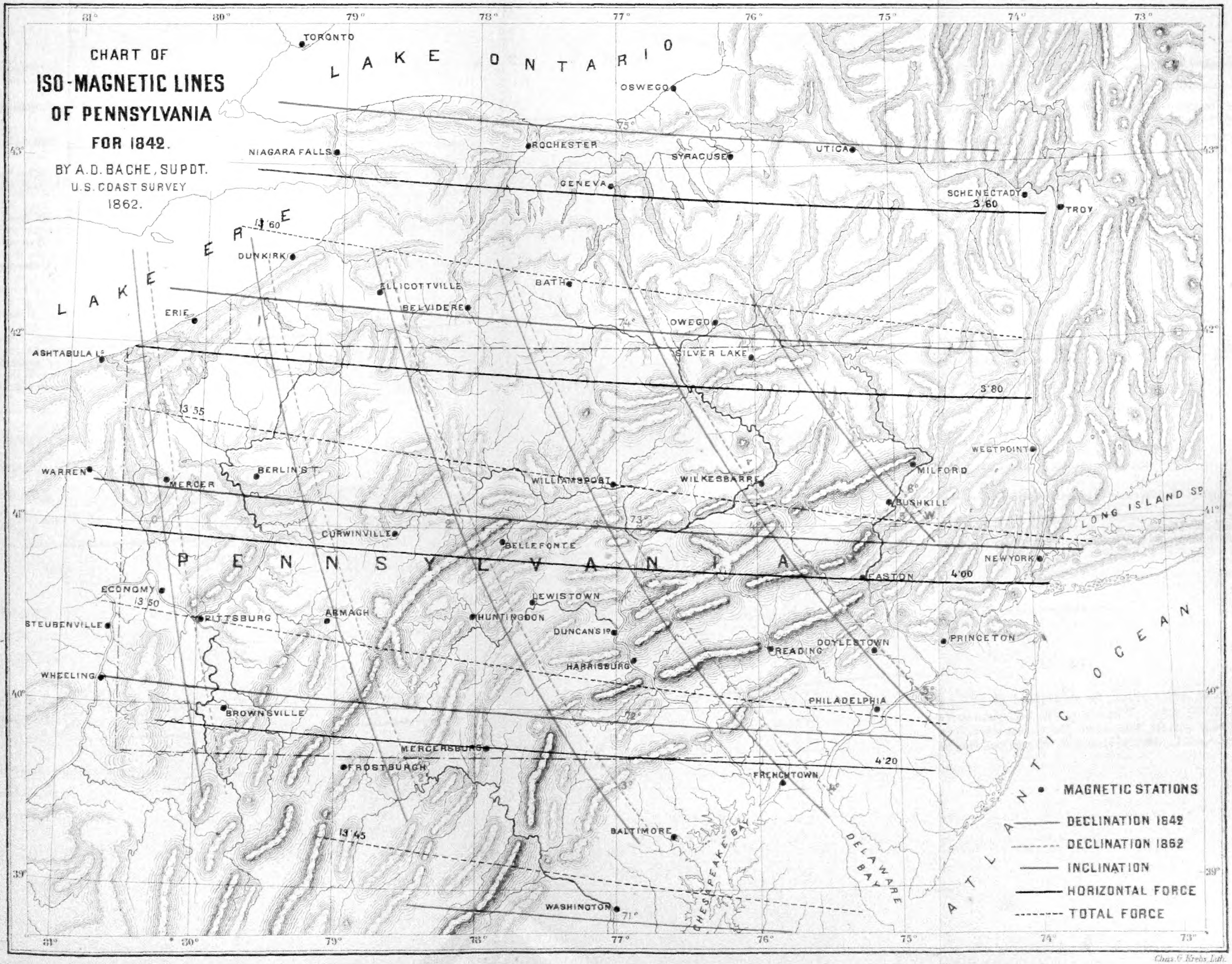

CHART OF
ISO-MAGNETIC LINES
OF PENNSYLVANIA
FOR 1842.
BY A. D. BACHE, SUPDT.
U.S. COAST SURVEY
1862.

● MAGNETIC STATIONS
DECLINATION 1842
DECLINATION 1862
INCLINATION
HORIZONTAL FORCE
TOTAL FORCE

Chas. G. Krebs, Lith.