THE

# AMERICAN JOURNAL

OF

# SCIENCE AND ARTS.

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THIRD SERIES.

VOL. III.—[WHOLE NUMBER, CIII.]

Nos. 13--18.

JANUARY TO JUNE, 1872.

WITH TWO MAPS AND THIRTEEN PLATES.

NEW HAVEN: EDITORS.
1872.

PRINTED BY TUTTLE, MOREHOUSE & TAYLOR, 221 STATE ST.

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### SCIENTIFIC INTELLIGENCE.



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### ERRATA.

Vol. ii, p. 408, title, *for* J. P. SOUTHWORTH *read* R. J. SOUTHWORTH.
Vol. iii (March, 1872), p. 198, line 22 from top, for 80 by 110, read 80 by 60.

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AMERICAN

# JOURNAL OF SCIENCE AND ARTS.

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## ART. I.—*On Alpine Geology;** by T. STERRY HUNT.

SINCE the days of de Saussure, the Alps have been the object of constant study. No other portion of Europe offers so many problems of interest to the geologist and the physical geographer as this great mountain chain, whether we consider its lakes, glaciers and moraines, its curiously disturbed and inverted fossiliferous strata, which seem, at first sight, arranged for the confusion alike of paleontologists and stratigraphists, or the crystalline rocks which form its highest summits. To give a list of the various investigators who have contributed their share to the elucidation of this region would, of itself, be no slight task, and would besides be foreign to our present purpose; which is to call attention to the learned work of Prof. Alphonse Favre of Geneva, in which he has given us the results of more than twenty-five years of labor in the study of Alpine geology, chiefly in Savoy and the adjacent parts of Piedmont and Switzerland, embracing Mont Blanc and its vicinity. It is now twelve years since the present writer had occasion to review in this Journal (II, xxix, 118) some points in Alpine geology raised by our author in his memoir *Sur les terrains liassque et keuperien de la Savoie*, published in 1859. Since that time the views then maintained by Favre, have, in spite of much opposition, gained ground, and are set forth at length in the present work, supported by an amount of evidence which seems convincing. We shall endeavor from

* Recherches Géologiquer dans les parties de la Savoie, du Piémont, et de la Suisse voisines du Mont Blanc, avec un Atlas de 32 planches, par Alphonse Favre, Professeur de Géologie à l'Académie de Genève. 3 vols. 8vo. Paris, 1867.

its pages to present a condensed summary of our present knowledge of the structure of Mont Blanc and the adjacent regions.

The crystalline rocks of the Alps, as first shown by Studer, do not form a continuous chain, but appear as distinct masses, separated from each other by uncrystalline sedimentary deposits, generally fossiliferous. According to Desor, there are between Nice and the plains of Hungary not less than thirty-four such areas, standing up like islands from out of the sedimentary rocks, and presenting for the most part a fan-like structure (*en eventail*). Of these masses of crystalline rock, Mont Blanc is the most remarkable, and is described by Elie de Beaumont as "rising through a solution of continuity in the secondary strata, which may be compared to a great button-hole." The length of this area of crystalline rock, measured from the Col du Bonhomme on the S. W. to Saxon in the Valais on the N. E., is fifty-nine kilometers, while its breadth, from Chamonix on the N. W. to Entrèves near Courmayeur on the S. E., is fourteen kilometers. The length of the central mass of protogine is, however, only twenty-seven kilometers. Of the numerous peaks in this area the highest attains an elevation of 4810 meters above the level of the sea, being 3760 meters above the valley of Chamonix and 3520 meters above the valley of Entrèves. This great mass is described by Favre as supported at the four corners by as many buttresses rising from the surrounding valleys, and known as the Cols de Balme, de Voza, de la Seigne and de Ferret. The distance between the two valleys just named is only 13,500 meters, and the boldness with which the mountain rises from them is strikingly apparent if we take the Col de l'Aiguille du Midi and the Col du Géant, which are about 3460 meters above the sea, and distant from each other 5,000 meters, giving a slope of about 30°. A still greater inclination is obtained if we choose, instead of these, the summits of the Aiguilles which bear the same names, and, although now isolated, represent portions of the former mass of Mont Blanc.

The crystalline rocks of this region present two types, 1st, the protogines which form the center, and 2nd, the crystalline schists which occupy the flanks and form the Aiguilles Rouges. These schists are also found at a great elevation on the mountain; at the Grands Mulets (4666 meters), the rocks are talcose and quartzose schists with graphite, hornblende, epidote, talc, and asbestus, and similar rocks and minerals are found from thence to the summit. The protogines themselves, according to the evidence of nearly all who have studied them, are stratified rocks, gneissic in structure, and pass in places into more schistose varieties, though Favre regards the distinction between these and the crystalline schists proper as one clearly marked.

The outlines presented by the weathering of the protogine are very unlike the rounded forms assumed by true granite rocks. According to Delesse, the rock to which Jurine gave the name of protogine is a talco-micaceous granite or gneiss, made up of quartz, generally more or less grayish or smoky in tint, with orthoclase, grayish or reddish in color, and a white or greenish oligoclase with characteristic striæ, often penetrated with greenish talc. The mica [biotite], which some previous observer had mistaken for chlorite, is dark-green in color, becoming of a reddish bronze by exposure. It is binaxial, nearly anhydrous, and contains a large portion of ferric oxide. The composition of the protogine rock, as a whole, differs from that of ordinary granite, according to Delesse, only in the presence of one or two hundredths of iron-oxide and magnesia. The name of arkesine was given by Jurine to a variety of protogine containing chlorite with hornblende, and sometimes sphene. Among the other crystalline rocks of the Alps are various talcose and chloritic schists, with steatites, chromiferous serpentines, diallage rocks, diorites, and euphotides, associated with beds of petrosilex or eurite, frequently porphyritic. Highly micaceous schists, often quartzose, and holding garnet, staurolite and cyanite, are also met with among the crystalline rocks of the Alps. A great belt of serpentine and chloritic schists, traced for a long distance, may be seen at the base of the Montanvert overlaid by the euritic porphyries into which they appear to graduate, the whole series, here supposed to be inverted, dipping at about 60° from the valley of Chamonix toward Mont Blanc, and overlaid by the more massive gneiss or protogine. The chloritic and talcose schists of the Alps have close resemblances with those of the Urals, and as Damour has shown, contain a great many mineral species in common with them. Favre has moreover remarked the strong likeness between the chloritic and talcose schists and the mica-schists with staurolite of the western Alps and those found in Great Britain.

Granite, though not abundant in the vicinity of Mont Blanc, occurs in several localities, the best known of which is Valorsine, where a porphyroid granite with black mica forms considerable masses, and sends large veins into the adjacent gneiss. These, with others found at the Col de Balme and in the Aiguilles Rouges, appear to be true eruptive granites. Numerous small veins met with among the crystalline schists in the gorge of Trient appear, however, to belong to what I have described as endogenous granites (*Notes on Granite Rocks*, this Jour., II, i, 87). Favre has himself maintained that they are the results of aqueous infiltration, and has noticed the fact of a joint running longitudinally through the middle of many of them as an evidence of this mode of formation.

The uncrystalline strata in the region around Mont Blanc include representatives of the carboniferous, triassic, jurassic, neocomian, cretaceous and tertiary. The existence of an apparently carboniferous flora, and its intimate association with a liassic fauna, has long been a well known fact in Alpine geology. In 1859, Favre pointed out the existence of a zone of triassic rocks in this region represented by red and green shales, with sandstones, gypsum, and a cavernous magnesian limestone (cargneule). These rocks had long before been referred to this period by Buckland and Bakewell, but their horizon was established by the discovery of Favre that their position is intermediate between the carboniferous and the strata containing *Aricula contorta*, the Kössen beds, or the Rhætic beds of Gümbel, which are recognized as forming a passage between the trias and the lias, at the base of the Jurassic system. To these, to the northwest of Mont Blanc, succeed the higher members of the system, followed by the neocomian, the cretaceous and the nummulitic strata of the eocene with overlying sandstones and shales, the flysch of some Alpine geologists.

Few questions in geology have been more keenly debated, or given rise to more often repeated examinations, than the association of a carboniferous flora with liassic belemnites in the districts of Maurienne and Tarentaise, to the southwest of Mont Blanc. As seen at Petit-Cœur, the schists, with impressions of ferns and beds of anthracite, were so long ago as 1828 described by Elie de Beaumont as apparently intercalated in the Jurassic system. Scipion Gras, and Sismonda after him, have agreed in regarding the rocks as constituting one great system, which according to Gras is of carboniferous age, but with a jurassic fauna, while de Beaumont and Sismonda, on the contrary, regarded it as of jurassic age, but with a carboniferous flora, and imagined that by some means there had been in this region a local survival of the vegetation of the paleozoic period. These conclusions were accepted by many geologists, though rejected by not a few. A brief account of the controversy up to that date will be found in this Journal for January, 1860, page 120, and in the work of Favre now before us the whole matter is discussed at great length in chapter xxx. The anthracitic system of the Alps, as recognized by Gras, was by him estimated to have a thickness of from 25,000 to 30,000 feet, and included besides the dolomites and gypsums now referred by Favre to the trias, coal-plants and layers of anthracite, together with limestones holding belemnites of jurassic age. Included in this great system were, moreover, gneissic, micaceous and talcose rocks, with graphite, serpentine, euphotide, etc., all of which were regarded by Gras as formed by the local alteration of portions of the anthracitic system. To this was added in 1860 the discovery by Pillet of nummulitic beds intercalated in the same series near St. Julien in Maurienne. This fact was, however, in accordance with the conclusion previously reached by Sismonda from an examination of Taninge, that "the plants of the carboniferous period were still flourishing while the seas were depositing the rocks of the nummulitic period."

The question involved in this controversy had more than a local interest, since it touched the very basis of paleontology, by pretending that in the Alps the laws of succession which elsewhere prevail were suspended, and that the same type of vegetation had continued unchanged from the paleozoic to the tertiary period. Already in 1841 Favre had brought forward the suggestion of Voltz, that these apparent anomalies might be explained by inversions of the strata, but this notion was rejected by de Mortillet and Murchison, as inadmissible for the section at Petit-Cœur. The recognition by Favre in 1861 of the true age and position of the cargneules and their associated rocks, however, threw a new light on the question, for it was shown that these triassic rocks were interposed at Petit-Cœur between the limestones holding belemnites and the schists with coal-plants. In 1861, the Geological Society of France held its extraordinary session at St. Jean in Maurienne, and there also the succession was made clearly evident, as follows: nummulitic, liassic, infra-liassic, triassic, and carboniferous; the last resting on crystalline schists.

Attempts had been made to sustain the supposed jurassic age of the so-called anthracitic formation, by maintaining that some at least of the coal-plants were jurassic forms; but Heer, who had long maintained the contrary, published in 1863 a farther study of the fossil flora of Switzerland and Savoy, in which he showed that of sixty species fourteen are peculiar to these regions, while forty-six belong to the carboniferous flora of Europe, and twenty-seven are common with that of North America. One species only has been indentified as of liassic age, viz: *Odontopteris cycadea* Brongn., and is found in a locality near jurassic belemnites, but associated with no other plant.

Both Lory and Pillet now admit with Favre that the supposed paleontological anomalies of this region have no existence, and that this anthracitic system includes carboniferous, jurassic and nummulitic strata inverted and folded upon themselves; nor is it without reason in this connection that Lory remarks upon "the illusions without number to which a purely stratigraphical study of the Alps may give rise." To this we may add the judgment of Dumont, in discussing the disturbed and inverted anthracitic system of the Ardennes, that for regions thus affected "we cannot establish the relative age of the rocks from their inclination or their superposition."

These conclusions were not, however, admitted by Sismonda, who in 1866 presented to the Royal Academy of Sciences of Turin an elaborate memoir on the anthracitic system of the Alps.* In this, while admitting at Petit-Cœur the existence of evidence of more or less contortion, rupture and over-riding (*enchevauchement*) of the strata, he still maintains that the anthracitic system of Maurienne and Tarentaise is one great continuous series of jurassic age, from the fundamental gneiss and protogine, upon which it immediately rests, to the upper member in which occur thick beds of anthracite with an abundant carboniferous flora; which he assigns, however, to the middle oolite (Oxfordian); the great mass of strata below being referred to the lias. He then particularly indicated the line of the great Mont Cenis tunnel, which, commencing in the upper anthracitic member, should pass downward through the quartzites and gypsums, thence through talcose schists and limestones, as far as Bardonecchia. These schists and limestones, according to him, are in "a very advanced state of metamorphism," and include eruptive serpentines, with euphotide, steatite and other magnesian rocks.

Since the completion of the tunnel, Messrs. Sismonda and Elie de Beaumont have presented to the Academy of Sciences of Paris an extended report on the geological results obtained in this great work. It is accompanied by a description of 134 specimens of the rocks collected at intervals throughout the entire distance of the tunnel, which it will be remembered passes from near Modane in Savoy to Bardonecchia in Piedmont (about fifteen miles to the southwest of Mont Cenis), a distance of 12,220 meters. The direction of the tunnel is N. 14° W., and the dip of the strata throughout nearly uniform, N. 55° W. at an angle of about 50°. From this we deduce by calculation that the vertical thickness of the strata is equal to nearly 60 per cent of the distance traversed, or in round numbers about 7000 meters. Of this not less than 5831 meters, beginning at the southern extremity, are occupied by the lustrous more or less talcose schists with crystalline micaceous limestones, often cut by veins of quartz with chlorite and calcite. Above there are 515 meters in thickness of alternations of anhydrous sulphate of lime (karstenite) with talcose schist and crystalline limestone. The anhydrite enclosed lamellar talc in irregular nodules, with dolomite, crystallized quartz, sulphur, and masses of rock-salt. This was overlaid by 220 meters of quartzite, occasionally alternating with greenish talcose schists, and enclosing veins and masses of anhydrite. A considerable break occurs in the series of specimens above this, but for the distance of 1707 meters from the northern entrance to the tunnel, corresponding to a vertical thickness of 1024 meters, we have principally sand-

* Memoirs of the Acad., 2d series, xxiv, 333.

stones, conglomerates and argillites, occasionally with anthracite. The serpentines and euphotides which appear among the crystalline schists at Bramant, near the line of the tunnel, were not met with, nor was the underlying gneiss encountered. The work terminated at Bardonecchia among the crystalline limestones.

According to Sismonda and Elie de Beaumont, there is throughout this entire section no evidence of inversion, dislocation or repetition in the series of 7000 meters of strata, a conclusion which they support by very cogent arguments. Lory, on the contrary, while he agrees with the observers just mentioned in looking upon the crystalline strata as altered mesozoic, conceives them to include both trias and lias, and to be placed beneath the true carboniferous by a great inversion of the whole succession. This series of crystalline rocks is very conspicuous along the S. E. side of Mont Blanc, extending into the Valais, and is regarded by Lory as a peculiar modification of the trias and lias, so enormously thickened and so profoundly altered as to be very unlike these formations to the northwest of Mont Blanc. In this view he is followed by Favre (§ 666. § 753). The serpentines and related rocks of this series are by de Beaumont, Sismonda and Lory considered to be eruptive. The latter speaks of these as eruptions contemporaneous with the deposition of the strata, probably accompanied by emanations which effected the alteration of the sediments. According to Favre, they are clearly interstratified with the lustrous argillo-talcose schists, micaceous limestones and quartzites of the great series, and are by him placed in the trias. He has particularly described those of Mont Joret and those of the Val de Bruglié near the Petit St. Bernard, where they are immediately interstratified with greenish schists and associated with steatite, hornblendic and gneissic strata. The serpentines of Taninge in the Chablais, to the northwest of Mont Blanc, he also classes with these in the trias. The conclusions of Lory and Favre as to the geological age of these crystalline schists and limestones, appear to us untenable in the light of Sismonda's investigations. If we admit with the latter that the whole section of the tunnel represents an uninverted series, and with Favre that its uppermost and uncrystalline portion at Modane is truly of carboniferous age, it is clear that the great mass of crystalline schists which underlie the latter should correspond more or less completely to the pre-carboniferous crystalline strata to the northwest of Mont Blanc. Among these latter, in fact, as observed by Favre, there occur at Col Joli and Taninge crystalline limestones and talcose schists like those of Maurienne. According to this view, which harmonizes the conflicting opinions, and makes the crystalline schists and limestones of the southeast pre-carboniferous, the anhydrites, with limestones, talcose slates and quartzites seen in the Mont Cenis tunnel, are not the equivalents of the gypsum and cargneule of the trias, but may correspond to the anhydrites, which with gypsum, dolomite, serpentine and chloritic slate, are met with in the primitive schists of Fahlun in Sweden.

The existence of great and perplexing inversions of strata in many parts of the Alps is well known. One of the most striking cases is that figured by Murchison in his remarkable paper on the geology of the Alps in 1848 (Quar. Jour. Geol. Soc., v, 246), as occurring at the pass of Martinsloch in the canton of Glarus, 8000 feet above the sea. Here nummulitic beds, dipping at a high angle S.S.E., are regularly overlaid by the succeeding sandstone (flysch); resting unconformably and in a nearly horizontal attitude upon the edges of which are 150 feet of hard jurassic limestone, overlaid in its turn by talcose and micaceous schists, which are by Escher regarded as similar to those which underlie these limestones in the valley below. This mass of flysch appears near by to dip beneath these limestones, which, in their turn, are regularly overlaid by neocomian and cretaceous strata. This remarkable superposition of secondary and older crystalline rocks to tertiary is explained by Murchison, in accordance with the suggestion of H. D. Rogers, as the probable result of fracture and displacement along an anticlinal. Many striking examples of inversion are described by Favre in the vicinity of Mont Blanc. The mountain of the Voirons, near Geneva, shows at its base tertiary overlaid by cretaceous rocks, upon which jurassic strata are superimposed. Similar phenomena are met with along the north side of the Alps from Geneva to Austria, and at various localities on the southern side, in Lombardy. This inversion, moreover, is by no means confined to secondary and tertiary strata. In the valley of Chamonix the secondary limestones dip at a high angle toward Mont Blanc, and plunge beneath its crystalline schists. Other examples of the superposition of crystalline schists to the fossiliferous sediments have been pointed out by Elie de Beaumont in the mountains of Oisans, and confirmed by Lory and Dausse, while similar cases have been recognized by Morlot and von Hauer in the eastern Alps, and by Ramond, de Boucheporn and others in the Pyrenees. All of these cases are by Favre regarded as examples of the same process of inversion already noticed in so many instances among the secondary and tertiary strata of the region. He proceeds to contrast these examples with that of the gneisses, chloritic and micaceous schists which in western Scotland, according to Murchison, overlie fossiliferous lower silurian beds, and are by him regarded as younger. This, upon the authority of Murchison, Favre regards as a singular and anomalous fact. It should, however, be said that this view of Murchison is rejected by Nicoll, who explains the appearances as the result of dislocation and oversliding of older crystalline schists upon the newer fossiliferous beds, in which case the western Highlands will form no exception to the general law of similar appearances in the Alps and Pyrenees.*

The fact that the jurassic rocks in the valley of Chamonix pass beneath the crystalline schists of Mont Blanc was first noticed by de Saussure, and was afterwards observed by Bergmann and by Bertrand, who argued from this that the limestones were older than the gneiss. Bertrand's paper, as noticed by Favre, occurs in the *Jour. des Mines*, vii, 376 (1797–1798). Later, in 1824, we find Keferstein inquiring whether these overlying gneisses and protogines might not be altered flysch (that is, eocene tertiary), a view which he subsequently maintained. Similar views have found favor among later geologists: we find Murchison asserting the eocene age of certain Alpine gneisses, mica-schists and granites; while Lyell has suggested that the protogines, gneisses, etc., of the Alps may have resulted from the alteration both of secondary and tertiary strata. (Anniversary Address to the Geological Society, 1850). Studer has taught that the flysch of the Grisons has been changed into crystalline gneiss, while Rozet and Fournet, with Lory and Sismonda, have assigned to the Jurassic period the great system of gneiss, with talcose and micaceous schists, which make up Monts Cenis and Pelvoux, and much of the mountains on the frontier of Piedmont and in the Valais.

Hutton, as early as 1788, had taught that what he called the primary schists were sediments, the ruins of earlier rocks altered by heat, but it does not appear that he attempted to fix the relative age of any such altered rocks. In fact, the notion of geological epochs, based upon the study of fossils, was not as yet fully recognized. The suggestions of Bergmann and Bertrand that the crystalline rocks of the Alps are newer than the fossiliferous limestones which pass beneath them, seems to have been the first attempt to give to Hutton's view a definite and special application, and the inception of that theory with which we have since become familiar, viz: the conversion of mountain masses of paleozoic, mesozoic and even cenozoic sediments in the Alps and elsewhere into gneisses and other crystaline rocks. Numerous sections in the vicinity of Mont Blanc show the sedimentary strata in their normal attitude, resting unconformably upon the crystalline schists, while in some localities the whole succession from the carboniferous to the eocene,

* T. Sterry Hunt, Address before the American Association for the Advancement of Science, 1871, page 30.

both inclusive, is met with. In many parts, however, the carboniferous is wanting, and the trias forms the base of the column, while elsewhere the infra-liassic beds repose on the crystalline schists, and in the Bernese Alps no fossiliferous beds lower than the oolite are observed. These facts would appear to be connected with the movement of subsidence; which permitted the deposition of marine limestones above the carboniferous strata, and Favre has farther pointed out, in the vicinity of Dorenaz, a want of conformity between these and the succeeding formations.

To the carboniferous belongs the well-known conglomerate of Valorsine, which includes pebbles of gneiss, quartzite, talcose and mica-schist, and of quartz veins holding tourmaline. The paste, which is reddish, talcose and micaceous, seems identical with many of the pebbles, so that it is sometimes difficult to distinguish these from the matrix. A thin fibrous envelope often surrounds the pebbles (§ 521). Although the alternation of these beds with others holding plants shows them to be of carboniferous age, it is often, says Favre, difficult to fix the lower limit of this formation on account of the great resemblance between certain of the carboniferous sandstones and portions of the older crystalline schists, which, in cases where the former are destitute of pebbles, makes it impossible to distingish between the two. Necker, in like manner, asserted that it was impossible to draw a line of demarkation, and was hence led to assert a passage from the one to the other. The same close resemblance was noticed by de Saussure, and is testified to by de Mortillet and by Sismonda, who says of the feldspathic sandstone (*gres*) near St. Jean in Maurienne, that "unless we take care we run the risk of being deceived, and of confounding it with gneiss," while elsewhere similar rocks assume the aspect of granite from the predominance in them of feldspar. Hence it has happened that observers like Dolomieu and Bakewell placed the anthracites of the Alps in the mica-slate formation, and that Berger described as a "veined granite" the Aiguille des Posettes, which, according to Favre, consists of nearly vertical beds of carboniferous sediments. In illustration of this condition of things, Favre cites the observation of Boulanger, according to whom the triassic sandstones of the department of Allier are made up of quartz, feldspar and mica, so united as to give rise to a sandstone which would be taken for a primitive rock but for the occasional presence of a rolled pebble of granite.* The paste of this Valorsine conglomerate, which seems identical with certain of the enclosed pebbles, appears according to Favre to have undergone

* See Favre, *Terrains liassique et keuperien*, etc. (1859), pp. 78, 79, to which in his work he refers the reader for further explanation on this point.

a certain re-arrangement, so that the beds of these "pretendus schists crystallins" of the carboniferous are with difficulty distinguished from the "vrais schists crystallins" upon which they rest unconformably. I insist the more upon these details, because in the earlier notice of Favre's investigations I erroneously represented him as including in the carboniferous a great mass of the older crystalline schists.

In this connection we may cite the observation of Sedgwick, who cites similar cases of recomposed rocks in Scotland, "which it is not always possible to distinguish from the parent rock," and remarks that "a mechanical rock may appear highly crystalline because it is composed of crystalline parts derived from some pre-existing crystalline rock."* Emmons also has called attention to the existence of secondary or recomposed beds of talcose, chloritic and micaceous schists in the Taconic hills of western New England, which, according to him, have been confounded with the older parent rocks. It would hardly seem necessary to call attention to facts which are familiar to all field-geologists who have worked much among newer deposits in the vicinity of older crystalline rocks, were it not that their significance is so great in connection with Alpine geology.

This deceptive resemblance to the older crystalline rocks in the Alps, as might be supposed, is not confined to the carboniferous. Similar cases are noticed by Favre in the trias, while at the Cols du Bonhomme and des Fours are crystalline aggregates also noticed by Saussure as closely resembling the older crystalline rocks, which are shown by the fossils of inter-stratified beds to be of infra-liassic age. Studer, in opposition to Murchison, maintained that the apparently granitic layers in the flysch (eocene) near Interlaken are but the debris of an older crystalline rock, while the crystalline schists of the Bolghen mountain in the eastern Alps, supposed by Murchison to be in some way interposed in the flysch, are both by Studer and by Boué, regarded as merely masses of the older crystalline rocks in a tertiary conglomerate.†

In discussing the age of the "true crystalline schists" of the Alps, to make use of his expression already quoted, Favre, as we have seen, places them beneath the carboniferous, and in opposition to the suggestion of Murchison and the opinion of Gueymard, that they may be of cambrian and silurian age, concludes that we have no proof of the existence of representatives of these systems in the western Alps (§ 808). In this connection we may note with Favre the presence at Dienten in the Tyrol, of a silurian fauna, intercalated in beds of gray and green chloritic schists (§ 697 *b*). The gneiss of Mettenbach, near the Jungfrau, has afforded to Favre a pale green ophicalce

* Geol. Transactions (1835), iii, 479. † Ibid., iii, 334; Geol. Journ., v, 210.

resembling that of the laurentian, in which he has detected *Eozoon Canadense* (§ 697 *a*). Having thus declared his conviction of the great antiquity of the crystalline schists, whose ruins enter into the composition of the conglomerate of Valorsine, he proceeds to remark that "the part played in the Alps of Savoy by that mysterious force called metamorphism, to which the formation of the crystalline schists is often attributed, has been greatly exaggerated." He adds, "I have always been surprised to find in the Alps so few traces of this pretended action," and suggests that the question has been complicated by the resemblances already noted between the crystalline schists and the recomposed rocks of the coal measures (§ 697 *c*). In the same spirit he declared in 1859, that there are "scarcely any evidences of alteration after the Valorsine conglomerate;" in the paste of which he admits a crystalline re-arrangement by no means improbable.* It appears inconsistent with these expressions of opinion to find our author admitting with Lory the triassic and jurassic age of the great mass of lustrous schists and micaceous limestones which are overlaid by the carboniferous at Modane, and at various localities, as we have seen, include serpentines, steatites, etc. Our author feels this a difficulty, and speaks of these serpentines, unlike those of the Montanvert, the Aiguilles Rouges, etc., as belonging to non-crystalline formations, a character which can hardly be ascribed to them. If, however, Sismonda be correct in placing them below rocks which are, according to Favre, true coal measures, these serpentines and steatites, with their accompanying schists and limestones, are, as we have already shown, in the same horizon with the crystalline schists to the north of Mont Blanc.

The origin of the fan-like structure attributed to the Alps by nearly all observers since the time of de Saussure, and correctly represented in the sections published by Studer in 1851, and by Favre in 1859, is explained by the latter in accordance with the view put forward by Lory in 1860.† He supposes that the underlying crystalline rocks forced, by great lateral pressure, formed an elevated anticlinal arch, which, breaking on the crown, from the excess of curvature, shows the lowest rocks in the center of the rupture, flanked on either side by the overlying strata. These, in their upper part, are subjected to a comparatively feeble lateral pressure, while the deeper portions are forcibly compressed by the smaller folds on either side, from which results the fan-like or sheaf-like structure of the beds. The newer strata in the synclinals are by this process arranged in troughs, and are more or less overlaid by the older rocks. Such a

* *Terrains liassique et keuperien*, 77.

† Lory, description geologique du Dauphiné, p. 180

synclinal exists in the valley of Chamonix, between the two ruptured and eroded anticlinals represented by Mont Blanc and the Brevent. In illustration of this structure Favre has given a grand section commencing to the northwest in the mountain known as Les Fiz, which, overlooking the Col d'Anterne, rises to a height of 3180 meters and displays all the Alpine formations from the sandstones of Taviglionaz, overlying the nummulitic beds, down to the carboniferous, which is seen resting on the crystalline schists. These appear in the height of Pormenaz and in the Brevent, at the northwest base of which the carboniferous rocks are arranged in a sharp fold dipping beneath the crystalline strata. The latter to the northeast rise in the Aiguilles Rouges, which are steep hills of vertical beds including hornblendic, chloritic and talcose rocks, with petrosilex, eclogite and serpentine. The highest of the Aiguilles rises 2944 meters above the sea, and consequently 1892 meters above the valley of Chamonix. This summit, which was visited by Favre, was found to be capped by horizontal strata, consisting at the top of about thirty-seven meters of jurassic beds, with belemnites and ammonites, underlaid by infra-liassic strata with cargneules, sandstones and schists, the whole resting upon vertical strata of unctuous mica-schists, which enclosed a bed of saccharoidal limestone. From thence we pass over the valley of Chamonix, which holds enfolded in crystalline schists, triassic and jurassic strata, and over the summit of Mont Blanc to find the same folding repeated between the base of the latter and the protogines of Mont Chetif. The fan-like structure attributed to this last is questioned by Lory, according to whom the strata of this mountain dip uniformly to the southeast, and are overlaid by the great mass of crystalline talcose schists and micaceous limestones assigned by him to the trias, but apparently, as we have endeavored to show, a portion of the pre-carboniferous crystalline schists. These rocks are well displayed farther on in the mountain of Cramont, and are regarded by Favre as identical with those of Mont Cenis.* Lory conceives that the attitude of the rocks of Mont Chetif to the jurassic strata in the trough at the southeast base of Mont Blanc is due to a great fault with an uplift, which has brought these older rocks to overlie the jurassic beds.

With the facts before us, we can with Favre trace the history of Mont Blanc from the time when over a partially submerged region of gneiss and crystalline schists the carboniferous strata with their beds of coal and their plant-remains were being deposited; many of the strata being made up from the partially disintegrated crystalline schists and scarcely distinguishable from them. After some disturbance the secondary formations were

* See in this connection Hebert, Bull. Soc. Geol. de Fr., 2, xxv, 356.

laid down unconformably alike over the carboniferous and the older strata, followed by the nummulitic beds and their overlying sandstones, the whole, from the base of the trias, having in this region an aggregate thickness of about 1250 meters. Subseqently to this occurred the great movements which threw into folds all these strata, enclosing, as in the Tarentaise, the nummulites with jurassic and carboniferous fossils among the folds of the crystalline schists. This was followed by great denudation, which removed from the broken anticlinals the secondary rocks, leaving however, in the horizontal jurassic beds which still cap the Arguilles Rouges, an evidence of the former spread of these formations, which once extended over what is now the summit of Mont Blanc. It is worthy of note, that the highest portions of this latter do not exhibit the underlying gneiss, but are capped by crystalline schists, which may be supposed to rest upon it, as do the secondary strata upon the schists of the Aiguilles Rouges. These elevated points are evidences of the enormous erosion in this region, the results of which have contributed to build up in the lower regions of the Alps and in the Jura, the great masses of miocene sediment known as the molasse; a formation partly marine and partly lacustrine, which attain in some parts a thickness of more than 2,000 meters. This period was followed by other movements, which have raised the beds of molasse to a vertical attitude and in some cases inverted them, so that they appear dipping beneath the nummulitic formation. It is worthy of note that the molasse near Geneva includes in its upper part a lacustrine limestone, followed by marls with gypsum, and by lignites.

That the nature of the fan-like structure of the Alps is correctly represented in the sections of Studer, Lory and Favre, can, we think, no longer admit of doubt. Another explanation was, however, possible; the dipping of the beds on either side toward the center of the mass might indicate synclinal mountains, lying between two eroded anticlinals. Such a mountain-structure appears not to be uncommon in regions where the undulations are moderate; and is, according to Lesley, frequent in the anthracite region of Pennsylvania. Snowdon in Wales, according to Ramsay, and Ben Nevis and Ben Lawers in the Scottish Highlands (Murchison), are also examples of this structure, the summits of all of these being composed of newer strata, beneath which, on either side, dip the older formations. When, therefore, geologists of authority from Bertrand and Keferstein to Murchison and Lyell maintained that the crystalline rocks of Mont Blanc were newer than the limestones of the valleys on either side, and even declared them to be altered sediments of the tertiary period, it was difficult to regard Mont Blanc as any thing else than a synclinal mountain similar in general structure and origin to those just mentioned. Hence it was that in 1860 (this Journal, II, xxix, 118) I remarked "the weight of evidence now tends to show that the crystalline nucleus of the Alps, so far from being an extruded mass of so-called primitive rock, is really an altered sedimentary deposit more recent than many of the fossiliferous strata upon their flanks, so that the Alps, as a whole, have a general synclinal structure." This view of the recent age of the crystalline rocks of this region, supported though it has been by the authority of great names, must now, we conceive, be abandoned, and their great antiquity, as maintained by the learned professor of Geneva, admitted. It, however, remains true that the extrusion and laying bare of these ancient crystalline rocks is, as we have seen, an event geologically very recent.

It would greatly exceed our present limits to notice our author's learned discussion of the superficial geology, including the glacial phenomena, of the Alpine region, to which the present work is devoted. His views upon some of the most keenly controverted questions with regard to glacial action will be found set forth in his letter to Sir R. I. Murchison on the Origin of Alpine Lakes and Valleys, which appeared in the L., E. and D. Philos. Magazine, for March, 1865.

This beautiful work of Prof. Favre is accompanied by an atlas of thirty two folio plates, embracing maps, sections, views and figures of organic remains, which elucidate the text in a very complete manner. It is a magnificent monument to the industry, acumen and scientific zeal of one who for a quarter of a century, has devoted his time and his fortune to the pursuit of science, and has worthily completed the task which his illustrious countryman de Saussure commenced.

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## Art. II.—*Supplementary Note on the Genus Lichenocrinus;* by F. B. Meek.

Since writing the remarks published in the October number of this Journal (p. 299), I have received from Mr. Dyer a very complete suit of specimens belonging to the two known species of this curious type. One of these specimens seems almost to demonstrate that the long, slender, column-like appendage, mentioned in the descriptions, cannot correspond to the ventral tube or so-called proboscis of crinoids. This specimen is a small individual of *L. Dyeri*, only measuring 0·22 inch in diameter across the disc; yet its column-like appendage measures near

2·80 inches in length, and tapers very gradually and regularly from a diameter of 0·03 inch near the disc, to that of scarcely 0·01 inch near the free end, where it actually appears to taper to a mucronate point. Of course the canal, within so attenuated an appendage, must be extremely minute, and could scarcely have performed the same functions as that of the ventral tube of a crinoid, even if open at the free end, which is at least exceedingly improbable.

The extreme tenuity of the free end of this appendage (which I had already mentioned as an objection to viewing it as a ventral tube), appears to be almost, if not quite, as strong an objection to the suggestion that possibly the disc might have been a root, with the real body attached at the other extremity of the long appendage; since it is scarcely possible that a body could have been supported at the free end of such an extremely slender, hair-like organ as that of the specimen under consideration.

This and some of the other specimens also show that, at least in the species *Dyeri*, this long appendage, although apparently equally divided longitudinally by five sutures along its entire length, does not always have the pieces of which it is composed, distinctly alternating and interlocking along these sutures, excepting near the disc. On the contrary, these pieces sometimes become gradually less and less alternately arranged, until they appear to the eye, as examined by the aid of a glass, to abut against each other, so as to form regular joints, like those of a minute column composed of little rings or discs. In the specimen under consideration there appears, at a first glance, to be two of these long appendages issuing from one disc, or body, but a closer inspection shows that there are two of the discs growing or crushed, one against, or partly upon the other.

The inquiry has been suggested, whether these may not have been free crinoids, with the power of attaching and detaching themselves at will, by the flat side opposite the long appendage? Among the objections, however, that present themselves to this view, may be mentioned the fact, that the most careful examinations under the very best magnifiers, of both the inner and outer surfaces of this flat side, by which the disc is usually found attached, fail to detect even the most minute openings; and as there are no traces of arms or pinnulæ, it is difficult to understand by what means the animal could thus have attached and detached itself, or have sought, and adjusted itself to, a suitable station, when once detached. In addition to this, they are sometimes found growing upon uneven surfaces, and closely conforming to the inequalities of the same, even to lines and furrows on the surface of a shell; while the rigid radiating laminæ of the interior would seem to preclude the possibility of such an adjustment by flexibility.*

It is perhaps scarcely necessary to add, that the irregular arrangement of the plates composing the disc of this type, without any tendency to arrange themselves into radial and interradial series, together with its general habit of growth, show that it belongs to the *Cystoidea*, and not to the typical group of *Crinoidea*. Its want of arms and pinnulæ also approximate it to the *Cystoidea*, in which the arms are generally in a more or less rudimentary condition, or the former, in some cases, even entirely wanting. In its apparent entire absence of both arms and pinnulæ, and especially in its want of visible openings, and the possession of a system of internal radiating laminæ, it is entirely peculiar, and unlike any other known type, either of the typical *Crinoidea* or *Cystoidea*. How the respiratory, reproductive, and nutritive functions, of such a being as it appears to be, could have been performed, remains a mystery, and hence it is evident that something yet remains to be learned in regard to its structure.

Of course, such a form cannot be properly ranged in any of the recognized families of the typical *Crinoidea* or of the *Cystoidea*, but should be regarded as the type of a new family of the latter, under the name *Lichenocrinidæ*.

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## Art. III.—*A Cretaceous Basin in the Sauk Valley, Minnesota;* by J. H. Kloos.

Ascending the Mississippi from Prairie du Chien to St. Paul, we pass between the lowest deposits of the Silurian formation, as it is developed in the Northwest. As far as the mouth of the St. Croix river, the shores of the mighty stream consist of the lower or Potsdam sandstone, capped by the lower magnesian limestone, generally considered to be the equivalent of the Calciferous sandstone of New York. From the St. Croix river to Red Rock, the castellated bluffs consist entirely of magnesian limestone, and give a peculiar character to the scenery; the sandstone, participating in the gradual and hardly perceptible northern dip of the strata, having disappeared under the level of the water. At Red Rock, St. Peters sandstone and

* One specimen, now before me, from Mr. Dyer's collection, is seen lying in the matrix in such a manner as to expose the detached under side of the disc; while one of its edges is curved and folded upon itself. As none of the plates, however, is broken or displaced, nor any of the sutures between them gaping along the folded edge, I cannot believe this folding due to flexibility, but that some peculiarity of its station caused this individual to *grow* in this way.

Trenton limestone take the place of Potsdam and Calciferous, continuing to St. Paul and St. Anthony.

These are the last exposures of Paleozoic strata on the Mississippi; they disappear above the Falls of St. Anthony under an extensive covering of drift. Nothing but clay, gravel, sand and boulders are exposed in the low banks of the river, until near the city of St. Cloud, where we reach a belt of granitic, syenitic and dioritic rocks, rising in long belts of low hills over the surrounding prairie. Here and farther above, the river takes its way in a series of rapids over the ledges of the crystalline rocks. These extend over 35 miles, the intervals between them being filled and levelled with drift. On the north, at the village of Little Falls, they are succeeded by mica and quartzite slates, dipping to the northwest under angles varying from 65° to 72°.

This belt is an upheaval of Azoic rocks, crossing the State of Minnesota over its entire length from north to south, and corresponding probably to the lower part of the Laurentian system of Canada. It is exposed on the Rainy River and the lakes in the extreme northern part of the State, as well as on the St. Louis, Rum, Mississippi and St. Peter rivers, though over its greatest extension concealed by recent deposits. Gneissoid rocks, prevalent in the northern portion of this belt, are not found on the Mississippi, where, besides syenitic granites, the so-called anorthosite rocks form a characteristic feature of the formation.* I have not yet succeeded in finding the crystalline limestones of the Canadian Laurentian, though at several places west of the Mississippi I have met with large limestone boulders, which I refer to this period. At St. Cloud, Sauk Rapids and Watab on the Mississippi, the rocks of the Laurentian ridges are quarried and are commencing to be used extensively for fronts of large blocks and government buildings at St. Paul, Chicago and even in cities lower down the Mississippi Valley. Some of the syenitic and dioritic varieties form a splendid material for ornamental work and monuments.

Leaving the Mississippi at St. Cloud and going westward up the Sauk Valley, we cross the belt of Laurentian rocks at right angles, and remain among the low granitic hills for 25 miles. There is no continuous ridge or uplift; at several places we find ledges of granite, syenite, granitoporphyry, hypersthenite and diorite, either exposed at the water's edge or cropping out on the prairie. The river, however, has not cut deep enough into the solid rock to show the continuance of the ledges, and the glaciers and icebergs of the erratic period have swept over

* Sauk Centre, 40 miles west of the Mississippi, is the only place where I found an outcrop of granite to have a somewhat gneissoid structure. It is here associated with a diabase.

the whole country, levelling the surface, and leaving only the highest uplifts of the older formation exposed to view.

The first rock we met with after crossing the St. Cloud prairie, is a red feldspathic granite, protruding from the drift at the point where the Rockville road reaches the Sauk. Like all the granitic and syenitic rocks which I observed in this part of the State, it contains, together with the common feldspar or orthoclase, an albite or other oligoclastic feldspar with well defined striated cleavage planes.

Eight miles from St. Cloud on the bank of the river, I saw the first boulder of an exceedingly course granite, different from any rock exposed on the Mississippi. These boulders are frequent on the prairie between Rockville and Cold Spring, on which they form a marked feature by their large size and peculiar shape.

The exposed part of one is 12 feet long, 10 feet wide and 8½ feet high. Another one measured 24 by 14 by 5 feet. All planes and edges of these boulders are rounded, except one plane corresponding with a system of fissures, well defined on every one of them. At the largest of all, the corresponding fragment was still visible, though detached from the principal mass, and a space of four feet now intervening, in which brush and grass had taken root.

These huge masses of granite have not been transported far. At Rockville the same rock forms a distinct ledge, running from the range of hills toward the river. The cliffs of the outrunning ledge show the same outlines as the boulders.

Near Cold Spring we come to another exposure of granite, the intervening four miles forming quite a broken prairie, traversed by erratic hills covered with timber. Here the river takes a leap over the ledge of rock and forms a good water-power, which is used for manufacturing purposes. A porphyritic granite, not distinguishable from the same kind of rock on the east side of the Mississippi, rises in beautiful cliffs above the water, and crossing these we reach another extensive exposure of the above described coarse granite. Both cross the Sauk, and the line between them is marked by a depression, in which a bridge has been swung across; they strike very nearly east and west. From here to Richmond the coarse granite is altogether the prevalent rock. Several ridges are distinguishable, cropping out on the slightly rolling table land, and their presence is marked on the surface by a coarse grit of feldspar and quartz. They are seemingly in range with the line of hills at Cold Spring, bearing generally east and west.

Richmond itself is built on a high level prairie, entirely covered with farms, but having rather a sandy soil. To the right the view is bounded by a range of timbered hills, rising abruptly above the prairie and extending in a westerly direction. Near the river and to the southeast of the village, I found quite a variety of anorthosite rocks, containing a triclinic feldspar in fine crystals, with some variety of pyroxene. The texture of these rocks is generally fine-grained; some are somewhat coarser and porphyritic. They are all of dark color, and occur in parallel veins in the granite.

These kinds of crystalline rocks have a wide range in the Laurentian belt of Minnesota, and present many points of interest. I hope soon to have an opportunity to compare them with similar rocks, which in Germany have been the subject of elaborate chemical and mineralogical investigations, and expect to come to very interesting results. As yet I have had no occasion to determine the nature of the feldspar and the species of pyroxene, though I expect to find labradorite, anorthite and hyperite, with hornblende, mica and perhaps protobastite the principal constituents.

The Sauk river cuts 30 feet deep into the prairie at Richmond. In its banks deposits are exposed, differing entirely from any which are found in the valley below this point. They consist principally of plastic clays, of which the prevalent color is a dark blue; still there are streaks of a brilliant white running through these, and some containing more iron are yellowish. At one place we see them rest on a conglomerate of decomposed granite of a white and light-reddish color. At another point on the river, a thin seam of iron ore, impure peroxide of iron, runs through the strata, and a few feet above the conglomerate a thin seam of an impure lignite can be seen. All these strata lie apparently horizontal. They belong to an older period than the Drift formation, and, as I will show further on, are part of the eastern extension of a Cretaceous basin in the old crystalline rocks, which extend south and west, and is probably connected with the Cretaceous basin of Dakota, so extensively developed on the Missouri river.

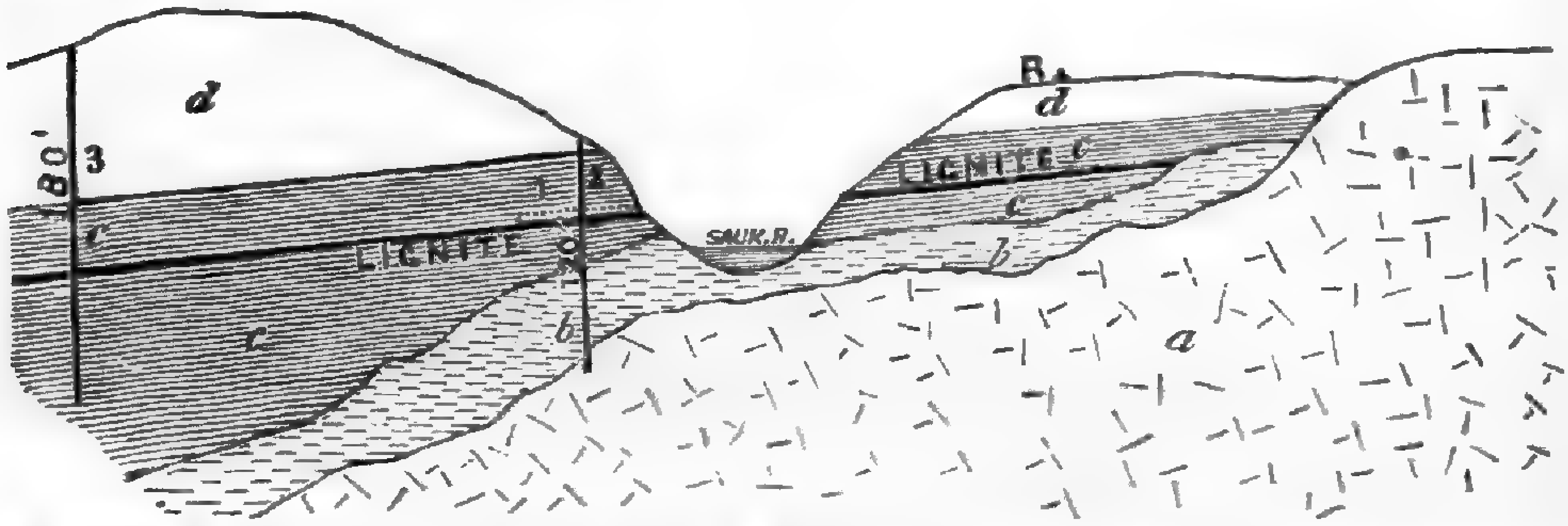
The banks of the Sauk river do not throw much light upon the age of the strata, the plastic clay having only furnished me the small tooth of a Carcharodon. The shaft and borings, which have lately been sunk by parties expecting to find coal beds of economical importance, have, however, brought to light shales and slates containing fossils, from which we may conclude with absolute certainty that the formation is an equivalent of the Benton group or No. 2 of the northwestern series of Cretaceous, as established by Meek and Hayden. Not only are the remains of fossil shells and of fishes the same as those found in the Benton group, but the development and nature of the deposits are entirely similar. In both localities they consist predominently of plastic clays, with some shale, slate, impure lignite and iron ore. The plasticity of those heavy clay-beds is so peculiar to the Benton group, that it can easily be distinguished from the sandy and marly deposits, as well as from the marly limestones composing the succeeding number of the Cretaceous.

As the explorations in search of coal, above referred to, have been made by persons entirely ignorant of geology, I received very imperfect data in regard to the different strata through which the borings were made. A farmer having discovered the seam of lignite in the bank of the river, commenced several years ago digging a drift. After having advanced 60 feet, he had to abandon his imperfect mining operation, the river rising suddenly after a heavy rainfall and filling his drift. He afterwards found coal three miles north of Richmond among the timbered hills, and investigated here through three or four little shafts. Not being protected in any shape, the work had also to be abandoned on account of the water rushing in, after he had dug a few feet. Nothing was done further until recently, when some parties from St. Cloud leased all the land in and around Richmond for the purpose of exploring the supposed coal fields. They commenced sinking shafts and borings near the spot where the short drift was driven into the river bank six years ago. This old drift opens ¼ mile northwest of Richmond on the west side of the river a few feet over the conglomerate mentioned above, and in the blue clay. Of the coal or lignite formerly found here, very little can now be seen. The small fragments which I found were very impure, and consisted mostly of bituminous shale. The man who performed the work in 1865, told me that he had followed a seam of lignite four inches thick, which kept increasing in thickness, but remained impure and was considerably mixed with shale. The lignite seems to dip towards the interior of a high hill of drift, which rises abruptly from the river in a southwestern direction. He estimated the dip for the whole length of his 60 feet drift to be four feet, which would indicate quite an inclined condition of the strata, as would naturally be the case at the extreme end of a basin, near the old shore of the Cretaceous sea.

In a southwestern direction from the opening of the drift, almost on the top of the hill, a shaft was sunk and continued by boring for 180 feet. The information relative to the traversed strata, which I received here, was entirely unreliable, and showed the greatest ignorance on the part of the man who had charge of the work. The material lately brought to the surface, and that piled up around the shaft, consisted of blue, white and yellowish plastic clays, with few boulders and some shale. There must have been a heavy covering of drift and gravel to be traversed before the clay was reached, the opening of the shaft lying considerably above the plateau or level prairie on which Richmond is built, but I have no means of ascertaining the thickness of the different strata. This boring has since been abandoned at 180 feet, when no more coal had been encountered than what the old drift had brought to light.

Nearer the river another shaft and boring had been sunk. Here I found several fragments of shale containing scales of cycloid-fishes, which had been met with near the surface. The boring was afterwards continued to a depth of 112 feet, when the borer struck a hard rock, which proved to be granite. It was drilled for eight feet, and the fragments brought to light by the pump consist of feldspar, quartz and pyrites, such as are found in varieties of pegmatite or graphic granite, which I also found at the nearest outcropping ridges of the crystalline rocks.

The profile of the strata on a line running nearly northeast and southwest, going through the different points where investigations have been made, would show as in the annexed woodcut:




1, drift 60′ long; 2, 3, shafts 112′ and 180′ deep. *a, a*, granite; *b, b*, kaolin; *c, c*, plastic clays and shales of the Benton group Cretaceous; *d, d*, drift.

Having heard that fossils had been found in digging wells on some farms situated on the timbered hills south of Richmond, I extended my investigations in that direction. There are no further exposures on the surface, which is exceedingly broken but entirely shaped out in deposits of a Post-tertiary age. Two miles south of Richmond I came to a farm, where a well had excited the wonder and curiosity of the neighbors. This well was 30 feet deep, from where a hole had been sunk a further distance of 10 feet. At a depth of eight feet the blue clay (*c. c.* of the profile) was struck, passing into shale near the bottom of the well and containing a number of fossils. The water of this well was strongly saturated with sulphureted hydrogen, but lost the taste and smell almost entirely after having been exposed for some time to the atmosphere. When at the place, I was not able to obtain more than fragments of the shells, which I had, however, no difficulty in recognizing as belonging to the genus *Inoceramus*. Afterwards the well was dug down further, and I obtained some pretty fair casts and parts of the shells, which will be mentioned farther on, in a note by Mr. Meek.

When last heard from, the well had a depth of 55 feet, and a boring had been sunk to a further depth of 25 feet. The following section is a nearly accurate description of the strata traversed:

8 feet gravel and sand.
30 " dark blue laminated clay. Fragments of *Inoceramus problematicus* and crystals of gypsum.
8 " clay and hard sandy shale of a light blue color, with pyrites, mica and fish scales. Cast of *Inoceramus.* At 40 feet a thin seam of lignite.
10 " same clay with more shale 3 to 4 inches thick. Shells of *Inoceramus* and *Scaphites* in the shale having retained their original color and pearly luster. In 50 feet another seam of lignite.
15 " dark blue clay without shale; color darker than the clay above and turning almost black. At 65 feet a hard shale of a grayish black color had to be drilled through.
10 " clay with thin layers and seams of pyrites.

As this boring is commenced at an elevation of 30 feet above the level of the base, communicating with the Sauk river, we are on nearly the same level with the prairie at Richmond. In a slough, having an outlet to the lake, at the foot of the hills, the blue clay lies near the surface.

The locality which furnished me the fossils is two miles south of Richmond, in continuation of the line of our profile. The formation here has probably a thickness of several hundred feet.

The following note in regard to the fossils already mentioned, is from Mr. F. B. Meek, to whom they were submitted:

Mr. Kloos—Dear Sir: The specimens sent by you from near Richmond, Minnesota, were duly received. They consist of casts of *Inoceramus problematicus,* impressions apparently of *Ammonites percarinatus,* scales of fishes and a small shark tooth allied to *Corax* or *Galeus.* Among the drawings also sent by you, there is one of the inner volutions of *Scaphites larviformis,* or some nearly allied form.

From these fossils, and the lithological character of the bed in which they were found, there can be no reasonable doubt, that it belongs to the Cretaceous system, as well as to the Benton group of the Cretaceous series as developed in the upper Missouri country. As you have suggested, the locality at which these specimens were collected, cannot be far from the eastern limits of the great Cretaceous basin that occupies so much of the country along the Upper Missouri; and it is very desirable that the eastern boundary of this group of rocks should be traced out as accurately as possible, through Minnesota. Owing to the heavy deposits of Drift there, however, this will be a difficult task, and can only be done by careful observations of all that is revealed by deep wells and other excavations. Consequently it is important that all the facts, brought to light in this way, should be carefully noted and published.

The amount of labor and money squandered by the parties who sunk the shafts and borings, and excavated the drifts mentioned by you, with the vain hope of finding true coal there, is another example of the folly of undertaking such enterprises without consulting some competent geologist. A sight of any one of the fossils already mentioned, and a knowledge of the fact that the beds in which they occur lie down nearly or quite upon granite, would, as you are well aware, enable any geologist to decide, *at once*, that true coal will never be found there. And from all that is now known in regard to the Cretaceous series of the Upper Missouri, it is also exceedingly improbable that even lignite of sufficient purity, and in proper quantities to be of much practical value, will ever be discovered in the region mentioned.

Very truly yours, F. B. MEEK.

Washington City, D. C., 1871.

Future investigations must develop the extent of this Cretaceous basin. At only one more locality have I succeeded so far in finding the same clay. This is on the north shore of White Bear Lake, in Pope county, near Glenwood, a village situated forty-two miles west of Richmond, and seventy-five miles west of the Mississippi. Here it makes its appearance under a cover of drift, which must be at least 200 feet thick and in which all of the beautiful landscape has been shaped, which has made Glenwood a favorite resort for tourists and pleasure-seekers. This locality is the only positive proof I have, therefore, that these strata extend over the western portion of the State, though I have not the least doubt that this is the case, and that the Cretaceous clays underlie the Red River flats of Quarternary origin.

In the southern part of the State, on the Cottonwood river, Professor James Hall has traced the beds of lignite with friable sandstones and arenaceous clays, containing leaves of dicotyledonous trees, known to be Cretaceous.* This basin, lying in the red quartzites of the Huronian formation, is probably an equivalent of the Dakota group on the Missouri. Fragments of baculites have been found in Noble county in the extreme southern part of the State, in the clay beds several feet under the surface. These fragments are now in the possession of Dr. Sweenye, President of the Academy of Natural Science at St. Paul, and seem to indicate the occurrence of the highest beds of the Cretaceous series in Minnesota.

* Notes upon the Geology of some portions of Minnesota, from St. Paul to the western part of the State (Trans. American Phil. Soc., vol. xiii, pp. 329).

Though all these localities are fully 250 miles east of the Missouri, there is nothing in the configuration of western Minnesota and eastern Dakota to forbid the thought of a connection of the Cretaceous strata from the Mississippi to the Missouri. There are no uplifts of older rocks in any of the hills and watersheds, which are met with between the two rivers in this latitude. Both the Leaf Hills in Minnesota, and the Coteaux in Dakota, are huge accumulations of drift. I have crossed the Leaf Hills in several places for the purpose of finding a line for a railroad to the British possessions, and have nowhere met with any rock in place. These hills are from six to ten miles wide, and consist of parallel ranges, extending nearly northeast and southwest. The slopes are everywhere covered with boulders and gravel, and the whole gives decidedly the impression of being a glacial formation, in which the long lines of parallel hills are old side-moraines, and the lower cross-ridges the former end-moraines.

I have not yet visited the Coteaux, but all information received from voyageurs and surveyors, having crossed the country between the Red River and the Missouri, tends to show that at least between the parallels of 45° and 47° they do not contain any upheavals, and that they are in every respect similar to the Leaf Hills.

Both ranges consequently have a later origin than the Cretaceous formation, and did not exist when the country was submerged by the Cretaceous sea. They do not necessitate a separation of the Cretaceous series in different basins. The Benton and subsequent groups being several hundred feet thick and of a decidedly marine origin, it is more likely that one large sea has covered the interior of the American continent instead of shoal lakes, which would have given origin to lacustrine deposits.

On the maps showing the extent of the Missouri Cretaceous, the eastern limits of the formation are shown as disappearing under a heavy covering of drift, and as yet nothing was known as to the position of the eastern rim of this extensive basin.

The Sauk Valley and prairie at Richmond form the most eastern limits of the Cretaceous strata, and it is probable that they are also situated near the old northeastern shore of the sea, in which they have been deposited. The blue clay and seams of lignite have been traced three miles to the north of the village. At the present time, all signs of the presence of older deposits under the accumulation of drift have almost entirely been obliterated, and it is impossible to get a correct idea of the position of the strata. The State Geologist, Henry Eames, visited this locality in 1866, when three little shafts were sunk by the discoverer of the lignite. He describes the strata to be inclined under an angle of 65°. There seems to have been encountered three separate seams of lignite in short distance under each other, and separated by clay and shale. Eames assumes that they are fragments of the same bed having been brought into its present position by a great slide.*

Whatever may be the position of the strata in this locality, there can be no doubt that the granitic ledges of the Laurentian belt crop out in the vicinity, and that they are covered by heavy timber. At Sauk Center, a village situated on the Sauk river, forty miles west of the Mississippi, I found granite and diabase in parallel ledges, cropping out on the prairie. This place is only a few miles north of a line drawn from Richmond to Glenwood. The present bed and valley of the Sauk river can therefore safely be taken as nearly defining the northern limits of the basin.

Further researches, to define the eastern and northern boundaries of the great Cretaceous sea bordering on the Rocky Mountains, will be of great interest for the geology of the interior of the American continent. The future will probably show that Cretaceous strata are spread over a great area in Minnesota, resting on Laurentian, Huronian and Silurian rocks, and covered partly by Tertiary deposits.

St. Paul, Minnesota, October, 1871.

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## Art. IV.—*On a New Species of Fossil from the Lower Silurian;* by U. P. James.

Cyrtolites costatus. Body of shell nearly cylindrical; volutions about three, barely contiguous, enlarging rapidly; aperture nearly circular, slightly expanded; surface marked by strong longitudinal costæ, smaller costæ coming in at different stages of growth, so that as they approach the aperture every third one is stronger and more elevated than the two between; strong transverse ribs or lines of growth at irregular intervals, with fine striæ between; umbilicus large and deep; diameter of disk eight lines, but in this respect individuals of different ages must vary, as well as in the number intermediate costæ.

This species may be readily determined by the strong longitudinal costæ and deep umbilicus.

*Position and locality.*—Lower Silurian, Warren county, Ohio, about the middle of the Cincinnati group. Found September, 1871. My cabinet.

* H. Eames, Geological Reconnoissance of the Northern, Middle and other Counties of Minnesota, in 1866, St. Paul, 1867.

ART. V.—*Glacial Action on Mount Katahdin;* by JOHN DE LASKI, Carver's Harbor, Maine.

ON the twenty-first of September last, in company with Mr. George E. Bird of Portland, a graduate of Harvard College, and a guide from Sherman, the next town south of Pattern, I ascended Mount Katahdin, the highest land in Maine, on the south side by way of one of the "slides." The weather was fine, with few clouds in the sky till late in the afternoon. This slide I take to be the same by which Prof. Charles H. Hitchcock and party ascended to the top of Katahdin ten years ago.* On this route, after crossing Avalanche Brook at the base of the mountain—the stream of which is fed by springs up toward the top of Katahdin—we found fossiliferous rocks at various heights in our path. Boulders of this character were met with well up toward the "Horseback" ride, and I judged the highest place of their occurrence to be seven hundred feet below the "Chimney" top. This is the highest peak in the region except Pomola, the apex of Katahdin, which according to Dr. Young, with whom I visited the mountain twenty-four years ago, is five thousand three hundred feet above the sea, and according to Prof. Hitchcock, eighty-five feet higher.† I do not think the "Chimney" top is more than three hundred feet below the top of Pomola, and probably two hundred would be nearer the truth; and if this is added to the seven hundred feet, and the amount taken from the height, we have four thousand three hundred and eighty-five feet for the height of the fossils above the sea; and if we call the foot of the slide three thousand feet above the ocean, we have nearly fourteen hundred feet above the foot of the slide for the locality of the upper fossils.

In connection with these Devonian fossils—all of them impressions of shells of Oriskany beds—we found small boulders of micaceous sandstone and arenaceous schist, and a specimen of epidote; and Mr. Bird found a specimen of flint, undistinguishable from chalk flint, higher than the localities of the foreign boulders found by me. I should judge his specimen to have lain five or six hundred feet higher than the boulders containing fossils. The mass of flint would weigh a pound or more, and was water-worn.

Now the question presents itself, how came these erratic boulders—fossiliferous and non-fossiliferous— on the south side of Katahdin? The entire mountain so far as I saw it—and I have also been up it by the way of the north side to the top, and down that of its eastern side—is syenite, like that of the "granite" of Vinalhaven, but generally of a coarser texture.

* Report of Scientific Survey of Maine for 1861, p. 397 † Ib., p., 308.

I am not able to agree with Prof. Hitchcock in regard to the manner of the deposit of these fossiliferous boulders. He suggested that "they came round the west side of the mountain."* If we admit the iceberg theory—for the last few years considered nearly extinct, and which Mr. Hitchcock advocated at the time of writing the sentence above, ten years ago—there is the smallest possibility that those Devonian fossils could have been transported by icebergs—or floe-ice—from their native beds just north of Katahdin from fifteen to thirty five miles, and dropped on the south side of the mountain. The Oriskany beds are three thousand feet lower than the locality where the fossils were found on the shoulders of Katahdin.

The southwestern and southeastern sides of Katahdin bear evidence of glacial erosion—that is, these slopes have the uniform cut-off appearance, that all our northern hills have, even down to the ledges of our fields. At the base of the slide by which we ascended, we took the direction and found that all the higher parts of the mountain bore northwest, north, and northeast; and it is therefore evident that a glacial sheet slowly moving over this part of Maine, and not investing the higher parts of Katahdin, could not have had a portion of its mass so deflected—from the west, or east—as to crowd its boulders into this southern locality; for the sheering of the glacier must have been at right angles to its normal path. The glacial stream would have poured its boulders into this quiet and depressed basin of ice on the southern side of Katahdin, at an angle probably never more than forty-five degrees. And theory would give a much greater height to the crests of the deflecting ice-ridges or waves of the glacier, than the height of the locality of those fossils found by Prof. Hitchcock and myself. Furthermore, could these fossils, originally *in situ* not far distant from Katahdin, on low-lying lands, have worked themselves, during their short journey, from the bottom of a glacier to a position fourteen hundred feet higher into the body of the ice-cap? Though large boulders do sometimes appear on the surface of a valley-glacier (having obtained this position from some inferior locality owing to the complex pressure of the moving ice-mass), we may safely doubt, I think, whether small boulders weighing from half a pound to two or three pounds, would be likely to be materially displaced as regards their original position in the great glacier, during a progress of not many miles, and that up an inclined plain.

Nor is there much probability that those fossils were originally deposited in the localities where we find them. The "slide" is everywhere a plain of yielding sand and gravel, whose material has a constant tendency to descend.

* Report of Scientific Survey for 1861, p. 395.

Along the "Horseback" lie boulders so perched upon one another that we are sure they were not piled up by any frosts to which the mountain has been exposed in modern times; in fact, no frost agency could have put them in their present position. The ridge is narrow, and drops at an angle not differing much from forty-five degrees. We can safely presume that snow never accumulates on this ridge to any considerable depth. This locality is the very focus of winds at all seasons of the year, and especially during the winter months. What snow falls there is probably transformed into ice, and would not have much downward movement over the narrow ridge as avalanches. These boulders I consider to have been loosened by the glacier, which invested and overtopped them, though some of them may be erratic. The evidences in regard to the boulders all the way to the "Chimney," is of like character; and the same may be said about those lying at the base of Pomola, on the north and northwest sides of the high ridge of which it is the pinnacle. This ridge runs for two or three miles toward the southwest, and is three hundred feet above the table-land. The entire side of this hill is obstructed with granite boulders, generally angular, and some of them from ten to twenty feet square. The great blocks are heaped upon each other without order and to such a height that it is exceedingly difficult to climb over them.

I believe the top of Katahdin to have been overridden by the glacier, and that the ice-cap has everywhere degraded its summit, though, like Hitchcock, I saw nothing of the glacier polish and scratches there; nor should we expect to find them on so high an eminence composed of coarse granite, where no soil can accumulate to protect them from the eroding action of winter frosts. Prof. Hitchcock thinks that the northern sides of Katahdin at any considerable height have not been stossed by the drift agent.* I can say with great confidence, that the northern side of the mountain just below the "Monument," which is three thousand five hundred feet above the Wassattacook, washing the base of the hill, really "appears like one great stoss side," and is a glacially degraded wall, just as all our hills in Maine are, at all heights below that of Katahdin. We see boulders with rounded corners lying in place there, and wonder why they have not been toppled down the mountain by the winter frosts.

Furthermore, we have the fact of the disruption of the top of Katahdin into "strata," as Mr. Hitchcock designates them. On the south side of the mountain, just under the "Chimney," this disruption is very marked, apparently horizontal, though the sheets probably dip toward the south. Now

* Report of Scientific Survey for 1861, p. 396.

the case is that the strata everywhere slope from the shoulders of the mountain downward. On the north side, the dip is toward the north; on the east, toward the east; on the west, toward the west; and on the south, generally toward the south. This is the case with all the "granite" hills of Maine, and is referable to the action of the great glacier over them. This structure has *not* been superinduced by superficial changes of temperature," as Dr. Hunt conjectures, in Silliman's Journal, July, 1870, p. 88. Among all the quarries of Vinalhaven, the surface is broken into sheets or "platforms," and at all depths penetrated by the workmen. The deeper the quarry is worked, the thicker are the sheets. They are generally regular in their lines of fracture, running sometimes almost across the quarry, without much variation as to horizontality; and again we see the lines somewhat waved and distorted. The depths of these sheets in the quarries wholly exclude the idea of their origin being referable to variation of atmospheric temperature, or to any other cause, I think, than that of glacial action.* The first suspicion I had years ago of the enormous thickness of the great glacier, was suggested by these remarkable fractures. In the locality under the "Chimney," which I have just mentioned, where the formation is in sheets, and which is more than four thousand five hundred feet above the sea, quite a stream of water runs out of the fracture and falls into the "Avalanche Brook," which also, probably, has a similar origin. Wherever, therefore, the bare front of Katahdin is open to view, I think it will be found to be shattered as I have described; and in my judgment these effects must be referred to glacial action. Now the glacier could not have broken up the top of Katahdin, unless the ice-cap had been several hundred feet in thickness above the summit, to insure the pressure necessary to fracture the rock, in connection with the general progressive motion of the mass. It was the slow grinding motion of this ice-sheet which broke up all the surface of New England to great depths. I am therefore not disposed to estimate the thickness of the glacier at *less* than eight thousand feet, as I have done in my article on the "Motion of Glaciers," in Vol. I, Part II, of the Proceedings of the Portland Society of Natural History.

I add a word on the route to Katahdin.

Of the different routes to Katahdin taken by tourists, one is by way of the West Branch of the Penobscot, either down it by the way of Moosehead Lake, or up it from its junction with the East Branch; and by the way of Sherman to the Hunt Farm, and the Wassatacook Stream. On this route, the

* May not the origin of this structure antedate both the ice and the action of superficial temperature?—EDS.

path is generally taken to Katahdin Pond, and south to the mountain, though I should prefer the route up the Wassatacook to the place where Katahdin comes down to this stream, and so up the mountain from the north, where it is easier of ascent. Before the summit is reached in this direction, there is a chance to camp in the mixed growth of trees; and starting early, you can get over the top of the mountain without that exhausting labor which attends ascent by the other routes. The magnificence of this mountain is not appreciated without a visit to it. Its base above the surrounding country running north and south must be nearly ten miles long, and its top in this direction not far from six miles. The summit is in general flat, though having several peaks.

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## ART. VI.—*Table for the Computation of Relative Altitudes;* by CLEVELAND ABBE.

THE computation of relative altitudes by barometrical measurements is so conveniently performed by means of the tables published by Diffe in Schumacher's Jahrbuch, and given by Guyot as tables D IV of the Smithsonian collection, that I, some time ago, had occasion to transform these into the units of measure commonly used in the United States. I have not altered the contents given in the Smithsonian edition, but have extended the tables to a range sufficient to cover several extreme cases that have come to my notice. The daily use of the barometer in this country for hypsometrical determinations, leads me to think that the tables here presented will be as convenient to others as they have proved to myself.

The directions for the use of these tables are not different from those given on pages 54–57 of Section D of the Smithsonian tables. It is assumed that there are given, the temperatures ($t$ and $p'$) in Fahrenheit at the lower and upper station, the barometric readings ($b$ and $b'$) in inches and reduced to the freezing point; also the latitudes or average latitude of the stations. The altitude $h$ is found in American feet by the formula

$$\log h = \log u + A + c + c'$$

where

$$u = \log b - \log b'$$

and $c$ and $c'$ are the small corrections for the change in the force of gravity with the latitude and the altitude respectively.

Washington, Nov., 1871.

TABLE I.

| $t+t'$ FAHR. | A | | $t+t'$ FAHR. | A | | $t+t$ FAHR. | A | | $t+t'$ FAHR. | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| −120 | 4·68081 | 60 | −60 | 4·71583 | 56 | 0 | 4.74825 | 52 | + 60 | 4·77842 | 49 |
| 119 | 141 | 61 | 59 | 639 | 56 | + 1 | 877 | 52 | 61 | 891 | 48 |
| 118 | 202 | 61 | 58 | 695 | 56 | 2 | 929 | 52 | 62 | 939 | 48 |
| 117 | 263 | 60 | 57 | 751 | 56 | 3 | 4·74981 | 52 | 63 | 4·77987 | 49 |
| 116 | 323 | 60 | 56 | 807 | 56 | 4 | 4·75033 | 52 | 64 | 4·78036 | 49 |
| 115 | 383 | 61 | 55 | 863 | 55 | 5 | 085 | 51 | 65 | 085 | 48 |
| 114 | 444 | 61 | 54 | 918 | 56 | 6 | 136 | 52 | 66 | 133 | 48 |
| 113 | 505 | 60 | 53 | 4·71974 | 56 | 7 | 188 | 52 | 67 | 181 | 48 |
| 112 | 565 | 60 | 52 | 4·72030 | 55 | 8 | 240 | 51 | 68 | 229 | 48 |
| 111 | 625 | 59 | 51 | 085 | 55 | 9 | 291 | 52 | 69 | 277 | 49 |
| −110 | 684 | 60 | −50 | 140 | 55 | +10 | 343 | 51 | + 70 | 326 | 48 |
| 109 | 744 | 60 | 49 | 195 | 56 | 11 | 394 | 51 | 71 | 374 | 48 |
| 108 | 804 | 60 | 48 | 251 | 55 | 12 | 445 | 52 | 72 | 422 | 48 |
| 107 | 864 | 60 | 47 | 306 | 55 | 13 | 497 | 51 | 73 | 470 | 47 |
| 106 | 924 | 59 | 46 | 365 | 55 | 14 | 548 | 51 | 74 | 517 | 48 |
| 105 | 4·68983 | 60 | 45 | 416 | 55 | 15 | 599 | 51 | 75 | 565 | 48 |
| 104 | 4·69043 | 59 | 44 | 471 | 55 | 16 | 650 | 51 | 76 | 613 | 47 |
| 103 | 102 | 59 | 43 | 526 | 55 | 17 | 701 | 51 | 77 | 660 | 48 |
| 102 | 161 | 60 | 42 | 581 | 55 | 18 | 752 | 51 | 78 | 708 | 48 |
| 101 | 221 | 59 | 41 | 636 | 55 | 19 | 803 | 51 | 79 | 756 | 48 |
| −100 | 280 | 59 | −40 | 691 | 54 | +20 | 854 | 51 | + 80 | 804 | 47 |
| 99 | 339 | 59 | 39 | 745 | 55 | 21 | 905 | 51 | 81 | 851 | 48 |
| 98 | 398 | 59 | 38 | 800 | 55 | 22 | 4·75956 | 51 | 82 | 899 | 47 |
| 97 | 457 | 59 | 37 | 855 | 54 | 23 | 4.76007 | 50 | 83 | 946 | 47 |
| 96 | 516 | 59 | 36 | 909 | 54 | 24 | 057 | 50 | 84 | 4·78993 | 47 |
| 95 | 575 | 58 | 35 | 4·72963 | 56 | 25 | 107 | 51 | 85 | 4·79040 | 47 |
| 94 | 633 | 58 | 34 | 4·73017 | 54 | 26 | 158 | 50 | 86 | 087 | 48 |
| 93 | 691 | 59 | 33 | 071 | 54 | 27 | 208 | 51 | 87 | 135 | 47 |
| 92 | 750 | 59 | 32 | 126 | 54 | 28 | 259 | 50 | 88 | 182 | 47 |
| 91 | 809 | 58 | 31 | 180 | 54 | 29 | 309 | 50 | 89 | 229 | 47 |
| − 90 | 867 | 58 | −30 | 234 | 54 | +30 | 359 | 51 | + 90 | 276 | 47 |
| 89 | 925 | 59 | 29 | 288 | 54 | 31 | 410 | 50 | 91 | 323 | 47 |
| 88 | 4·69984 | 58 | 28 | 342 | 54 | 32 | 460 | 50 | 92 | 370 | 47 |
| 87 | 4·70042 | 58 | 27 | 396 | 54 | 33 | 510 | 50 | 93 | 417 | 47 |
| 86 | 100 | 58 | 26 | 450 | 53 | 34 | 560 | 50 | 94 | 464 | 47 |
| 85 | 158 | 58 | 25 | 503 | 54 | 35 | 610 | 50 | 95 | 511 | 46 |
| 84 | 216 | 57 | 24 | 557 | 53 | 36 | 660 | 50 | 96 | 557 | 47 |
| 83 | 273 | 58 | 23 | 610 | 54 | 37 | 710 | 50 | 97 | 604 | 47 |
| 82 | 331 | 58 | 22 | 664 | 54 | 38 | 760 | 49 | 98 | 651 | 47 |
| 81 | 389 | 58 | 21 | 718 | 53 | 39 | 809 | 50 | 99 | 698 | 46 |
| − 80 | 447 | 58 | −20 | 771 | 53 | +40 | 859 | 50 | +100 | 744 | 46 |
| 79 | 505 | 57 | 19 | 824 | 54 | 41 | 909 | 50 | 101 | 790 | 46 |
| 78 | 562 | 57 | 18 | 878 | 53 | 42 | 4·76959 | 50 | 102 | 836 | 47 |
| 77 | 619 | 58 | 17 | 931 | 53 | 43 | 4·77009 | 49 | 103 | 883 | 47 |
| 76 | 677 | 57 | 16 | 4·73984 | 53 | 44 | 058 | 50 | 104 | 930 | 47 |
| 75 | 734 | 57 | 15 | 4·74037 | 53 | 45 | 108 | 49 | 105 | 4·79977 | 46 |
| 74 | 791 | 57 | 14 | 090 | 53 | 46 | 157 | 49 | 106 | 4·80023 | 46 |
| 73 | 848 | 57 | 13 | 143 | 52 | 47 | 206 | 50 | 107 | 069 | 46 |
| 72 | 905 | 57 | 12 | 195 | 53 | 48 | 256 | 49 | 108 | 115 | 46 |
| 71 | 4·70962 | 57 | 11 | 248 | 53 | 49 | 305 | 49 | 109 | 161 | 46 |
| − 70 | 4·71019 | 57 | −10 | 301 | 53 | +50 | 354 | 49 | +110 | 207 | 45 |
| 69 | 076 | 57 | 9 | 354 | 52 | 51 | 403 | 49 | 111 | 252 | 46 |
| 68 | 133 | 56 | 8 | 406 | 52 | 52 | 452 | 49 | 112 | 298 | 46 |
| 67 | 189 | 56 | 7 | 458 | 53 | 53 | 501 | 49 | 113 | 344 | 46 |
| 66 | 245 | 57 | 6 | 511 | 52 | 54 | 550 | 49 | 114 | 390 | 46 |
| 65 | 302 | 56 | 5 | 563 | 53 | 55 | 599 | 48 | 115 | 436 | 46 |
| 64 | 358 | 57 | 4 | 616 | 52 | 56 | 647 | 49 | 116 | 482 | 46 |
| 63 | 415 | 56 | 3 | 668 | 53 | 57 | 696 | 49 | 117 | 528 | 45 |
| 62 | 471 | 56 | 2 | 721 | 52 | 58 | 745 | 49 | 118 | 573 | 46 |
| 61 | 527 | 56 | − 1 | 773 | 52 | 59 | 794 | 48 | 119 | 619 | 45 |
| − 60 | 4·71583 | | 0 | 4·74825 | | +60 | 4·77842 | | +120 | 4·80664 | |

TABLE I—Continued.

| $t+t'$ FAHR. | A | | $t+t'$ FAHR. | A | | $t+t'$ FAHR. | A | | $t+t'$ FAHR. | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| +120 | 4·80664 | 46 | +150 | 4·82010 | 44 | +180 | 4·83315 | 43 | +210 | 4·84583 | 41 |
| 121 | 710 | 46 | 151 | 054 | 44 | 181 | 358 | 43 | 211 | 624 | 42 |
| 122 | 756 | 45 | 152 | 098 | 44 | 182 | 401 | 43 | 212 | 666 | 41 |
| 123 | 801 | 45 | 153 | 142 | 44 | 183 | 444 | 43 | 213 | 707 | 42 |
| 124 | 846 | 45 | 154 | 186 | 44 | 184 | 487 | 43 | 214 | 749 | 41 |
| 125 | 891 | 46 | 155 | 230 | 44 | 185 | 530 | 42 | 215 | 790 | 42 |
| 126 | 937 | 45 | 156 | 274 | 44 | 186 | 572 | 42 | 216 | 832 | 41 |
| 127 | 4·80982 | 45 | 157 | 318 | 44 | 187 | 614 | 43 | 217 | 873 | 42 |
| 128 | 4·81027 | 46 | 158 | 362 | 44 | 188 | 657 | 43 | 218 | 915 | 42 |
| 129 | 073 | 44 | 159 | 406 | 43 | 189 | 700 | 42 | 219 | 957 | 41 |
| +130 | 117 | 46 | +160 | 449 | 44 | +190 | 742 | 42 | +220 | 4·84998 | 41 |
| 131 | 163 | 44 | 161 | 493 | 44 | 191 | 784 | 42 | 221 | 4·85039 | 41 |
| 132 | 207 | 45 | 162 | 537 | 44 | 192 | 826 | 43 | 222 | 080 | 40 |
| 133 | 252 | 45 | 163 | 581 | 44 | 193 | 869 | 42 | 223 | 120 | 42 |
| 134 | 297 | 45 | 164 | 625 | 43 | 194 | 911 | 43 | 224 | 162 | 41 |
| 135 | 342 | 45 | 165 | 668 | 44 | 195 | 954 | 42 | 225 | 203 | 41 |
| 136 | 387 | 45 | 166 | 712 | 42 | 196 | 4·83996 | 42 | 226 | 244 | 41 |
| 137 | 432 | 45 | 167 | 754 | 44 | 197 | 4·84038 | 42 | 227 | 285 | 41 |
| 138 | 477 | 44 | 168 | 798 | 43 | 198 | 080 | 42 | 228 | 326 | 41 |
| 139 | 521 | 45 | 169 | 841 | 44 | 199 | 122 | 42 | 229 | 367 | 41 |
| +140 | 566 | 45 | +170 | 885 | 43 | +200 | 164 | 42 | +230 | 408 | 41 |
| 141 | 611 | 45 | 171 | 928 | 43 | 201 | 206 | 42 | 231 | 449 | 41 |
| 142 | 656 | 44 | 172 | 4·82971 | 43 | 202 | 248 | 42 | 232 | 490 | 41 |
| 143 | 700 | 45 | 173 | 4·83014 | 43 | 203 | 290 | 42 | 233 | 531 | 40 |
| 144 | 745 | 44 | 174 | 057 | 43 | 204 | 332 | 42 | 234 | 571 | 41 |
| 145 | 789 | 44 | 175 | 100 | 43 | 205 | 374 | 42 | 235 | 612 | 41 |
| 146 | 833 | 44 | 176 | 143 | 44 | 206 | 416 | 42 | 236 | 653 | 41 |
| 147 | 877 | 44 | 177 | 187 | 43 | 207 | 458 | 41 | 237 | 694 | 40 |
| 148 | 921 | 45 | 178 | 230 | 43 | 208 | 499 | 42 | 238 | 734 | 41 |
| 149 | 4·81966 | 44 | 179 | 273 | 42 | 209 | 541 | 42 | 239 | 775 | 40 |
| +150 | 4·82010 | | +180 | 4·83315 | | +210 | 4·84583 | | +240 | 4·85815 | |

## II.—*Correction for Latitude.*

| Lat. | c. | Lat. | c. | Lat. | c. | Lat. | c. |
|---|---|---|---|---|---|---|---|
| 0° | +113 | 23° | 78 | 45° | 0 | 68° | −81 |
| 1° | 113 | 24 | 75 | 46 | − 4 | 69 | 84 |
| 2 | 112 | 25 | +72 | 47 | 8 | 70 | −86 |
| 3 | 112 | 26 | 69 | 48 | 12 | 71 | 89 |
| 4 | 112 | 27 | 66 | 49 | 16 | 72 | 91 |
| | +111 | 28 | 63 | 50 | −20 | 73 | 93 |
| 6 | 110 | 29 | 60 | 51 | 23 | 74 | 96 |
| 7 | 109 | 30 | +56 | 52 | 27 | 75 | −98 |
| 8 | 108 | 31 | 53 | 53 | 31 | 76 | 100 |
| 9 | 107 | 32 | 49 | 54 | 35 | 77 | 101 |
| 10 | +106 | 33 | 46 | 55 | −39 | 78 | 103 |
| 11 | 104 | 34 | 42 | 56 | 42 | 79 | 104 |
| 12 | 103 | 35 | +39 | 57 | 46 | 80 | −106 |
| 13 | 101 | 36 | 35 | 58 | 49 | 81 | 107 |
| 14 | 100 | 37 | 31 | 59 | 53 | 82 | 108 |
| 15 | + 98 | 38 | 27 | 60 | −56 | 83 | 109 |
| 16 | 96 | 39 | 23 | 61 | 60 | 84 | 110 |
| 17 | 93 | 40 | +20 | 62 | 63 | 85 | −111 |
| 18 | 91 | 41 | 16 | 63 | 66 | 86 | 112 |
| 19 | 89 | 42 | 12 | 64 | 69 | 87 | 112 |
| 20 | + 86 | 43 | 8 | 65 | −72 | 88 | 112 |
| 21 | 84 | 44 | + 4 | 66 | 75 | 89 | 113 |
| 22 | 81 | 45 | 0 | 67 | 78 | 90 | −113 |
| 23 | + 78 | | | 68 | −81 | | |

III.—*Correction for Altitude.*

| Difference of altitude. | c'. | Difference of altitude. | c'. |
|---|---|---|---|
| 0 feet to 240 | 0 | 5050 feet to 5531 | +11 |
| 240 " 722 | + 1 | 5531 " 6012 | 12 |
| 722 " 1203 | 2 | 6012 " 6493 | 13 |
| 1203 " 1683 | 3 | 6493 " 6974 | 14 |
| 1683 " 2164 | 4 | 6974 " 7455 | 15 |
| 2164 " 2645 | 5 | 7455 " 7936 | 16 |
| 2645 " 3126 | 6 | 7936 " 8417 | 17 |
| 3126 " 3607 | 7 | 8417 " 8898 | 18 |
| 3607 " 4088 | 8 | 8898 " 9378 | 19 |
| 4088 " 4569 | 9 | 9378 " 9860 | +20 |
| 4569 " 5050 | +10 | 9860 " 10341 | 21 |

NOTE.—$c$ and $c'$ are given in units of the fifth decimal place.

ART. VII.—*On the relative proportion of Iron and Sulphur in the "Pyrite" contained in several specimens of Iowa Coal;* by RUSH EMERY.

THE idea of making the following examination was suggested to the writer by a notice, in a former number of this Journal, of the results obtained by Prof. Wormley of the Ohio Geological Survey, in his analyses of the compounds of iron and sulphur found in the coals of that State. In these analyses the amount of sulphur was found too large for combination with the iron as $FeS_2$.

The method adopted in the following analyses was:—(1) A weighed quantity of the coarsely pulverized coal (see column 2 in the Table of Analyses) was soaked in water acidulated with a few drops of HCl, the object being to extract from the coal all mineral substances capable of solution by this treatment, and especially soluble salts of iron, the presence of which would vitiate the accuracy of the results with regard to the relative proportion of iron and sulphur in the insoluble compounds remaining. This solution was evaporated to dryness; and the weight of the residue thus obtained is given in column 3 of the following table. It will be noticed that, with a single exception, this soluble mineral matter exceeds in quantity the combined amount of iron and sulphur, as given in columns 4 and 6. Only a qualitative examination was made of the soluble matter, any more extended investigation of it being foreign to the main question. Very large quantities of Fe and $H_2SO_4$ were found in all the samples, thus showing the extent to which decomposition of a sulphide had already taken place. In most cases, however, there was little external evidence of decomposition. In Nos. 1, 2, 5 and 10, large amounts of Ca were found; in No. 3, a very small quantity; none in the others. In all of the cases where Ca was found, $CO_2$ was also present, and especially in the first four named. It is believed that what is frequently regarded as gypsum in coal deposits, is in many cases a mixture of calcium carbonate and sulphate. In a large number of examinations of Iowa coals, made by the writer in connection with his labors as chemist of the late Geological Survey of that State, there were but few cases where the application of the test failed to show the presence of $CO_2$.

(2) The insoluble—by treatment (1)—iron sulphide was thoroughly digested with HCl and $KClO_3$: the solution thus obtained, after being boiled to expel Cl, was divided into two portions: $Fe_2O_3$ and $BaSO_4$ determined successively in each; Fe and S calculated; and the means of the two analyses taken. See columns 4 and 6.

It was also found by carefully testing the filtrate from the precipitate of $Fe_2O_3$, that Ca was present in but three cases, and then in very small amount.

The samples for analysis were selected with a view of obtaining the largest possible quantity of visible sulphide, while not excluding that which existed in a form invisible to the eye and disseminated through the coal.

The results of this investigation are given in the following

*Table of Analyses.*

| No. of Analysis. | Quantity of coal taken. | Quantity of matter dissolved by $H_2O+HCl$. | Quantity of Fe in insoluble residue after digestion with $HCl+KClO_3$. | Quantity of S required to combine with the Fe found, in order to form $FeS_2$. | Quantity of S found. | Excess or defici'ncy of S. (D=column 5—col. 6; E=col. 6—col. 5). | Percentage of S in the compound of S & Fe. (See cols. 4 and 6.) In $FeS_2$, S=53·33 pr. ct. |
|---|---|---|---|---|---|---|---|
| 1 | 19·479 | 3·388 | ·192 | ·219 | ·158 | D. ·061 | 45·14 |
| 2 | 11·722 | ·785 | ·106 | ·121 | ·186 | E. ·065 | 63·70 |
| 3 | 11·356 | ·484 | ·197 | ·225 | ·278 | E. ·053 | 58·53 |
| 4 | 12·095 | ·396 | ·106 | ·121 | ·168 | E. ·047 | 61·31 |
| 5 | 19·802 | 2·767 | ·362 | ·414 | ·409 | D. ·005 | 53·05 |
| 6 | 17·290 | 3·819 | ·564 | ·645 | ·642 | D. ·003 | 53·23 |
| 7 | 12·015 | ·480 | ·224 | ·256 | ·262 | E. ·006 | 53·91 |
| 8 | 15·611 | 1·579 | ·244 | ·279 | ·429 | E. ·150 | 63·74 |
| 9 | 22·767 | 1·703 | ·396 | ·453 | ·407 | D. ·046 | 50·68 |
| 10 | 17·693 | 1·532 | ·250 | ·286 | ·284 | D. ·002 | 53·18 |

It will be seen by the preceding table, that in Nos. 5, 6, 7 and 10, the relative proportion of Fe and S correspond nearly to that existing in $FeS_2$; in Nos. 2, 3, 4 and 8, there is a marked excess of S; while Nos. 1 and 9 give the unexpected result of a marked deficiency.

It is a source of regret to the writer that other duties have prevented the making of a larger number of analyses; but it is to be hoped that others may contribute to the investigation of this subject.

The samples for analysis were furnished through the kindness of Dr. C. A. White of Iowa City, late Director of the Iowa Geological Survey.

Genesee Agricultural School, Lima, N. Y., Oct. 31st, 1871.

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## ART. VIII.—*On the Occurrence in nature of Amorphous Mercuric Sulphide*;* by Dr. GIDEON E. MOORE.

IN the winter of 1867–68, my honored friend, Professor J. D. Whitney, chief of the State Geological Survey of California, directed my attention to a peculiar black mercury ore, which he had first noticed during a geological journey through Lake County, California, in the spring of 1863. From its very peculiar physical properties he had been led to conjecture that it might possibly, on investigation, turn out to be an isomorphous mixture of mercuric sulphide and selenide, analogous to the *Onofrite* of *Haidinger*.

I undertook the investigation, in conjunction with other items of analytical work, for the California Geological Survey. As however, the issue of the reports of this institution has been temporarily delayed, and as the results of the investigation have proven to be not without interest, I have decided, with Professor Whitney's kind permission, to make them at once public.

The mineral occurs lining fissures and cavities in a peculiar siliceous veinstone, and is associated with crystallized and massive iron and copper pyrites, and very small brilliant ruby-red crystals of cinnabar.

The latter, which are of prismatic habitus, show the combination I, $\frac{4}{5}$ (fig. 1), and are provided with terminal faces at one end only. Although brilliant, the faces do not give perfect reflections. The measurements therefore, which could only be made by observing the reflections of a lamp flame, are only approximately correct.

1.


The mean of six consecutive measurements gave:

| | Found. | Calculated. |
|---|---|---|
| $I \wedge 1$ | 120° 14′ | 120° |
| $I \wedge \frac{4}{5}$ | 137° 42′ | 136° 36′. |

In most of the specimens the minerals were arranged in the following order.

First, a layer of pyrites of moderate thickness, lining the walls of the cavity, then a proportionately thick layer of the

* From the Journal für prakt. Chemie, neue Folge.

black mineral in question, very irregular in thickness and full of cavities, lining which the cinnabar crystals occurred. The cinnabar occurs also in fine grains, in places so intermixed with the black mineral as almost to present the appearance of an intermediate stage between the two. This appearance is, however, only superficial; the lens always shows a sharp line of demarcation, for the cinnabar occurs always crystallized or crystalline, the black mineral always amorphous.* This admixture made it difficult to obtain enough of the pure mineral for investigation. By careful selection with the lens among the smaller fragments, a sample was, however, at last obtained, which presented the following properties.

Entirely destitute of structure or cleavage. Fracture subconchoidal to uneven, with brilliant surfaces. Very brittle when struck or bent, but tough under the knife. In the agate mortar the powder packs readily under the pestle, and takes a high polish and metallic luster, similar to graphite. Color greyish black. Streak on porcelain pure black. Luster metallic. Cuts with a shining surface. Hardness about 3 of Mohs' scale, somewhat greater than that of cinnabar, but difficult to determine exactly on account of brittleness. Specific gravity 7·701 to 7·748, varying somewhat in different specimens, owing to intermixed cinnabar.

Pyrognostic characters those of cinnabar. In the closed tube it sublimes totally except a slight residue of quartz and ferric oxide. The black sublimate yields a vermilion red powder when care has been taken, that, during the sublimation, the temperature of the upper part of the tube has not been very much lower than the subliming temperature of cinnabar. The experiment suceeds best in vacuo; the residue is then not oxide but sulphide of iron.

A qualitative analysis showed the presence of mercury and sulphur, with very small quantities of iron and silica. The quantitative analysis was made in duplicate, as follows:

* In all of the six or seven specimens which I had examined previous to the publication of this paper, the mineral occurs, as stated, without a vestige of crystalline structure. Mr. Emil Durand, of San Francisco, has, however, discovered specimens in which minute black crystals occur, and published a notice of his discovery in the San Francisco papers.

Through the kindness of Prof. Geo. J. Brush, I have had the privilege of examining two of Mr. Durand's specimens. The crystals are quite small, very irregularly developed, and betray in their frequent re-entrent angles a strong tendency to the formation of twins. In some cases, instead of simple individuals they appear to be aggregates of minute crystals. The habit is frequently almost *cubical*, and strikingly different from that of the long prismatic crystals of cinnabar which occur intermixed with and often implanted on them.

Unfortunately none of the specimens are sufficiently perfect to permit a determination of the crystalline form. The difference in habit is, however, sufficiently striking to warrant the supposition that they are probably *not* isomorphous with cinnabar.

I. (*a*) 1·4065 grm., decomposed by Woehler's method with chlorine gas yielded $BaSO_4$ 1·4130 grm., insoluble matters (quartz) 0·0036 grm. (*b*) 0·8310 grm. yielded HgS 0·8290 grm, $Fe_2O_3$

II. (*a*) 1·4893 grm., oxidized with chlorine gas in solution of
0·0040 grm.
caustic potash, gave $BaSO_4$ 1·5010 grm., quartz 0·0035 grm. (*b*) 1·2365 grm., oxidized with nitro-hydrochloric acid, yielded HgS 1·2320 grm., $Fe_2O_3$ 0·0081 grm.

These figures correspond to the following percentage composition:

| | I. | II. | Mean. |
|---|---|---|---|
| S | 13·79 | 13·84 | 13·82 |
| Hg | 85·69 | 85·89 | 85·79 |
| Fe | 0·33 | 0·45 | 0·39 |
| Quartz | 0·26 | 0·24 | 0·25 |
| | | | 100·25 |

which in its turn corresponds to:

| | | | |
|---|---|---|---|
| HgS | 98·92 | containing | 13·64 S. |
| $FeS_2$ | 0·83 | " | 0·44 S. |
| Quartz | 0·25 | | ---- |
| | 100.00 | | 14·08 S. |

The mineral is, therefore, simply mercuric sulphide with a little intermixed pyrites and gangue, the cause of the black color, absence of crystalline structure, and low specific gravity, which distinguish it so strikingly from cinnabar, remaining still to be ascertained. In spite of the very satisfactory result of the quantitative analysis, traces of coloring matter might, in this, as in the qualitative analysis, have escaped observation. That the color is not due to the small amount of iron pyrites is evident; Bealey,* for instance, found in his analysis of a beautiful red cinnabar from California as much as 1·40 per cent of *iron*. The only *volatile* matters which might be supposed capable of producing such a coloration are *selenium*, tellurium (?), arsenic (?), antimony,† and lastly bituminous compounds, such as those to which *Idrialite* owes its dark color. The large quantity of sulphureted hydrogen precipitate obtained during the analysis might easily have concealed traces of the first named substances, while carbon compounds would naturally only reveal themselves to special tests, therefore:

The barium sulphate, obtained during the analysis, was ignited in a current of hydrogen, as in the quantitative separation of selenium from sulphur, whereby a very slight reduction to barium sulphide ensued. The powder evolved a trace of sul-

* Quart. Jour. Chem. Soc., vol. iv, p. 180, and Jour. für prakt. Chem., lv, 234.
† Wehrle Ann. Chem. Pharm., viii, 181.

phureted hydrogen with hydrochloric acid, but did not lose appreciably in weight. Furthermore, 3 grams of the mineral were fused with sodium carbonate and potassium nitrate; the mass, boiled with hydrochloric acid to reduce selenic and telluric to selenous and tellurous acids, and then treated with sulphurous acid, gave no precipitate even after long standing. A control experiment, carried out on the same quantity of the mineral, to which a few milligrams of selenium had previously been added, gave a very good reaction.

Three grams were fused with sodium carbonate and potassium nitrate. The result, when treated after the usual routine of a qualitative analysis, gave no trace of arsenic, antimony or any other impurity.

The powdered mineral yielded no bitumen to ether. 2,1751 grams were, therefore, burned with lead chromate as in an organic analysis and the resulting gases, after passing over a stretch of ignited metallic copper, conducted into baryta water. No precipitate was formed until, toward the end of the operation, a current of air was passed through the apparatus. The trifling precipitate, which then came down, was quickly filtered off, washed and dissolved in hydrochloric acid, to which some chlorine water had previously been added, to oxidize any sulphurous acid which might still be present. After standing some time, the fluid was filtered from the traces of barium sulphate, which had precipitated, and the baryta thrown down as carbonate. The precipitate weighed 0·0155 grms., corresponding to *carbon* 0·0010 grms., or 0·04 per cent of the original mineral, a quantity so small that it may be safely ascribed to the imperfect purification of the air used in the combustion.

No chemical reason for the peculiar difference in properties from cinnabar could, therefore, be detected.

Mercuric sulphide, as prepared in the laboratory, exists in two forms, which were first recognized by Berzelius as distinct isomeric modifications. The first of these is the black precipitate produced by sulphureted hydrogen in solutions of mercuric salts. The second, obtained from the first by long continued agitation, treatment with alkaline sulphides, etc., is the crystalline red powder, *vermilion.* Only the latter variety, under the name of *cinnabar*, has hitherto been recognized in nature. The assumption lay near that I had to do with the one first named, especially, as the very low specific gravity could not be accounted for by the presence of *traces* of impurities. The natural cinnabar has a specific varying from 8·0 to 8·2, in the mean 8·1. Taking the latter number as a basis, the specific gravity calculated for a mixture like the one in question would be 8·0165, whereas it is in fact 7·701.

The most convincing proof of the correctness of this supposition was afforded by the direct conversion of the mineral into the red modification. A small portion was triturated with water to the finest powder, sealed in a tube with solution of potassium pentasulphide, and exposed to the temperature of boiling water. The powder, which was pure black at first, showed on the morning of the third day a decided tinge of red. As soon as no further change could be perceived, the tube was opened. The powder then showed a brownish red color, not of course to be compared with vermilion, but still quite satisfactory to one familiar with the refinements of manipulation required to produce the finer shades of color in the latter substance, and, perhaps, all that could be expected, in view of the great difference in susceptibility to chemical action usually existing between a native mineral and an artificial precipitate.

It was still desirable to compare the specific gravity of the mineral with that of the black precipitated mercuric sulphide. As, however, I have been unable to find any recorded determination of the latter, it was necessary to determine it myself. This was at first no easy matter. The precipitate possesses in an eminent degree the annoying peculiarity of retaining, with great tenacity, a coating of air, which makes a perfect admixture with water well nigh unattainable by ordinary means. When boiled, the mixture spirts with almost explosive violence, and forms in addition a greasy-looking scum, which cannot be made to sink. Attempts to use the air-pump in the ordinary manner were likewise unsuccessful, on account of the strong foaming which ensued. I was, therefore, obliged to have recourse to an expedient of which, as it may perhaps be useful to others in similar difficulties, a detailed description may not appear superfluous.

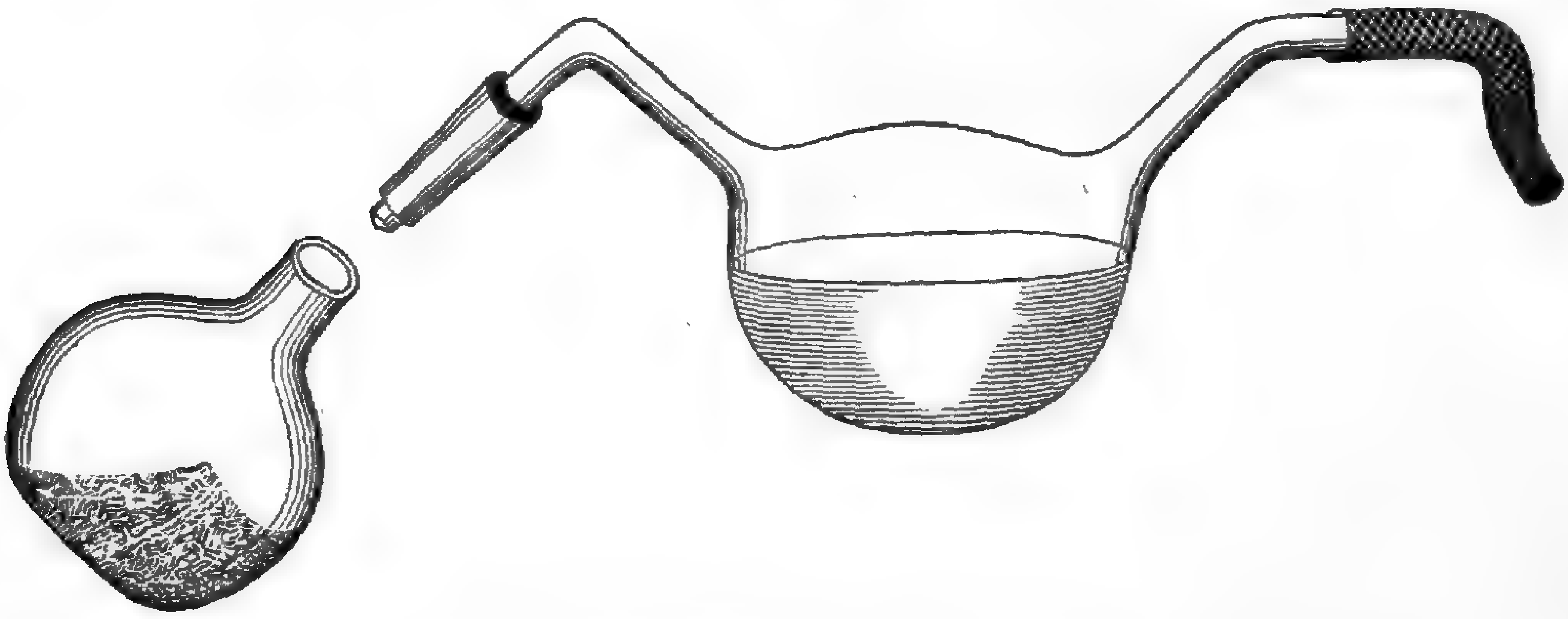
Pure mercuric sulphide was prepared by the action of sulphureted hydrogen on solution of mercuric nitrate. Every care was taken to insure perfect saturation, and, after thorough washing and drying, the mass was repeatedly digested with pure carbon disulphide, until all free sulphur had been removed.

After careful drying, a weighed portion was placed in a weighed specific gravity flask of the ordinary pattern. This was connected with a Bunsen's pump,* by means of a triply bent tube, fig. 2, whose middle part had been widened out into a bulb of about equal capacity with the flask itself, the communications between the bulb-tube, which was filled to three-fourths with water, and the flask being made air-tight by means

* As Bunsen's pump is not always to be found so perfect in construction as to permit the attainment of the maximum degree of rarification, it may be preferable in most cases to use Sprengel's mercury air-pump.

of a moist rubber collar. As soon as the manometer of the pump indicated the maximum of rarification, the apparatus was

2.



inclined, whereby the water ran quietly from the bulb into the flask, penetrating every pore of the mass within it without forming a particle of scum. It was only necessary to remove from the pump, fill up with water, and, as soon as the temperature of the balance room had been attained, to weigh.

Three determinations made in this manner on respectively 1·9750, 3·8337 and 3·1155 grams, gave for the specific gravity the numbers 7·552, 7·551 and 7·553, in the mean 7·552 compared with water at 15° C.*

A sample of vermilion, whose specific gravity had been ascertained to be 8·090, was reconverted into the black variety by the method of Fuchs',† by heating until the temperature of sublimation was just attained, and then plunging suddenly into cold water. (The operation was performed in an atmosphere of carbonic acid.) The powder, however, conducts heat too slowly to be instantaneously cooled throughout its whole extent, consequently a perfect conversion could not be effected. The dark grayish black powder showed a specific gravity of 7·980, and assumed a reddish color by pulverization.

I think the foregoing results are sufficient to establish the complete identity of the mineral in question with the amorphous mercuric sulphide of the laboratory. The slight difference in specific gravity is partly due to the impossibility of getting enough of the mineral for a specific gravity determination, entirely free from admixture with cinnabar, partly probably to the fact that artificial precipitates almost invariably differ slightly in this respect from native minerals.

* It is worthy of note, that the above specific gravity agrees very well with that calculated from the specific gravities of the ingredients. Accepting as a basis for calculation the specific gravity of mercury at 0° C., 13·5959 (Regnault), and that of rhombic sulphur 2·045 (Marchand and Scheerer), we have for the *atomic volume* of mercuric sulphide 15·1792, which corresponds to the specific gravity **7·6428.** A still more perfect accordance is the result when we employ the specific gravity of monoclinic sulphur, 1·982 (M. & S.); we then obtain the number **7·5188.**

† Pogg. Ann. xxxi, 581.

To facilitate comparison, I have arranged the properties of the native red and black and the artificial black mercuric sulphide in the following table:—

| Red (native). | Black (native). | Black (artificial). |
|---|---|---|
| Always crystallized or crystalline. | Always amorphous. | Heavy black amorphous powder, takes by pressure a high polish and metallic lustre. Obtained by sublimation as a black amorphous mass, with metallic lustre. (*Fuchs*, loc. cit.) |
| Cleavage, perfect. | Totally destitute of cleavage. | |
| Lustre, adamantine, inclining to metallic in the darker varieties. | Lustre, metallic. | |
| Color, cochineal red, inclining to brownish and lead gray. | Color, grayish black. | |
| Streak, scarlet. | Streak, black. | |
| Specific gravity, 8·0—8·2. | Specific gravity, 7·701. | Specific gravity, 7·552. |

The difference between the two minerals seems to me greater than that between two *varieties* of the same species. I cannot see why the rule by which diamond and graphite are classed as distinct species, should not also be applicable in this instance. I feel therefore warranted in introducing this mineral to science as a new species and in assigning to it, under the name *Metacinnabar* (Metacinnabarite), a position distinct from that of its isomer cinnabar.

It is not improbable that the mineral has been hitherto confounded with the darker varieties of cinnabar, from which, however, its destitution of crystalline structure, black streak and low specific gravity, eminently distinguish it.

The arrangement of the minerals in the vein would seem to favor the following theory of the formation of the meta-cinnabar. The pyrites were evidently first deposited, possibly by aqueous agency. If now, into a cold cavity thus lined, vapors of mercuric sulphide were to be admitted, they would condense, not to the red, but to the black modification, as Fuchs' method of preparing the latter sufficiently demonstrates. Later, as the temperature of the surrounding mass had become somewhat raised, the red variety would begin to form, and we accordingly find in all the specimens that the crystals of the latter occur coating the black. The fine granular mixture of both may have been the result of an intermediate degree of temperature, or, what is more probable, as it does not occur in all the specimens and is sometimes included between two layers of nearly pure meta-cinnabar, it may have resulted from a gradual alteration in molecular condition from this mineral to cinnabar. This theory would derive additional probability from the fact that the mineral occurs in a region abounding in the most striking evidences of volcanic action.*

* Vide Whitney's Reports of the Geological Survey of California, vol. i, Geology, p. 80, et seq.

At its locality* the mineral occurs in considerable abundance, and, according to the statement of the president of the company, H. P. Livermore, Esq., of San Francisco, to whose kindness I am indebted for the material for this investigation, constitutes the most abundant and valuable ore of the mine.

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## Art. IX.—*Norian Rocks in New Hampshire;* by C. H. Hitchcock, State Geologist of New Hampshire.

During the past summer (1871) I have made a reconnaissance of the southwest part of the White Mountains, or the district bounded north by the Ammonoosuc River, east by the Saco, south by the towns of Sandwich and Tamworth, west mostly by the Pemigewasset River. This area is entirely a forest country, with several alpine summits covered by dwarf-spruces, and as even logging roads are scarce, geological explorations were carried on with extreme difficulty. With the aid of several gentlemen from the class of 1871, Dartmouth College, the greater portion of this area has been traversed, and enough specimens have been brought out to enable us to form some idea of the different groups existing in this *terra incognita.* The search has brought to light formations hitherto supposed to be entirely alien to New England; and perhaps the key has been discovered which shall open to us the stratigraphical structure of the whole State. I refer to the discovery of massive labradorite and the associated minerals of the *Norian or Upper Laurentian Group.* These cover an area of several square miles in Waterville and Albany, adjoining towns, and probably occur in other parts of the State also. Whether the various gneisses, granites, felsites and jaspers in this part of the mountains, all differing from anything found elsewhere in the State, are to be assigned to the same series, remains to be proved. The occurrence of the labradorite in a new locality is of special interest at this time, when scientists are discussing the fundamental question, whether certain predominant minerals in metamorphic formations may be employed like fossils to indicate difference of geological age.

At the Montreal meeting (1857) of the American Association for the Advancement of Science, Sir W. E. Logan announced† that the Laurentian rocks could probably be divided into two groups, dependent upon the species of feldspar present, the potash feldspars characterizing one, and the lime and soda feldspars the other portion. This position is not discussed in

* The "Redington Quicksilver Mine," Lake County, California.
† Proc. Amer. Assoc. Adv. Sci., 1857, p. 47.

the Geology of Canada for 1863, except in a supplementary chapter, where, on page 836, considerations are presented favoring the view that the anorthosite group rests unconformably upon the orthoclase gneisses. The Canadian Survey proposed to call this new group the Upper Laurentian or Labrador system. Recently* Dr. T. Sterry Hunt has briefly described the various localities where these rocks occur, and proposed for them the designation of *Norian*, after Norite (from Norway), a name early used for a labradorite rock in Norway; presenting also further evidence to show the unconformable superposition of the Norian upon the Laurentian.

The most easily accessible locality is in Waterville, a small mountain hamlet in the southern part of the elevated district, about twenty miles northeasterly from Plymouth. For the convenience of those who may wish to visit this place, it may be said that a daily stage runs from Plymouth, the head quarters of the Boston, Concord and Montreal Railroad, to Greely's Hotel, a house kept open during the summer months. The accommodations are good, and the house is less than two miles distant from the first of the labradorite exposures, the route being by a footpath through the woods, passing a picturesque cataract. Inquiry must be made for the "slide upon Mount Passaconnaway." As soon as the end of this so-called slide is reached, the observer will find an immense amount of boulders and drift wood that were brought down in the great freshet of Oct., 1869. The facts concerning this great "wash-out," have been well described by Dr. G. H. Perkins, to whose description the reader is referred† for further topographical details than are given here. The rock which Dr. Perkins speaks of as "hornblende," proves to be the massive labradorite. Mr. J. H. Huntington went over this slide in 1870, and brought back a number of specimens which appeared to be labradorite; one was sent to Dr. Hunt, who wrote as follows concerning it, about eight months since. "The specimen brought by Mr. Huntington is a Labradorite or Norite rock, which resembles in composition and aspect that of the Labradorian; with this difference, however, that it is much more tender and friable, and in this respect resembles the granitic gneisses of the White Mountains as compared with similar rocks in the Adirondacks." I was not able to visit the locality myself till August 18 and 19, and subsequently on September 20, in company with Professor Dana; whose views with regard to the nature of the rock confirmed those I had previously entertained.

The great freshet coming down from the south side of Mount Passaconnaway, or the most southern of the "Tripyramid," has exposed many ledges that would otherwise have remained con-

* This Journal, II, vol. xlix, p. 180. † Do., p. 158

cealed, on account of the easily decomposing character of the labradorite. The first rock seen is a gneiss with nodular orthoclase, dipping by compass about 80°, S 70° W. The strata are indicated by folia of a dark hypersthenic mineral, often forming bunches or nodules. Jointed planes dipping about 25° westerly might be mistaken for strata. One might be so easily deceived, that it seems as if they must be the planes described at the Cascades and on Mount Osceola by J. P. Lesley.* This mountain is certainly composed of similar rock, and it covers quite a large area to the west and south.

A few rods higher up the stream, which I propose to call *Norway Brook*, the first ledge of the labradorite rock appears. Its junction with the gneiss is concealed by drift. For about a mile the ledges are mostly composed of this rock, a compound of labradorite and chrysolite, some exposures appearing for sixty or seventy feet. It is a perplexing matter to determine the lines of stratification, as the outcrops are divided by two prominent sets of jointed planes either of which might be called layers of deposition, the rock being essentially homogeneous. One set dip about 20° northerly and are the most numerous. The other dip about 75°, W. 10° S. The latter correspond better in position to the gneissic strata first seen than the former. This band of dark-colored rock, by some mistaken for basalt, is abruptly succeeded by a syenitic rock, fine-grained, with little quartz and mica. The feldspar seems to be Labradorite. The line of junction is irregular, averaging the course N. 20° E., while the dip of the plane of separation is about 85° westerly. Some of this feldspathic rock has been injected into irregular cavities of the dark Norite. Still higher up, the stream has cut a deep notch into the mountain; and the rock is coarser grained, consisting of whitish feldspar, which also is Labradorite according to recent analyses (see beyond), with hornblende, titanic iron, and a little epidote. This stream has worn its way along a ferruginous band, which may indicate the true position of the strata, dipping E. 15° S. and E. 35° N. The surface is almost entirely decomposed, though recently uncovered. Large nodules of essentially the same rock, but very tough, abound; also geodic cavities with orthoclase, albite, quartz and rarely stilbite. Above the notch the rock is like that immediately succeeding the dark compound of labradorite and chrysolite, with geodes, or feldspathic veins. At the point where the slide proper commences, and the valley turns at right angles, the dip curves, and a new variety of feldspathic rock is first seen, which continues to the top of the mountain, the southern of the three pyramids of Passaconnaway. There is very little quartz, but two kinds of feldspar, one of them reddish, probably orthoclase.

* Proc. Amer. Acad. Sci., Philadelphia, 1860, p. 363.

Mica is abundant, and some specimens show hornblende in its place. The rock has a syenitic aspect, and it also contains the same geodes as the rocks below, with actinolite, amethyst and other minerals not seen before.

This single line of exposure is the only one thus far examined, as the ledges farther north are entirely concealed by drift. It would seem as if those highest up topographically might be the lowest stratigraphically. With our present knowledge, nothing depends upon the immediate decision of this question, so far as the Norian bands are concerned. The lowest would be the reddish syenite, next a gray syenite, next the white easily-decomposing compound of similar character, next the gray syenite, and last of all the labradorite and chrysolite. These are all Norian. If the strata are to be regarded as dipping west nearly vertically, and not inverted, then the nodular gneiss first mentioned probably overlies the labradorite series.

In order to determine the adjacent formations, I examined first the valley of Cascade Brook, which is parallel with Norway Brook to the south, and from a quarter to half a mile distant. At the Cascades the same nodular gneiss first mentioned appears. Above that porphyritic gneiss occurs, much disturbed, but averaging a dip of 75°, N. 20° E. This course is nearly at right angles to the one thought to be that of the Norian rocks; or, if the other sort of planes be accepted as the true planes of deposition, the latter would appear to overlie the porphyritic gneiss unconformably. This latter rock covers the whole south-east part of Waterville, extending five or six miles southerly into Sandwich, and is part of the great mass which has been traced as far south as Fitzwilliam, if not through Massachusetts, sometimes fifteen miles wide. To the north of Norway Brook no very satisfactory explorations have been made. The specimens obtained were of nodular gneiss. To the north-east and east, the information is much more satisfactory. The whole of Passaconaway seems to be syenite. Additional facts are thus stated by J. H. Huntington, Assistant Geologist:

"On the east side of Tripyramid Mountain, and west of Sabba Day Brook, a branch of Swift river, the labradorite is so distinctive in its characteristics that it is easily recognized, and what is remarkable, some of the cleavable crystals show the play of colors. South it passes into a breccia, which overlies a well defined gneiss, and north we find the same syenitic rock that outcrops in the slide on the south-west side of the south peak of Tripyramid Mountain. Extensive as this rock is in Waterville, it is not limited to this locality, for the whole south-east slope of Chocorua is labradorite, and it is not improbable that it extends from Waterville through the town of Albany. On Chocorua, the labradorite outcrops in the slide that is generally followed by people who ascend this mountain."

Since my visits to Waterville, I have found similar syenites to those of Passaconaway, together with very interesting breccias not unlike those of Albany, upon Gunstock and Belknap mountains in Gilford. These locations are near Winnipiseogee Lake, and also occur in connection with porphyritic gneiss. Red Hill in Moultonboro is also composed of a similar syenite, though I have not seen in it any labradorite. It seems to lie upon a gneissic synclinal; other localities of similar character are Lightning Mountain in Strafford, and Mt. Monadnock in Vermont, close by Colebrook, on the upper Connecticut. The Quincy syenite of Massachusetts is said to lie contiguous to porphyritic granite in Abington, Mass., and its extension into New Hampshire, in Seabrook, is accompanied by porphyritic gneiss, with crystals of feldspar less conspicuous than usual.

Rocks in this mountainous district recently brought to light, and possibly related to the Norian or Huronian, are the jaspers of Albany and Twin Mountain, and extensive deposits of felsite capping Lafayette, Flume, Liberty, Twin, and other mountains. Chemical examination may show them to be related to the lime feldspars. They will be analyzed in due time.

There is an abundance of material afforded by these facts for speculating upon the ages of the metamorphic rocks in New Hampshire and Massachusetts. One cannot avoid forming conclusions as fast as new facts present themselves; but as I hope to be able to make further investigations in this field, it will be best to reserve our inferences for some other occasion, when additional information may afford more satisfactory results.

I am happy to state, in closing, that the minerals of the Waterville rocks have been recently under chemical investigation by Mr. Edward S. Dana, at New Haven; and that it is through his analyses that I am able to state confidently, that the mineral mainly constituting the dark-gray Waterville rock is, as Mr. Hunt had suggested, labradorite. By the same means I have learned that the light colored feldspar, from the upper locality at Waterville, very unlike the other in aspect and much resembling common feldspar, is also labradorite; and that the yellow mineral of the dark labradorite rock is chrysolite. Mr. Dana has consented to publish his results in an article following this.

Hanover, N. H., Dec. 1, 1871.

ART. X.—*Contributions from the Laboratory of the Sheffield Scientific School.* No. XXIII.—*On the Composition of the Labradorite rocks of Waterville, New Hampshire;* by E. S. DANA.

THE specimens of labradorite rock, which I have had under examination, were obtained by Professor Dana last September, on a visit with Prof. Hitchcock to the locality at Waterville, New Hampshire.

There are two distinct varieties, both mentioned by Prof. Hitchcock in the preceding article. The first (see page 45, line 13, et seq.) is a dark-colored rock, consisting in the main of a triclinic feldspar, together with small yellowish grains of a mineral, which Prof. Brush in a blowpipe examination referred to chrysolite. A careful examination reveals to the eye also some minute grains of a magnetic ore of iron, and also a very little of a black mineral, probably hornblende.

The feldspar has a dark smoky color, without iridescence, and is beautifully striated. It fuses B. B. with somewhat less readiness than ordinary labradorite, and is scarcely attacked by acids. It was picked out as carefully as possible, and analyzed with the following result:

| | I. | II. | III. | Mean. |
|---|---|---|---|---|
| $SiO_2$ | 51·04 | 51·02 | ---- | 51·03 |
| $Al_2O_3$ ($TiO_2$) | 26·34 | 26·07 | ---- | 26·20 |
| $Fe_2O_3$ | 4·79 | 5·13 | ---- | 4·96 |
| CaO | 14·09 | 14·23 | ---- | 14·16 |
| NaO | ---- | ---- | 3·44 | 3·44 |
| KO | ---- | ---- | ·58 | ·58 |
| | | | | 100·37 |

The large percentage of iron (determined volumetrically) had not been expected, as the eye had failed to detect any impurities in the fragments selected for analysis. Some very thin pieces were afterward examined under the microscope; and by this means it was found that even the clearest pieces contained very minute grains of an iron ore, from $\frac{1}{50}$th to $\frac{1}{200}$th of an inch in diameter, which were strongly attractable by the magnet. Microscopic dark specks less than $\frac{1}{10000}$th of an inch in size were also observed and at first referred to the same cause, but on magnifying them 800 diameters, it was concluded that they were air-cavities in the structure of the feldspar, and not any foreign matter. The peculiar dark-smoky color of the rock is doubtless to be explained by the presence of these particles of iron ore.

This magnetic iron ore, a sufficient amount for the test having been picked out by the magnet, gave a decided reaction for titanic acid. It is, therefore, probably a very magnetic titanic iron, though it was impossible to obtain a sufficient amount of the substance for a quantitative determination of the titanium. The absence of any octahedral faces or isometric structure in the grains is in favor of their being titanic iron.

In consequence of this impurity, which could hardly be removed, it is not to be expected that the analysis should give a satisfactory formula; the result obtained, however, is sufficient to prove that the feldspar is unquestionably labradorite.

The analyses of the mineral, supposed to be chrysolite, occurring in yellow, glassy grains, afforded:

| | I. | II. | Mean. |
|---|---|---|---|
| $SiO_2$ | 38·82 | 38·88 | 38·85 |
| $Al_2O_3$ | tr. | tr. | tr. |
| FeO | 28·00 | 28·15 | 28·07 |
| MnO | 1·12 | 1·36 | 1·24 |
| MgO | 30·88 | 30·36 | 30·62 |
| CaO | 1·26 | 1·60 | 1·43 |
| | 100·08 | 100·35 | 100·21 |

The oxygen ratio of the bases and silica afforded is nearly 1 : 1, and of the iron and magnesia about 1 : 2; whence the formula $(\frac{1}{3}\dot{F}e+\frac{2}{3}\dot{M}g)_2\ddot{S}$. This is then a chrysolite containing an unusually large per-centage of iron (here a constituent of the mineral, and not owing to the presence of impurities). The amount of iron is not strange considering the fact that the rock contains diffused throughout it so much free iron ore.

This chrysolite has the same ratio deduced for hyalosiderite, bnt still differs widely in fusibility and other characters. It is in fact a true chrysolite in all respects, while hyalosiderite is a doubtful compound, probably owing its fusibility in part to the potash present. B. B. the chrysolite is nearly infusible.

In two samples of this labradorite rock, obtained with care so as to represent the average composition, 1·70 and 1·94 (mean 1·82) per cent. of MgO were obtained, which would give 5.94 as the per-centage of the chrysolite in the whole.

This rock, consisting of labradorite with grains of chrysolite disseminated through it, is one not previously described. Prof. Hitchcock has proposed to call it *Ossipyte*, after the name of the tribe of Indians (the Ossipees) formerly inhabiting that region.

The second variety of the rock (for position, etc., see page 45, 16th line from foot) presents quite a different appearance. The feldspar, here in large, cleavable masses, often half an inch long, and a dark mineral, the angle of whose cleavage planes proves it to be hornblende, form the mass; together with these are associated a magnetic titanic iron in segregated masses of some size, very little of a dark brown mica, and a green mineral, probably epidote. There is no chrysolite.

This feldspar has a grayish-white color, is destitute of iridescence, and only careful searching reveals any striations.

Two analyses afforded:

| | I. | II. | III. | Mean. |
|---|---|---|---|---|
| $SiO_2$ | 52·15 | 52·36 | ---- | 52·25 |
| $Al_2O_3$ | 27·63 | 27·39 | ---- | 27·51 |
| $Fe_2O_3$ | 1·09 | 1·07 | ---- | 1·08 |
| MgO | ·92 | 1·06 | ---- | ·99 |
| CaO | 13·10 | 13·45 | ---- | 13·22 |
| NaO | ---- | ---- | 3·68 | 3·68 |
| KO | ---- | ---- | 2·18 | 2·18 |
| | | | | 100·91 |

Both analyses show that the labradorite of the region is remarkable for the large proportion of lime present.

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## ART. XI.—*Recent German Arctic Explorations.*

### 1. *Letter of* A. PETERMANN, *dated Gotha, Oct.* 9, 1871.

It will be remembered that the present polar exploration was first agitated on this account; that Captain Osborn, R. N., almost seven years ago, proposed a new English expedition which had in view to explore the central arctic region, and to reach the North pole. The plan was to go up Baffin's Bay and through Smith's Sound; and had it received hearty approval and support among nautical and scientific circles, and with the authorities of England, there was every prospect that the English government would have equipped and sent out a large scientific expedition.

But when I submitted to the English authorities my views and project, which recommended the European North sea between East Greenland and Nova Zembla for the course of such an expedition, the plan of Capt. Osborn was set aside after the most thorough discussions of the most distinguished men at four meetings of the Royal Geographical Society at London, and acquiescence and recognition were accorded to my views. And while the English were, for seven years, satisfied with mere words and discussions, the remarkable readiness and generosity, and the lofty scientific and national feeling of the German nation made possible the equipment and sending out of two German scientific north-polar expeditions, under the command of Captain Koldeweg.

Besides this, at the same time extensive explorations, in the direction recommended by me, were set on foot by Dr. Dorst and Dr. Bessels in ships from Rosenthal, and by Count Zeil and Herr von Heuglin out of their own means, and important results were attained. The ice-sea fisheries have taken an important advance, so that Norwegian fishermen have gained a revenue which realized a dividend of 57 per cent., and in addition most valuable scientific observations and discoveries have been made.

Captain Koldeweg has lately expressed himself publicly that he was quite of Capt. Osborn's opinion in regard to a North-polar expedition, he believing the route through Smith's Sound altogether the best. But I do not think that he will obtain from anyone the money for a German expedition, which is to be prosecuted according to an English plan, abandoned by the English themselves, and for which he nevertheless considers two steam vessels and an equipment for at least three years as necessary.

Immediately after the second German North-polar expedition, in consequence of the difference of opinion between Koldeweg and myself, very uncomfortable differences arose, which are now greater than ever, while Koldeweg, as already mentioned, adopts principles the opposite of mine, and has gone over to Capt. Osborn and the English, and in relation to the whole eastern half of the European North sea has made the following public assertion,—"To wish to reach the North pole (between Spitzbergen and Nova Zembla), I should consider an entirely wrong undertaking, and should only join myself to an expedition sent there by this route, in case Dr. Petermann in person made the journey with me." For this view he gives no reason, as if he, Captain Koldeweg, did not need to have or to name any ground for his opinions and assertions.*

But to how little extent Capt. Koldeweg's views were shared by other experienced and scientific men, is evident from this, that while he expressed that decision in the past May, already in June an expedition started out which had especially in view the exploration of that sea which Koldeweg was disposed to investigate only in my company; and what is more, with this expedition there went his own companion, the deserving Lieutenant Julius Payer, with the well-qualified Lieutenant Weyprecht, a native of Baden, from the village of König in Odenwald.

Contrasted with the last expedition led by Koldeweg, the courage and eminent scientific minds of these men could not but have been recognized, even if they had had little success, because they set out with the most scanty means and merely a little hired Norwegian sailing vessel, while Koldeweg started with two fine ships, elegantly fitted up. The latter, with steam vessels, in two summers, merely reached to 75° 31′ N. lat., only ⅛° farther than Clavering 47 years before, and with sledges to 77° 1′ N. lat., while Payer and Weyprecht with the little sailing vessel, in that formidable sea, sailed to 79° N. lat., a distance, compared with their predecessors in that search, which exceeded at least tenfold those with Koldeweg.

The telegram which announced the return of Payer and Weyprecht from the extreme north to Trompsoë on the 3d of October, reads literally: "September offenes Meer von 42° bis 60° Oestlicher

* Hansa, 1871, No 10, S. 92.

Länge von Greenwich über 78° N. Breite verfolgt. Gröste Breite 79° N. Br. auf 43° Oestl. Länge, hier günstigste Eiszustände gegen Nord wahrscheinliche Verbindung mit Polynia gegen Ost, wahrscheinlich günstigster Nordpolweg."

The last part of the telegram is unintelligible, but I have reason for understanding it in this way, that King-Charles-Land, discovered in former years by Count Zeil and Herr von Heuglin, extends toward the south to 77° 12′ N. lat. Of this discovery and their work in East Spitzbergen in general, Count Zeil and Herr von Heuglin have won the most hearty acknowledgment from the Royal Geographical Society of London and from their late President, Sir Roderick Murchison.

The voyage and discovery of Payer and Weyprecht prove how little heed is to be given to the views and assertions of Capt. Koldeweg, but besides how much honor such explorers as Payer and Weyprecht deserve for their treatment of such errors, for their courage, and their high scientific enthusiasm.

In addition, it follows that all news hitherto made known from our European North sea had been announced under remarkably unfavorable conditions of ice and weather. It is to be supposed that Payer and Weyprecht evidently had to pass through a belt of drift-ice, before they reached that open Polar Sea extended over 18 degrees of longitude, and that they for the first time actually broke the North-polar ice belt just as Ross and Weddell had done at the South pole. In my chart (published June, 1870), in regard to the Gulf Stream, I have in accordance with the observations of Bessel, made in the Rosenthal steamship "Albert," of 1869, marked the Gulf Stream between 75° and 76° N. lat., which there* moreover shows a temperature of 41° F. and more at the sea surface. The name Gulf Stream, and the arrow on this chart† sufficiently mark the spot in 79° N. lat. and 43° E. long. (from Greenwich), which Weyprecht, as qualified and scientific as he is a thoughtful naval officer, in his telegram expresses as the "günstigsten Eiszustände gegen Nord der wahrscheinlichen Verbindung mit der Polynia gegen Ost, den wahrscheinlich günstigsten Nordpolweg."

I have also much interesting news of other North-polar expeditions of this year, and already keep a complete journal of them. I have almost ready a very interesting original Chart, which will be published in the next volume of the "Geographische Mittheilungen."

## 2.—*Letter of Lieutenant Julius Payer, of the recent German Expedition.*

This expedition has achieved a result for the exploration of the sea between Spitzbergen and Nova Zembla surpassing all expectations, and from which a greater undertaking will follow next

* Such a temperature as has never been observed in the Northern or Southern hemisphere.

† Geographische Mittheilungen, 1870, Tafel, 12.

year. Why it was not with consistency possible, nor right, to follow up one of the problems proposed, viz: to reach King-Charles-Land, Lieut. Weyprecht will explain in person. On the other hand, the discovery of an extended, open Polar sea, in the place of territory considered entirely unnavigable, and into which, even in its most southern portion, the Russians, Swedes, and also the German expedition of 1868 failed to penetrate, is calculated to give another form to the polar-question, and to afford a new and very promising basis for reaching the pole.

It is exceedingly to be regretted that the great German expedition of 1869–70 did not adopt this passage through the "Nova Zembla sea," which was previously pronounced by Dr. Petermann the most favorable for penetrating into the heart of the polar basin.

While weighty authorities, even up to our time, have declared positively against every route by the east of Spitzbergen, and while the numerous Russian expeditions, in our century, were not once even in a position to sail by the north of Nova Zembla, and in the past year, the voyage of the Norwegian Johannesen, close to the coast of this double island from the Kara sea into the Barents sea was considered an extraordinary, and, in many respects, a questionable event; our experience has proved *the existence of an extended open sea to the north of Nova Zembla.* But when also the sea was observed by the mariners Simonsen, Mattiesen, etc., this year, as too before, as almost completely free from ice, and when the former did not succeed in discovering in the neighorhood of the White Island the ice on which the capture of the walrus depends, yet in the autumn the connection of the open Nova Zembla sea with the Polynia of northern Siberia has been as good as proved. But with this discovery, an immense ice-territory disappears from our charts. It will certainly be represented that the year 1871 has been a particularly favorable one for ice-navigation, just as has often been said, wrongly and in absence of proof, of "unusually unfavorable" years. But throughout Norway the walrus-hunters and fishermen unite in calling the past summer absolutely the worst which has been known for a long time. If even the German expedition-vessel, "Germania," did not succeed in pushing farther than into the Kara sea, the cause of this backwardness of steam, compared with the ordinary sailing-vessel, is attributed, here in Norway, to the very deficient fitting of the Germania. It well be of great importance in the interest of the subject to give this ship, which, however, belongs to 1869–70, an impartial examination.

How now are we to explain the circumstances of the Polar voyage just completed, which differ so entirely from the previous one? We are so far from the presumption of imagining that we have acted with more energy and determination than others before us, that we, ourselves, do not think of desiring to place our little undertaking, as a genuine expedition, on the same footing with former ones. The solution of the riddle lies simply in this fact, that almost all expeditions to this region of the sea have started too early and returned too early, since the most favorable time for the navigation comes in the autumn.

All of these expeditions, too, have hugged too closely, either the coast of Nova Zembla or of Spitzbergen; while it seems to be the case that the portion of the Nova Zembla sea most favorable for reaching the north lies between the 40th and 42d degrees of longitude. We have here, without trouble, reached almost to 79° N. lat., and nothing, except want of provisions, prevented our penetrating farther to the north.

The Gulf-Stream appears to be the most probable cause of this remarkable condition of the ice, in the autumn, in the Nova Zembla sea, which is not to be compared, on the whole, with that on the coast of Greenland. Until the observations already made have been brought together and compared, this cannot be asserted with certainty, but only advanced as probable. In our opinion, however, these facts bear on the subject, viz: the temperature of the water in these high latitudes (in September) exceeding that of the air by 2° to 5° C.; the prevalence of mist, and of thunder storms; the appearance of a sky peculiar to the trades; the constant current toward the north on the coast of Nova Zembla; the ultramarine-blue color of the water, characteristic of the Gulf Stream; the remarkable wealth of the waters in the inferior animals, etc. It appears, then, that in the commencement of autumn the Gulf Stream leaves the coast of Nova Zembla, and advances westward, but that then it extends over a broader surface. This layer of warm water is of unequal depth, and diminishes in strength to the north.

An economical result of this expedition is the discovery of the enormous richness of the hitherto quite unexplored Nova Zembla sea in walrusses.

The scientific work accomplished during the voyage consists of a continuous series of observations of the temperature and density of the water, at the surface and at different depths; systematic meteorological observations in regard to the occurrence of banks, driftwood, currents in a double and, in part, three-fold series of deep sea soundings, declination determinations, geological investigations, collections of plants and rocks, etc.

Coast of Norway, on board the Harald Haarfagr, Oct. 9, 1871.

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## SCIENTIFIC INTELLIGENCE.

### I. Chemistry and Physics.

1. *On a new method of nickel-plating.*—Within the last few years a process of nickel-plating by electrolysis has been invented by Mr. Isaac Adams of Boston, and is now employed to a considerable extent in all of our large cities. Mr. Adams' process, which is patented, involves the employment of a bath of double sulphate of nickel and ammonium and of an anode of cast nickel.

The prices charged by companies working under the patent are extremely exorbitant, and as a coating of nickel is an excellent preventive against rust and injury by acid vapor, chemists will give a hearty welcome to a simple and cheap method of nickel-plating, which is open to the use of all. The process, which is due to Prof. F. Stolba, is as follows: The salt of nickel may be the chloride, sulphate, or double sulphate of nickel and potassium. It need not be chemically pure, but must contain no metals which are precipitated by zinc. In addition the operator will require a solution of chloride of zinc, obtained by dissolving commercial zinc in common chlorhydric acid, cuttings of sheet zinc, zinc-dust and pure chlorhydric acid. The process of plating may be effected in a vessel of porcelain or metal; the author prefers copper, which itself becomes plated with nickel. The articles to be plated may be of cast or wrought iron, steel, copper, brass, zinc or lead. They must be completely immersed in the liquid used for plating, and their surfaces must be perfectly free from fat and rust. Iron vessels may be cleaned by treating with a solution containing 3 or 4 per cent of chlorhydric acid. A sufficient quantity of a concentrated solution of chloride of zinc is now poured into the plating vessel, and from once to twice its volume of water added. The solution is then to be heated to the boiling point, and chlorhydric acid added drop by drop until the precipitate, formed by diluting the chloride of zinc with water, is redissolved. As much zinc-powder as will cover the point of a knife is then added, by which the metal of the vessel becomes, in a few minutes, plated with zinc wherever it is in contact with this liquid. Enough nickel-salt is then to be introduced to color the liquid distinctly green, after which the articles to be plated, and with them some small cuttings of zinc, are to be put in, care being taken to afford a sufficient number of points of contact. The liquid is then to be boiled, when the nickel is soon precipitated, and the work is finished in about 15 minutes. If particular parts of the articles are not plated, the boiling must be continued, fresh pieces of zinc, and, if necessary, fresh nickel salt, being added. It is important, if the coating of nickel is to be brilliant, that the liquid on boiling shall not be cloudy from basic zinc salt, or acid from free chlorhydric acid. The nickel-plated articles must be well washed with water and then cleaned with polishing chalk. The author found that articles of copper, plated with nickel, after several months' exposure to the atmosphere of the laboratory, appeared scarcely tarnished. It is important to remark that the same liquid may be employed repeatedly for nickel-plating, especially when chloride of nickel is employed. The same process applies to cobalt, but the coating with this metal, besides its cost, possesses no practical value.—*Polytechnisches Journal*, cci, p. 145 (July, 1871). W. G.

2. *On the direct oxidation of carbon to mellitic acid.*—At the recently held 44th meeting of German scientists and physicians, at Rostock, Prof. Schultze exhibited to the chemical section his beautiful process for the oxidation of carbon by hypermanganic acid,

in an alkaline solution. Pure wood charcoal, ignited in a current of chlorine gas, was employed. The products of this oxidation were oxalic acid in large quantity, other organic acids and mellitic acid. The identity of the acid was established by the highly characteristic reaction resulting in the formation of euchron and by distilling the acid with soda-lime. In this case benzol was formed, which was then converted into nitro-benzol and aniline. Schultze's very beautiful discovery furnishes a new synthesis of benzol and its immense and important series of derivatives, and chemists will look with great interest for the publication of the author's complete research.—*From a letter of v. Meyer in Berichte der Deutschen Chem. Gesell.*, Band iv, 1871, p. 801. W. G.

*Gmelin–Kraut: Handbuch der Chemie.*—All chemists will heartily welcome a new edition of Gmelin's indispensable Handbook, the inorganic portion of which has long been behind the science of the day, though still often consulted and never superceded. We have before us the first, second, third and fourth Lieferungen of the second division of the first volume, and the first and second Lieferungen of the third volume. The entire work is under the charge of Prof. Kraut, with Professors Naumann and Ritter and Dr. Jörgensen as collaborators, to ensure its rapid completion. The favorite old treatise appears with a larger and clearer page and better type, and, apparently, with no abatement of its former thorough and conscientious exhaustion of every topic treated. W. G.

*Neues Handwörterbuch der Chemie.*—We have also to welcome a new edition of the Handwörterbuch, the second supplement to which was completed a few years ago. The work is under the charge of Prof. von Fehling, with the assistance of nearly all the most prominent German chemists. Two Lieferungen of the first volume are published, and the entire work is to embrace six volumes. The type is much smaller than that employed in the first edition, but is clear and handsome. The new system is adopted throughout. The work promises to be a noble addition to chemical literature, but it is earnestly to be hoped that its publication will be pushed forward with all possible energy, and that, as in the earlier edition, the first volume will not be out of date before the last is begun. W. G.

## II. Geology and Natural History.

1. *Discovery of a remarkable Fossil Bird;* by Professor O. C. Marsh. (From a letter to Professor Dana, dated San Francisco, Cal., Nov. 29th, 1871.)—One of the treasures secured during our explorations this year was the greater portion of the skeleton of a large fossil bird, at least five feet in height, which I was fortunate enough to discover in the Upper Cretaceous of Western Kansas. This interesting specimen, although a true bird—as is clearly shown by the vertebræ and some other parts of the skeleton—differs widely from any known recent or extinct forms of that class,

and affords a fine example of a comprehensive type. The bones are all well preserved. The femur is very short, but the other portions of the legs are quite elongated. The metatarsal bones appear to have been separated. On my return, I shall fully describe this unique fossil under the name *Hesperornis regalis.*

2. *Occurrence of Diamonds in Xanthophyllite;* by P. v. JEREMEJEW.—In the xanthophyllite of the Schischimskian Mountains, near Slatoust, v. Jeremejew has observed diamonds of varying size irregularly distributed through the plates of the mineral. When magnified 30 diameters they are readily recognized, and with 200 diameters their crystalline form is seen to be that of the hexa-tetrahedron $3\text{-}\frac{3}{2}$, combined with the tetrahedron, the faces of the first form being distinctly convex, those of the latter flat [like fig. 59 in Dana's Min., p. 21, except that there are also small flat planes of the tetrahedron]. Most of the crystals are colorless and quite transparent; some have a pale brown tint. They are symmetrically disposed in the matrix, their trigonal intermediate axes being vertical to the foliation of the xanthophyllite. The green plates of this mineral, nearest the rounded masses of talcose slate and serpentine, enclose unusually large numbers of them, and they are likewise found in the two rocks themselves.—*Jahrbuch für Mineralogie,* 1871, p. 275.

3. *Triassic Sandstone of the Palisade Range.*—The composition of this rock from New Jersey localities, as obtained by Dr. P. Schweitzer, is given on page 459 of the last volume of this Journal, and the name felsite was cited from the same paper, as proposed by Prof. Henry Wurtz. In a letter recently received from Prof. Wurtz, we are informed that he has not applied that name to the rocks. He has a communication on the subject in the Proceedings of the N. Y. Lyceum of Natural History for Nov. 14, 1870, containing his own analyses and giving the same feldspathic constitution essentially to the rock. He found the shaly beds to have a density of 2·84, and inferred that they consisted essentially of disintegrated mica. He states in his letter that Dr. Schweitzer's analyses were made at the instigation of Dr. Newberry, with a view to test the ideas previously deduced by him. He questions whether the albitic character of the material of the sandstone may not be owing to the alteration of oligoclase to albite, and purposes to further investigate this point.

4. *Geological Survey of India.*—Volume III, Nos. 1 to 8, of the Palæontologia Indica connected with the Geological Survey of India, issued in 1870 and 1871, in all 410 pages 4to, with many plates, contains an account of the Cretaceous Pelecypoda of India, by Ferd. Stoliczka, Paleontologist of the Survey; the plates, 28 in number, are full of good figures. Vol. IV, Part I, contains a memoir, by Prof. Huxley, on the Vertebrate fossils of the Panchet rocks.

Volume VII. of the Memoirs of the Survey (8vo) treats of the Vindhyan Series in the N. W. and Central Provinces, by F. R. Mallet; of the Mineral Statistics of India, by Thos. Oldham, the Director of the Survey; Geology of the Shillong Plateau, by

H. B. Medlicott; and on the Kurhurbari, Deoghur and Karanpura Coal-fields, by T. H. Hughes.

The Records of the Survey which have appeared once in three months, contain many valuable papers on the Geology and productions of India, some of them illustrated by maps.

5. *Friderici Welwitschii Sertum Angolense.* 4to, pp. 94, tab. 25. Part 1 of vol. xxvii of the Transactions of the Linnean Society, 1869.—The most remarkable plant of a truly extraordinary flora is that which commemorates its discoverer, the *Welwitschia mirabilis*, which Dr. Hooker fully illustrated in a former volume of the Linnean Transactions. Of this strangest of plants, and of Dr. Hooker's almost exhaustive treatise upon it, we rendered some account at the time. Dr. Welwitsch now publishes a selection of a goodly number of very interesting plants from his Angolan and Benguelan collections, chiefly new genera or remarkable species; and the excellent plates are from drawings by Fitch. Upon some of the plates the aspect of the whole plant is delineated, e. g., *Pachypodium Lealii* and *Sesamothamnus Benguellensis* which, with some most bizarre species of *Vitis* and with *Welwitschia* itself, make the principal part of a queer pigmy-tumid arborescent growth, in a region too arid for ordinary vegetation. Another subject, *Acanthosicyos horrida*, is a Cucurbitaceous shrub, spiny and nearly leafless, with somewhat the aspect of a Furze or Broom, which in these same deserts bears a grateful acidulous fruit, larger than an orange, and sometimes as large as an ostrich's egg; the fleshy and oily seeds of which are also edible. As a solitary exception to the rule that all *Cacteæ* are American, *Rhipsalis Cassyta* is proved to be indigenous to a long stretch of tropical Africa; and we are now informed that our *Brasenia peltata*, having been found already in Oregon, Japan, N. E. India and Australia, has been detected in tropical Africa, solely in lake "Ivantalla," 5,000 feet above the Atlantic coast and about 120 geographical miles in the interior. Another North American genus, until now monotypic, is unexpectedly found to have an African representative, in *Brunnichia Africana*, discovered at a cataract in a wooded district, less than 2,500 feet above the level of the sea. *Pilostyles Æthiopica* represents another American type. As all the species known before are parasitic upon Leguminous shrubs or trees, this also grows upon *Berlinia paniculata*, a Cæsalpineous tree. *Aristida prodigiosa*, a grass which flourishes on the sandy hills of the most arid of regions, on account of its grayish hue hardly distinguishable from the sand in which it grows, furnishes the sole support of multitudes of zebras, antelopes, &c., throughout the long dry season. The force of Linnæus' remark, that there was always something new and strange coming from Africa, is not yet exhausted. A. G.

6. *Hooker's Icones Plantarum.* Third Series, vol. 1, part 4. January, 1871.—This completes the first volume of the revived Icones Plantarum, of which ten volumes (a thousand plates) were

published by Sir William Hooker. We received and duly noticed the first two parts of the new issue. The third part, by some mishap, has not been received, which we regret the more on account of its containing some new genera of Sandwich Island *Rubiaceæ*, in which our interest is renewed since Dr. Hillebrand has brought hither, and is now elaborating, his large recent collections of Hawaian plants. The most interesting plants of the part now before us are the following: *Ranunculus limoselloides*, of New Zealand, which "mimics," as the expression goes, a *Limosella*. *Chalepoa Magellanica* Hook. f, a Fuegian plant, with much the habit of *Diapensia* or rather *Pyxidanthera*, which has been for years somewhat known, and has puzzled the few botanists who have examined it, but only now published, and, for lack of any happier guess, is doubtfully referred to the *Pittosporeæ*. *Raphanocarpus Kirkii* Hook. f, an African Cucurbitaceous plant, which, with one erect and one suspended ovule, confirms the idea already entertained, that the primary divisions of this order in the new Genera Plantarum are not so well founded as could be wished. *Phyllacanthus Grisebachianus* Hook. f, the plant of C. Wright's Cuba collection named by Grisebach *Catesbæa phyllacantha*. *Brackenridgea Zanguebarica* Oliver, a second species, so far confirming the genus. A. G.

7. *Structure of the Pistil in Primulaceæ.*—Van Tieghem, upon his first study of the ovary of *Primula*, &c., finding that the vascular bundles of the free central placenta were disposed in a circle in a homogeneous parenchyma, adopted the apparently prevalent view that this placenta belongs to the axis and not to the carpels, this arrangement being that characteristic of stems. But further and more scrutinizing observations show that this conclusion does not follow. Without known exception, the vascular and woody bundles of stems have their spiral vessels on their inner face, their liber or bast cells on the outer face, i. e., presented to the circumference of the stem. Now Van Tieghem finds that the bundles in the placenta of *Primula* and other plants of the same order (as likewise in *Caryophyllaceæ*, &c.) present their liber-cells inward, their spiral vessels outward, contrary to the manner of vascular bundles of stems. These bundles originate in connection with those which pass into the ovarian walls, and which correspond to the margins of the five carpels; passing into the placenta they ramify, and the ovules are borne at their terminations. He then examined the outer floral whorls in cases where their parts produce an accessory piece or appendage on the inner face or at its base, such as the petals of *Ranunculus*, of Oleander, the crown of the perianth of *Narcissus*, the stamens of *Cobæa*, &c. In all these the vascular bundles of the internal appendage or crown equally have their liber-cells facing toward the axis of the flower, their spiral vessels turned from it. Van Tieghem therefore concludes that, as these accessory pieces are appendages or deduplications of the petals, stamens, &c., so the free central or basilar placenta consists of internal appendages or deduplications of the

carpels; also that each ovule answers to the lobe of a leaf. See Ann. Sci. Nat. for 1869, published in 1871. In a following paper, on *The Anatomy of the Flower of Santalaceæ*, Van Tieghem demonstrates an analogous structure in the flower of *Thesium* and *Osyris*, and draws the conclusion that each ovule, one for each of the three carpels, is the termination of an internal appendage or *talon* of a carpel. From a corresponding study of the vascular bundles of the sepals and superposed stamens, he likewise infers that the stamen is not autonomous, but is theoretically a petiolate internal appendage of the sepal behind it. Thus he homologizes the blossom of *Thesium*, &c., with that of Mistletoe, in which, according to his view (as already mentioned), the stamen and sepal, also the ovule and the carpel, each answer simply to one leaf; in the Mistletoe confounded without distinction farther than that the inner face is polleniferous or ovuliferous, according to the sex; in *Santalaceæ* a differentiation into separate organs, the ovule being here a separate and special lobe of the carpel. Thus, he concludes, disappears another example of so-called axile placentation, as it falls under the general law which he expresses essentially as follows:—The embryo-sac is always a cell of the parenchyma of a carpellary leaf; the ovule which contains this sac is always a lobe or part of the tissue of this leaf—more or less transformed, more or less separated from the rest of the leaf. A. G.

8. *Tieghem, Comparative Anatomy of the Cycadaceæ, Coniferæ, and Gnetaceæ.*—The principal results of this investigation (communicated to the French Academy of Sciences, published in Ann. Sci. Nat. for 1869) are given by the author in a *resumé* in Bull. Soc. Bot. France, March, 1870. To determine whether the ovules or whatever they be, are borne on a leaf or a branch, Tieghem examined the distribution of the vascular bundles, in the same manner as in his later investigations upon the placenta of Primula and the flowers of Mistletoe. This new evidence led him unequivocally to the conclusion, that

*Cycadaceæ* are gymnospermous; the leaves, produced directly on the axis of the female bud, develop ovules on their margins, so that each is an open free carpel.

*Coniferæ* also have naked ovules borne upon a leaf, but not upon leaves of the primary axis, i. e., upon bracts of the first order. The ovules are always borne upon the dorsal face of the first and only leaf of an axillary branch, which is therefore an open carpel, constituting the female flower. This leaf is always inverse, i. e., is directly opposite the subtending bract, so that this bract and the carpellary leaf face each other. The principal variations of this universal plan are the following.

This axillary branch reduced to its first leaf, and ovuliferous, is commonly of the second generation; but sometimes of the third (*Cephalotaxus* and *Taxus*), or even of the fourth generation (*Torreya*).

The carpellary leaf bears the ovules either on its base (*Thuja*, *Cupressus*, &c.), or on its middle (*Pinus*, *Sequoia*, &c.), or toward its summit (*Cunninghamia*, &c.); the ovules thus correspond each to the lobe of a leaf. In other cases the ovules terminate the leaf; then each half of the blade may be transformed into an ovule (*Ginkgo, Cephalotaxus*), or the whole blade may be transformed into a single ovule (*Taxus, Phyllocladus Podocarpus*); sometimes the petiole is much lengthened (*Ginkgo*), but oftener it is very short, and the carpellary leaf is then wholly transformed into two ovules (*Cephalotaxus*), or into a single one (*Podocarpus*).

The carpellary leaf is distinct throughout its whole length in *Pinus, Ginkgo, Podocarpus*, &c. Sometimes a sheath of parenchyma unites the vascular systems of the opposed bract and carpel more or less, so that they may be free only at the summit (*Thuja, Cupressus*, &c., *Sequoia, Arthotaxis*, &c., *Araucaria, Dammara*, &c., *Darydium*). The difference here is like that between superior and inferior ovary, so that one may say that certain *Coniferæ* have a free or superior, others an inferior or adherent ovary.

It follows that *Coniferæ* form one indivisible natural family,—are all reducible to one and the same type.

*Gnetaceæ* are half way between the ordinary *Gymnospermæ* and other Phænogamia. *Ephedra* has an ovary, indeed, but it is an open one, and without style or stigma. It is gymnospermous as to fecundation, as the action of the pollen upon the ovule is direct; but angiospermous as to fructification, as the fertilized ovule undergoes its transformations within a closed cavity, proper to each flower, and formed by the infolding of the leaf to which the ovule belongs.

Such are the principal features of a view which throws new light upon the morphology of the Gymnospermous plants, vindicates their claim to this name, and carries throughout a high probability of its essential correctness. A. G.

9. *Van Tieghem, Anatomy of the flowers and fruit of Mistletoe* (*Viscum album*).—Upon this subject the distinguished Dutch Vegetable Anatomist has published in Ann. Sci. Nat., ser. 5, t. 12, an elaborate and interesting, albeit considerably theoretical. paper, following up the line of research, and the ideas which he had pursued with great advantage in his earlier memoir on the floral structure of Gymnosperms, and determining whether an organ is of cauline or of foliar nature by studying the plan of the arrangement of its vascular bundles. Van Tieghem stoutly maintains that ovules in all cases pertain to a carpellary leaf, never to the axis; that the ovule is not an axis nor a bud, nor yet an organ *sui generis*, but is a dependance of a leaf,—a lobe (as it were) of a carpellary leaf transformed, to protect the embryo-sac and to aid in its fecundation; that in *Viscum* this ovule is reduced to the greatest possible simplicity, viz: to its essential part, the embryo-sac. His main conclusions are,—

(1.) That the male flower consists of four simple leaves only, that is, of two decussate pairs, each polliniferous upon the superior or inner face, and not of 8, as before supposed, i. e., 4 sepals and 4 stamens superposed to and connate with them.

(2.) In the female flower the ovule is reduced to an embryo-sac, which is a cell of the parenchyma of the base of the upper face of the third pair of bracts, i. e., the carpels. A. G.

10. *Clarence King's Geological Exploration of the 40th Parallel: Botany*, by SERENO WATSON, aided by Prof. DANIEL C. EATON and others. Illustrated by a map and 40 plates. Washington: Government Printing Office, 1871. pp. 525, 4to.—We propose to notice this volume particularly: indeed it well deserves a more thorough examination and more extended review than our time and space will now allow us to devote to it. It is published "by order of the Secretary of War, under the authority of Congress," as one of the Engineer Corps series, has been carefully edited and beautifully printed, so that the volume is every way an attractive one. Errors of the press are to be found, but they are apparently few, and the whole typography is remarkably excellent for the Government Printing Office. Our comparison is naturally with corresponding volumes of the Pacific Rail-Road Survey, and of the Mexican Boundary Survey, upon which the present volume is a notable improvement. The forty plates, filled with well chosen subjects, if not of the very highest style, are so well done and of such excellent promise that the name of the draughtsman (who is new to this class of work, we believe), Mr. J. H. Emerton, of Salem, Mass., should properly have been appended to them.

The General Report, of 53 pages, forms a separately-paged introduction to the "Catalogue," as it is termed, with excessive modesty, i. e., the systematic account of the plants collected, which makes up the principal bulk of the volume. This General Report will naturally be most interesting to general readers and naturalists, but no less so to special botanists. It is thoroughly readable matter; and we expect to see it reproduced in the scientific journals. Four or five pages sketch the geographical features of the region, tersely and clearly. But, when a stream of water is said to "become *demoralized* with alkali and is lost," we could wish that this popularized use of the word were buried with it. The meteorological notes, with tabulated observations by thermometer, evaporator, &c., are equally interesting, displaying the dryness of the Great Basin, its cold winters, and hot summers. The notes on the general character of the vegetation picture to us the botanical aspect of the region, the relative prevalence of the predominant species, the slow and cross-grained growth of what timber there is in the cañons, &c. A dead branch, apparently of *Pinus monophylla*, 8 inches in diameter, had the fibres so twisted that in 7 feet they made four complete circuits. A saw-mill in Ruby Valley offered the opportunity of ascertaining the age and dimensions of several specimens of *Pinus flexilis* from the upper cañons of the Humboldt Mountains; sections from 22 to 30 inches in diameter showed from 400 to 486 annual rings. The "everlasting sage-bush," *Artemisia tridentata*, displayed 65 rings on a section 8 inches in diameter, 37 upon 4 inches, &c. A *Juniperus occidentalis* 12 inches in diameter showed 250 rings. *Cercocar-*

*pus ledifolius*, it appears, may form a trunk of 2 feet in diameter, with 160 rings. The alkaline species, aquatic and meadow species, those of the drier valleys and foot-hills, the mountain species, &c., are separately enumerated; the introduced species, about 30 in number, are recorded, and finally the number of indigenous genera and species is given under their orders, and their distribution in the basin or over the borders on either side is tabulated. Of the 1141 species of the basin and of the Wahsatch and Uintas, 60 per cent. appear to inhabit also the Pacific slope, about 60 per cent. are not found east of the Rocky Mountains, 15 per cent. only approach the Mississippi or the Saskatchawan, 25 per cent. approach the Atlantic, 17 per cent. are Mexican or southern, and nearly 15 per cent. are Arctic.

A few pages at the close are devoted to the consideration of the agricultural resources of the basin, the limit to which is fixed by the deficiency of water. "The most fertile localities lie at the base of the sierras; but, as a rule, there is an apparent absence everywhere of a true soil or mould resulting from the decomposition of vegetable matter." A moderate amount of alkali in the soil appears not to be detrimental to culture. The soil which produces "sage bush" seems to be always cultivable when it can be irrigated. With the present supply of water, most economically used, it is thought that only one thousand out of 34,000 square miles of Northern Nevada could be brought under cultivation; of the southerly portion and of Western Utah much less. Eastern Utah, with larger and more constant supplies of water from the Wahsatch and the Uinta mountains, is much more favorably situated. The absence of graminivorous animals, excepting rabbits in the valleys and rarely a few mountain sheep or antelopes in the higher ranges, shows that the country is ill adapted for grazing. *Eurotia lanata* and a few other chenopodiaceous plants are eaten by sheep as a substitute for grass.

Mr. Watson raises the question whether—considering the amount of low shrubby and perennial vegetation which inhabits the plains and thrives without irrigation,—these plants themselves, or some more serviceable substitutes equally adapted to the climatic conditions, may not be turned to some profitable account under the necessities of a future population; and whether, in time to come, some forms of orchard, vineyard, or tree culture may not possibly be made to thrive in that region. He finds that the present plants on the whole are not lacking in expansion of foliage or succulence, at least that the more prevalent plants had an average of from 55 to 80 per cent of foliage or working surface; and a series of rough, but seemingly well devised experiments demonstrated that they give off by evaporation daily an amount equal to three-eighths of the weight of their available material. Dry as the soil appears to be, it is this, and not the atmosphere that must furnish the supply to make good this loss. Yet water is rarely to be had under a depth of 100 to 300 feet, often not even at that depth. The porous soil must allow of the free upward diffusion of moisture, also of deep penetration of the roots from above.

An excellent map is given, exhibiting the district from above the 42d parallel to below the 39th, on which the routes of the three several years are traced in colored lines, and the mountain ranges with the general configuration of the surface represented. We will endeavor hereafter to review the systematic part of this work. A. G.

11. *Prof. Oliver's Flora of Tropical Africa*, vol. ii (Reeve & Co., London, 1871), has just been received. It comprises the Polypetalous orders from *Leguminosæ* to *Ficoideæ* inclusive. The first of these orders fills over half of the volume; the Papilionaceous portion is by Mr. Baker, the other suborders, both largely and interestingly represented, are by Prof. Oliver himself. Of *Cæsalpinieæ* in particular there are several remarkable and peculiar genera. Prof. Oliver also elaborated the *Rosaceæ* and *Saxifragaceæ*, which are scanty, as well as other small families; Mr. Britten, one of the promising assistants at Kew, now transferred to the British Museum, has done the *Crassulaceæ;* Professor Lawson of Oxford, the *Combretaceæ* and the few *Myrtaceæ:* Dr. Hooker, the *Melastomaceæ*, which are considerable; Mr. Hiern of Cambridge, the *Lythraceæ;* Dr. Masters, the *Samydaceæ* and *Passifloreæ;* Dr. Hooker, the *Cucurbitaceæ*, which are represented by 34 genera, also the *Begoniaceæ;* and Prof. Oliver concludes with the somewhat miscellaneous group named *Ficoideæ*. The contrast continues notable between the miscellaneous character of Tropical African Botany, and the most peculiar character, richness and great diversity of South African vegetation. A. G.

12. *Heer: Flora Fossilis Arctica. Die Fossile Flora der Polarländer*, 2ter Band mit 59 Tafeln. 4to. (Winterthur, Würrter & Co., 1871.) This second volume of Heer's Arctic Fossil Flora is a collection (with title page, preface and index) of the following papers:—

(1.) *Contributions to the Fossil Flora of North Greenland, being a Description of the Plants collected by Mr. Edward Whymper during the summer of* 1867. This is from the Philosophical Transactions of the Royal Society, London, 1869, and is in English, illustrated by 18 plates.

(2.) *Flora Fossilis Alaskana*, with 10 plates. This is a paper contributed to the Transactions of the Royal Swedish Society of Sciences, Stockholm, 1869. It is in Latin, with a preface in German.

(3.) *Der Miocene Flora und Fauna Spitzbergens*, &c., with 16 plates—from the Transactions of the same society. This is in German, but with Latin diagnoses of species.

(4.) *Fossile Flora der Bären Insel*, with 15 plates—from the same Society's Transactions, 1870: in German and Latin. The plants described are of the coal formation.

The very interesting results which these memoirs contain have already been brought to our notice in this Journal. A. G.

13. *On Kansas Vertebrate Fossils.*—Prof. E. D. Cope has given a brief account, in the Proceedings of the Philosophical Society of Philadelphia, October, 1871, of some fossil vertebrates in the collections of the State Agricultural College of Kansas. They include the following species:

*Liodon dyspelor* Cope, now for the first time announced as a Kansas species; a species of Liodon near *L. proriger* Cope, and another near *L. ictericus* Cope; *Liodon latispinus* Cope, a new species of large size, nearly equalling the *L. Mitchillii*, that is 40 or 50 feet long; *Clidastes Wymanii?* Marsh; *Clidastes cinerarium* Cope; Ichthyodectes near *I. ctenodon* Cope; *Anogmius contractus*, a new genus and species, near *Ichthyodectes* in the vertebræ wanting lateral grooves, but like those of *Saurocephalus* in having the basal elements of the neural and hæmal elements not coössified with the centrum; a *Saurocephalus* near *prognathus* of Cope.

Professor Cope also gives brief notices of some fossils observed by himself on an excursion in the valley of Smoky Hill River, in Kansas. On Butte Creek a large part of the skeleton of a monster saurian, the *Liodon dyspelor* Cope, was exhumed. On the same bluff another Liodon and a Clidastes were discovered, with some fossil fishes. In neighboring bluffs, bones supposed to be those of a *Pterodactyl*, of two species of *Clidastes*, a *Dinosaur*, a Crocodile and of numerous fishes were brought to light.

At a similar location on Fox Creek, M. V. Hartwell found the skeleton of a very large fish, with "uncommonly powerful offensive dentition," probably of the Saurodonts. He names this Cretaceous species *Portheus molossus*. In the same region the very slender bones of a reptile were obtained, probably of the Testudinates, which he named *Protostega gigas*. The remains of a large *Liodon proriger* Cope, were found scattered, "his huge truncate, browsprit-like snout betraying his individuality at once;" also others of several species of *Clidastes*. Near Russel Springs, on the Smoky Hill, twenty-six miles distant, a large *Clidastes* was found, also bones of *Liodon ictericus* and of two new Clidastes.

Prof. Cope adds that the giants of this Cretaceous sea were the *Liodon proriger* Cope, *L. dyspelor* Cope, *Polycotylus latipinnis* Cope, and *Elasmosaurus platyurus* Cope. Of these, the first was apparently the most abundant; the second was the longest, exceeding in length perhaps any other known reptile; the last named had the most massive body, and exhibited an extraordinary appearance in consequence of the great length of its neck.

14. *Illustrated Catalogue of the Museum of Comparative Zoölogy.* No. IV. *Deep-Sea Corals;* by L. F. de Pourtalès. Cambridge, 1871. 93 pp. quarto, with eight lithographic plates.—In this work, all the stony corals which have been dredged during the several expeditions made by the U. S. Coast Survey for the purpose of exploring the bed of the Gulf Stream, off Florida, are fully described, and most of them are beautifully figured. The work is not only the most complete account that has yet appeared

of any group of deep-sea animals, but is also a very valuable contribution to the history and classification of corals. A large number of new forms, both of genera and species, are described, and important points in the structure and affinities of certain genera and species are discussed at length. It is accompanied by tables of the distribution of the species in depth, and the appendix contains an enumeration of the shallow water and reef-corals of Florida, with valuable notes upon their synonymy, modes of occurrence, etc.

The introduction contains a history of the expeditions, together with an account of the configuration and character of the bottom along the several lines of soundings and dredgings.

The whole number of corals obtained from deep-water is 48, of which three were dead, and probably accidentally transported from shallow waters. Of these, 28 species occurred at depths exceeding 200 fathoms, and 17 below 300 fathoms, though several of the latter were perhaps transported from somewhat shallower waters. Of reef-corals 49 species are enumerated, two of which are Millepores, belonging to the Hydroidea.

In several instances the writer would disagree with Mr. Pourtalès in reference to the synonymy of species and higher groups, as well as in respect to their affinities and classification, but a discussion of these points would lead too far for the present occasion. In general the classification of Milne Edwards and Haime has been followed, but several important and judicious changes have been adopted from others, and some new ones have been introduced. Among others the following points seem to require special notice. Turbinolidœ of E. and H., as adopted by Mr. Pourtalès, is erroneously made synonymous with Caryophyllidæ Verrill.* The latter included only a part of the former group, the second part having been made a family under the former name. Stylophoridæ had previously been characterized as a family by the writer in the work referred to in the note. In the same work the writer has shown the necessity of uniting the Cladocoraceæ and Astrangraceæ into a single family, the distinctions being hardly of generic value, and yet they are still kept apart by Mr. Pourtalès. The family Stylasteridæ Gray (emended), is fully discussed on page 32, and some additional facts of importance are given in regard to their structure. The observation that they have finely porous corals is new and interesting, and with other characters renders it probable that they should be referred to the Madreporacæ (Perforata of Edwards and Haime), as suggested by the author, who however hesitates, apparently unnecessarily, to make the change. We may add that other characters, making this view still more probable, are the small number of septa, and the depth and narrowness of the cells, and consequent elongation of the polyps,—features very characteristic of the Madreporaceæ. The polyps are still unknown in all the genera of this family. Although agreeing with Mr. Pourtalès in regarding the Eupsammidæ as a group of full

* Transactions Connecticut Academy, vol. i, p. 535, 1870.

family rank, we do not see any reason for separating it very widely from the Madreporidæ or in approximating it to the Turbinolidæ. The resemblances to the latter are very superficial, while it is united to the former by many intermediate forms. To *Isophyllia Guadulpensis* (p. 71), *I. rigida* Verrill is referred as a synonym, on the ground that it is not the *Astræa rigida* Dana. The latter identification is, however, correct, and was made after a careful examination of Dana's type. which had the septa and walls considerably worn. Ellis and Solander are given as the authority for *Mæandrina clivosa* Verrill, but their name was *Madrepora clivosa.* The name *Astræa* should be adopted instead of *Fuvia* (p. 75), for *A. rotulosa* was made the type of the genus by Lamarck in 1801 when it was first proposed, and he mentioned only one other species (*A. radians*) which he referred to a second division of the genus and which now forms the type of the genus *Siderastræa*, belonging among the Fungians. We see no reason whatever for supplanting the oldest name of the latter species (S. radians) by a later one, as has been done by Mr. Pourtalès.

Among the genera now first made known as belonging to the fauna of Florida and the West Indies are *Fungia*, *Dendrophyllia*, *Astrocœnia* and *Colangia*, the last a new genus allied to *Phyllangia.* A. E. V.

## III. Astronomy.

1. *On the mean motions of the four outer Planets.* (Extract from a letter of Prof. Benjamin Peirce to Prof. Newton, dated Dec. 13th, 1871.)—I have discovered three fixed equations between the mean motions of the four outer planets. If the mean motions of Jupiter, Saturn, Uranus and Neptune are respectively represented by $n^{\text{v}}$, $n^{\text{vi}}$, $n^{\text{vii}}$ and $n^{\text{viii}}$, these equations are

$$4n^{\text{vi}}+9n^{\text{viii}}=16n^{\text{vii}}$$
$$2n^{\text{v}}+17n^{\text{vii}}+6n^{\text{viii}}=12n^{\text{vi}}$$
$$3n^{\text{vii}}+8n^{\text{viii}}=n^{\text{v}}$$

Of the fixedness of the first of these equations I have no doubt; and am almost equally certain of the second, but feel rather more doubt concerning the third. Their reception involves a laborious revision of the theory of these planets, which I cannot hope to have the strength to accomplish, and must seriously change the elements of their orbits. If all the three equations are admitted, the mean motions of three of these planets can be computed when the fourth is given. Thus, I find

$$n^{\text{v}}=109256''\cdot719\ (1+\lambda)$$
$$n^{\text{vi}}=44001''\cdot8054(1+\lambda)$$
$$n^{\text{vii}}=15428''\cdot1822(1+\lambda)$$
$$n^{\text{viii}}=7871''\cdot5215(1+\lambda)$$

in which $\lambda$ is a correction to be ascertained after the revision of the theories.

If the third equation is rejected, the other two will give the mean motions of two of the planets when two are known. I have found in this case,

$$\begin{aligned} n^{\mathrm{v}} &= 109256''\cdot719+249\lambda \\ n^{\mathrm{vi}} &= 43996''\cdot127 \qquad +249\lambda' \\ n^{\mathrm{vii}} &= 15425''\cdot172-18\lambda+132\lambda' \\ n^{\mathrm{viii}} &= 7868''\cdot694-32\lambda+124\lambda' \end{aligned}$$

in which $\lambda$ and $\lambda'$ are corrections to be determined after the revision of the theories. I presented my argument concerning the establishment of these equations to the American Academy last evening. Even if they should be finally rejected, it is evident that in the present uncertainty, the corresponding planetary inequalities are so exceeding long, and of such uncertain length, that it will be necessary to present the corresponding perturbations in the same way as if they were exact.

2. *The Eclipse.*—The telegraph informs us that the eclipse observations on the 12th of December were successful, the weather being very favorable.

The expedition from England under the charge of Mr. Lockyer was destined for Jaffua in the island of Ceylon. It was joined upon the way by Jannsen and Respighi, from which we presume that the original design of the former to go to Java was given up.

It was expected that East Indian expeditions would occupy one or two stations near the Malabar coast, and one near Trichmopoly. Also expeditions from Australia to the line of the eclipse across the northern part of that continent were projected, and probably carried out.

3. *Star Maps—Suggested Improvement;* by E. S. MARTIN, Wilmington, N. C. (Communicated.)—All those who use star maps to any extent, and without the benefit of an assistant, have felt the inconvenience and loss of time incurred by leaving the telescope to consult the map. And as the light used to illume the maps causes the pupil of the eyes to contract, when a return to the tube is made nothing can be distinctly seen. Especially is this the case when any small stars or faint objects are under examination.

The following method is suggested as, in a measure, capable of remedying the trouble. Instead of stamping the stars on the map, as usual, let punctures be made, differing in size, so as to represent the different magnitudes. When a map thus prepared is spread out, and a light set behind it, all those punctures shine as stars. The eyes suffer no inconvenience from increase of light, and if the map is placed at or near the instrument, one eye may view the map, while the other looks into the tube. Thus a comparison may be made without much effort.

In order to better direct the eye where to look, in a blank sheet of paper, cut a hole the size of the field of view of the telescope, and place this sheet over the map. As successive portions of the heavens are brought into view by the rotary motion of the earth, slip this sheet along. Where wires are used in the instrument, threads may be stretched across the hole in the paper, and thus further assist the eye in the comparison of the map with the heavens.

The writer has himself profited much by this arrangement, he having punctured a common star map for the purpose.

4. *The Wisconsin Meteorite;* by I. A. LAPHAM.—Two additional fragments of this meteorite have been discovered, since the notice in this Journal,* one of $16\frac{1}{4}$ pounds in 1869, the other 33 pounds in 1871, making a total of 143 pounds. These last present the same external characters, and doubtless have the same chemical composition; the six fragments were all found in the same field.

5. *New Comet.*—A comet (1871, V.) was discovered at Milan, by Tempel, on the 3d November. It was small and faint, and with a declination of 9°25′ south (R. A. $18^{h}\ 37^{m}{\cdot}9$) was moving rapidly southward. The following elements are given by Oppolzer in the *Astron. Nachr.*, Nov., 1867, from the observations of the first four days.

$$T = \text{Dec. } 20{\cdot}1155 \text{ mean Berlin time.}$$

$$\left.\begin{aligned} \pi &= 22^\circ\ 25'\ 39'' \\ \Omega &= 145^\circ\ 19'\ 53'' \\ i &= 102^\circ\ \ 7'\ 40'' \end{aligned}\right\} \text{mean eq. 1871.}$$

$$\log q = 9{\cdot}87628$$

The resulting ephemeris gives a south declination of 37° 4′ on the 5th of December.

6. *Magnetometer Indications on September 7th;* by C. A. YOUNG (dated Hanover, Nov. 14, 1871).—Immediately after the remarkable solar disturbance of which a description was given in the last number of the Journal of Chemistry, a letter was addressed to the Greenwich Observatory, requesting information as to the behavior of the magnetic instruments at that moment. In due time, but too late for insertion last month, a courteous reply was received from Professor Airy, inclosing tracings from the photographic record-curves of the declinometer, and of the horizontal and vertical force magnetometers. These are shown in the cut below.

Contrary to my expectation, there was no specially marked disturbance of the magnets *simultaneous* with the "explosion" (if explosion it really was). It is not impossible that the small disturbances indicated on the first and second curves were really caused by it.

Professor Airy writes: "The day was one of magnetic disturbance, but it does not appear that any remarkable movement coincided with the beginning of your observation. There was a sudden movement nearly at the end."

About $2\frac{1}{2}$ hours after the "explosion," the magnetic storm began which developed into the beautiful aurora of that evening.

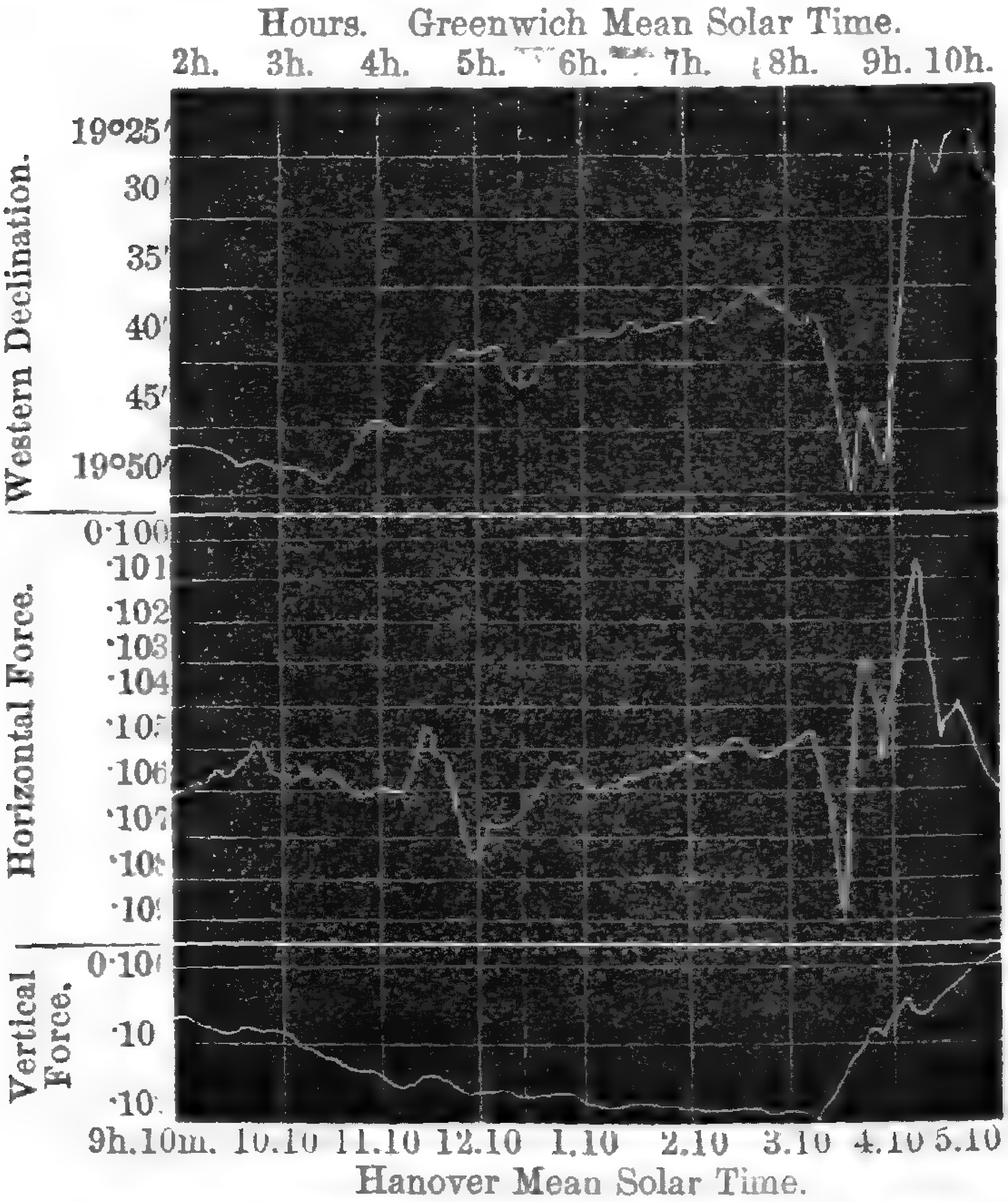
It would seem accordingly either that considerable time is occupied in transmitting a magnetic perturbation from the sun to the earth; or else, what is perhaps more probable, that mere *mechanical* movements in the solar atmosphere, such as the phenomena in question appears to have been, are less efficacious in disturbing

* Vol. xlvii, p. 271, March, 1871.

our magnetometers than certain other actions which are less conspicuous.

*Royal Observatory, Greenwich.*

*Magnetic changes, Sept. 7, 1871, from 2h. to 10h.*




The vertical dotted line indicates the probable time of the explosion, 12h. 40m Hanover time.

While there can be no possible doubt that there is a close connection between the condition of the solar surface and magnetic disturbances on the earth, much further investigation will be required to elucidate the matter.—*Boston Journal of Chemistry, December*, p. 68.

7. *The first Appendix to the Washington Observations for* 1869, being Reports on observations of the total solar eclipse of Dec. 22d, 1870, by the observers of the U. S. N. Observatory, has just been published. Prof. Newcomb arranged to observe at Gibraltar the transits of the sharp cusps of the solar crescent across the wires of a telescope, in order to obtain materials for correcting the lunar theory. The telegraphic determination of the longitude of Gibraltar, which is necessary to the completion of his purpose, was not possible at the time owing to an unfortunate break in the cable. Profs. Hall, Harkness and Eastman, at Syracuse, made successful and detailed observations for time, and upon the nature of the light of the corona and prominences.

Prof. Harkness concludes an extended discussion by proposing this theory of the corona. " When seen in a clear sky the corona is a purely solar phenomenon, produced by a vast body of self-luminous gas,—not improbably incandescent vapor of iron,—which envelopes the sun and is erupted from it in the same manner as the red prominences."

The observers were aided by Capt. Tupman of the British Navy, whose report is also given.

8. *Annals of the Dudley Observatory.* Vol. II.—This second volume of Annals of the Dudley Observatory contains the descriptions of the several self-recording meteorological instruments constructed by the Director, Mr. Hough, a series of hourly observations of barometric pressure during five years, with other meteorological records made at the observatory. In the appendix are observations on the total eclipse of Dec. 1869, on the meteors of Dec., 14th, 1867, &c., and the several annual reports of the Director to the Board of Trustees. Thirty-six charts are added, exhibiting the changes from day to day of the meteorological phenomena during the years 1868–70.

9. *Astronomische Tafeln und Formeln;* by C. F. W. Peters, Hamburg, 1871. (W. Mauke.) 8vo, 233 pages.—This series of tables is for the use of observers with fixed or portable instruments, and for general astronomical computations. It consists of nearly forty numerical tables, followed by a dozen pages of trigonometric and astronomic formulas. Some of the tables are like those in *Warnstorff's* edition of *Schumacher's Hülfstafeln*, but there are many new ones, and most of the old ones are recomputed or enlarged. The volume includes tables for conversion of mean into sidereal time, arcs into time, degrees, &c., into arcs; tables for computing parallax, nutation, aberration, figure of the earth, reduction to the meridian, refraction; also Ruhlmann's hypsometric tables, a very conveniently arranged table of squares of numbers, up to 10,000, for use in the method of least squares, a table of natural sines, tangents and secants, to five decimals for each minute of the quadrant, an interpolation table for use when 2d, 3d, 4th and 5th differences are employed, and tables for reduction of barometers of various scales.

10. *The American Ephemeris and Nautical Almanac for* 1874 is just out, two years in advance.

## IV. Miscellaneous Scientific Intelligence.

1. *Masses of Meteoric Iron.*—At the meeting of the Geological Society held on the 8th inst., there was read a letter from the Embassy at Copenhagen, transmitted by Earl Granville, mentioning that a Swedish scientific expedition, just returned from the coast of Greenland, had brought home a number of masses of meteoric iron found there upon the surface of the ground. These masses varied greatly in size; the largest was said to weigh 25 tons. Mr. David Forbes having recently returned from Stockholm, where he had the opportunity of examining these remarkable masses of native iron, took the opportunity of stating that

they had been first discovered last year by the Swedish arctic expedition, which brought back several blocks of considerable size which had been found on the coast of Greenland. The expedition of this year, however, has just succeeded in bringing back more than twenty additional specimens, amongst which two were of enormous size. The largest, weighing more than 49,000 Swedish pounds, or about 21 tons English, with a maximum sectional area of about 42 square feet, is now placed in the hall of the Royal Academy of Stockholm; whilst, as a compliment to Denmark, on whose territory they were found, the second largest, weighing 20,000 lbs., or about 9 tons, has been presented to the Museum of Copenhagen. Several of these specimens have been submited to chemical analysis, which proved them to contain nearly 5 per cent. of nickel, with from 1 to 2 per cent. of carbon, and to be quite identical in chemical composition with many aërolites of known meteoric origin. When polished and etched by acids, the surface of these masses of metallic iron shows the peculiar figures or markings usually considered characteristic of native iron of meteoric origin. The masses themselves were discovered lying loose on the shore, but immediately resting upon basaltic rocks (probably of Miocene age), in which they appear to have originally been imbedded; and not only have fragments of similar iron been met with in the basalt, but the basalt itself, upon being examined, is found to contain minute particles of metallic iron, identical in chemical composition with that of the large masses themselves, whilst some of the masses of native iron are observed to enclose fragments of the basalt. As the chemical composition and mineralogical character of these masses of native iron are quite different from those of any iron of terrestrial origin. and altogether identical with those of undoubted meteoric iron, Prof. Nordenskjold regards them as aërolites, and accounts for their occurrence in the basalt by supposing that they proceeded from a shower of meteorites which had fallen down and buried themselves in the molten basalt during an eruption in the Miocene period. Notwithstanding that these masses of metallic iron were found lying on the shore between the ebb and flow of tide, it has been found, upon their removal to Stockholm, that they perish with extraordinary rapidity, breaking up rapidly and falling to a fine powder. Attempts to preserve them by covering them with a coating of varnish have as yet proved unsuccessful; and it is actually proposed to preserve them from destruction by keeping them in a tank of alcohol. Mr. Maskelyne then stated that the British Museum already possessed a specimen of this native iron, and accounted for its rapid destruction on exposure by the absorption of chlorine from terrestrial sources, which brought about the formation of ferrous chloride. This was particularly marked in the case of the great Melbourne meteorite in the British Museum; he had succeeded in protecting this, as well as the Greenland specimen, by coating them externally, after previously heating them gently, with a varnish made of shellac dissolved in nearly absolute alcohol. He considered it probable that a meteoric mass falling with immense velocity might so shatter itself as to cause some of its fragments to enclose fragments of basalt, aud even to impregnate the neighbouring mass of basalt with minute particles of the metallic iron: but he considered the question of meteoric origin could only be decided by examining the same mass of basalt at some greater distance from the stones themselves, so as to prove whether the presence of such metallic iron was actually characteristic of the entire mass of the rock.—*Chemical News*, *Nov.* 17.

2. *On the Phosphorescence of the Eggs of the common Glow-worm;* by M. JOUSSET.—On the 16th of July last, in very warm weather, I collected in the part of the Château de Monjay two glowworms which shone brilliantly. These two females were coupled, and escorted by a supplementary male. I carried them to Paris in a glass tube; and the next day they laid about sixty eggs, of the size of a pin's head, which is very large in comparison with the size of the insect.

The shell of these eggs is so delicate that they cannot be touched without breaking it. The micropyle is very apparent; and their colour is yellowish.

It is worthy of note, and, as far as I know, has not yet been indicated, that these eggs are endowed with a bright phosphorescence. They are not only phosphorescent immediately after laying, but they remain phosphorescent. Those which I collected as above, presented the phenomenon without any diminution until the 23d of July—that is to say, for seven days.

I could not continue the observation any further, because, having left the tube containing them open, I found them dried up.

If one of these eggs is crushed in the dark, the liquid which spreads upon the glass is phosphorescent, and continues luminous until it is quite dry.—*Comptes Rendus*, September 4, 1871, p. 629. *Ann. Mag. Nat. Hist.*, IV, viii, 372.

3. *Coast Survey Deep-Sea Dredging Expedition.*—The general organization and plan of this expedition is stated in Vol. II. of this Journal, on page 228. The vessel—the steamer *Hassler*—has finally sailed, having left Boston on the 3d of December. The expedition is under the command of Captain P. C. Johnson, and Messrs. Kennedy and Day are the lieutenants. On account of the lateness of the season, the projected work in the Atlantic will be mostly given up, and probably be performed another season by the *A. D. Bache*, a consort of the *Hassler*. A letter from Prof. Agassiz to Prof. B. Peirce, Superintendent of the Coast Survey, dated the day before the sailing of the expedition, has been published, announcing in a prophetic way what discoveries the expedition may be expected to make through its deep-sea dredgings in the Southern Ocean and elsewhere. The idea, that Tertiary, Cretaceous and earlier types may be looked for in the depths of the ocean, has animated all the more recent dredging expeditions, and the success in this direction has been regarded as their greatest triumph. In view of this success, Prof. Verrill observed, in

this Journal, vol. xlix, 134 (January, 1870): "The discovery of the living Cystidean, noticed in the last number of this Journal, is another fact of the same kind, and so remarkable that it may not seem unreasonable to anticipate hereafter the discovery of living Ammonites and Trilobites." The new expedition, if its plans are carried out, may do much toward ascertaining whether such predictions are to be verified or not.

4. *Jay's Cabinet of Shells.*—The very extensive collection of shells of Mr. John C. Jay, comprising 14,000 species and 50,000 specimens, has been generously given by him to the American Museum of Natural History, established in the Central Park, New York. The letter of Mr. Jay, announcing the gift, is dated November 1st.

OBITUARY.

Charles Babbage, the author of the "ninth" Bridgewater Treatise, inventor of the calculating machine, and author of various memoirs on mathematical and physical subjects, died on the 20th of October last.

There is no fear that the worth of the late Charles Babbage will be over-estimated by this or any generation. To the majority of people he was little known except as an irritable and eccentric person, possessed by a strange idea of a calculating machine, which he failed to carry to completion. Only those who have carefully studied a number of his writings can adequately conceive the nobility of his nature and the depth of his genius. To deny that there were deficiencies in his character, which much diminished the value of his labours, would be useless, for they were readily apparent in every part of his life. The powers of mind possessed by Mr. Babbage, if used with judgment and persistence upon a limited range of subjects, must have placed him among the few greatest men who can create new methods or reform whole branches of knowledge. Unfortunately the works of Babbage are strangely fragmentary. It has been stated in the daily press that he wrote eighty volumes; but most of the eighty publications are short papers, often only a few pages in length, published in the transactions of learned societies. Those to which we can apply the name of books, such as "The Ninth Bridgewater Treatise," "The Reflections on the Decline of Science," or "The Account of the Exposition of 1851," are generally incomplete sketches, on which but little care could have been expended. We have, in fact, mere samples of what he could do. He was essentially one who began and did not complete. He sowed ideas, the fruit of which has been reaped by men less able but of more thrifty mental habits.

It was not time that was wanting to him. Born as long ago as the 26th of December, 1792, he has enjoyed a working life of nearly eighty years, and, though within the last few years his memory for immediate events and persons was rapidly decaying, the other intellectual powers seemed as strong as ever. The series of publications which constitute the real record of his life commenced in 1813 with the preface to the Transactions of the Analytical Society, a small club established by Babbage, Herschel, Peacock, and several other students at Cambridge, to promote, as it was humorously expressed, the principles of pure D-ism, that is, of the Leibnitzian notation and the methods of French mathematicians. Until 1822 Mr. Babbage's writings consisted exclusively of memoirs upon mathematical subjects, which, however little read in the present day, are yet of the highest interest, not only because they served to awaken English mathematicians to a sense of their backward position, but because they display the deepest insight into the principles of symbolic methods. His memoir in the "Cambridge Philosophical Transactions" for 1826, "On the Influence of Signs in Mathematical Reasoning," may be mentioned as an admirable example of his mathematical writings. In this paper, as in many other places, Mr. Babbage has expressed his opinion concerning the wonderful powers of a suitable notation in assisting the human mind.

As early as 1812 or 1813 he entertained the notion of calculating mathematical tables by mechanical means, and in 1819 or 1820 began to reduce his ideas to practice. Between 1820 and 1822 he completed a small model, and in 1823 commenced a more perfect engine with the assistance of public money. It would be needless as well as impossible to pursue in detail the history of this undertaking, fully stated as it is in several of Mr. Babbage's volumes. Suffice it to say that, commencing with 1,500*l.*, the cost of the Difference Engine grew and grew until 17,000*l.*, of public money had been expended. Mr. Babbage then most unfortunately put forward a new scheme for an Analytical Engine, which should indefinitely surpass in power the previously-designed engine. To trace out the intricacies of negotiation and misunderstanding which followed would be superfluous and painful. The result was that the Government withdrew all further assistance, the practical engineer threw up his work and took away his tools, and Mr. Babbage, relinquishing all notions of completing the Difference machine, bestowed all his energies upon the designs of the wonderful Analytical Engine. This great object of his aspirations was to be little less than the mind of a mathematician embodied in metallic wheels and levers. It was to be capable of any analytical operation, for instance, solving equations and tabulating the most complicated formulæ. Nothing but a careful study of the published accounts can give an adequate notion of the vast mechanical ingenuity lavished by Mr. Babbage upon this fascinating design. Although we are often without detailed explanations of the means, there can be little doubt that everything which Mr. Babbage asserted to be possible would have been theoretically possible. The engine was to possess a kind of power of prevision, and was to be so constructed that intentional disturbance of all the loose parts would give no error in the final result.

Although for many years Mr. Babbage entertained the intention of constructing this machine, and made many propositions, we can hardly suppose it capable of practical realisation. Before 1851 he appears to have despaired of its completion, but his workshops were never wholly closed. It was his pleasure to lead any friend or visitor through these rooms and explain their contents. No more strange or melancholy sight could well be seen. Around these rooms in Dorset Street were the ruins of a life-time of the most severe and ingenious mental labors perhaps ever exerted by man. The drawings of the machine were alone a wonderful result of skill and industry; cabinets full of tools, pieces of mechanism, and various contrivances for facilitating exact workmanship, were on every side now lying useless.

Mr. Babbage's inquiries were not at all restricted to mathematical and mechanical subjects. His work on the "Economy of Manufactures and Machinery," first published in 1832, is in reality a fragment of a treatise on Political Economy. Its popularity at the time was great, and, besides reprints in America, translations were published in four Continental languages. The book teems with original and true suggestions, among which we find the system of Industrial Partnerships now coming into practice. It is, in fact, impossible to over-praise the work, which, so far as it goes, is incomparably excellent. Having assisted in founding the Statistical Society of London in 1834, Mr. Babbage contributed to their Transactions a single paper, but as usual it was a model research, containing a complete analysis of the operations of the Clearing House during 1839. It was probably the earliest paper in which complicated statistical fluctuations were carefully analyzed, and it is only within the last few years that bankers have been persuaded by Sir John Lubbock to recognize the value of such statistics, and no longer to destroy them in secret. In this, as in other cases, many years passed before people generally had any notion of the value of Mr. Babbage's inquiries; and there can be little doubt that, had he devoted his lofty powers to economic studies, the science of Political Economy would have stood by this time in something very different from its present pseudo-scientific form.

Perhaps the most admirable of all his writings was the Ninth Bridgewater treatise, an unexpected addition to that well-known series in which Mr. Babbage showed the bearing of mathematical studies upon theology. This is one of the few scientific works in which the consistency of natural laws with breaches of continuity is clearly put forth. That Power which can assign laws can set them aside by higher laws. Apart from all particular theological inferences, there can be no question of the truth of the views stated by Babbage; but the work is hardly more remarkable for the profundity of its philosophy than for the elevated and eloquent style in which it was written, although as usual an unfinished fragment.

Of all Mr. Babbage's detached papers and volumes, it may be asserted that they will be found, when carefully studied, to be models of perfect logical thought and accurate expression. There is, probably, not a sentence ever penned by him in which lurked the least obscurity, confusion, or contradiction of thought. His language was clear, and lucid beyond comparison, and yet it was ever elegant, and rose at times into the most unaffected and true eloquence. We may entertain some fear that the style of scientific writing in the present day is becoming bald, careless, and even defective in philosophic accuracy. If so, the study of Mr. Babbage's writings would be the best antidote.

Let it be granted that in his life there was much to cause disappointment, and that the results of his labors, however great, are below his powers. Can we withhold our tribute of admiration to one who throughout his long life inflexibly devoted his exertions to the most lofty subjects? Some will cultivate science as an amusement, others as a source of pecuniary profit, or the means of gaining popularity. Mr. Babbage was one of those whose genius urged them against everything conducive to their immediate interests. He nobly upheld the character of a discoverer and inventor, despising any less reward than to carry out the highest conception which his mind brought forth. His very failures arose from no want of industry or ability, but from excess of resolution that his aims should be at the very highest. In these money-making days can we forget that he expended almost a fortune on his task? If, as people think, wealth and luxury are corrupting society, should they omit to honor one of whom it may be truly said, in the words of Merlin, that the single wish of his heart was "to give them greater minds?"—*Nature, Nov.* 9.

*Rev. J. A. Swan.*—It is with regret that we have to announce the recent death, in Boston, of Rev. J. A. SWAN, on the 31st of October last, at the age of 48. Mr. Swan has been long known among his New England friends for his love of natural history and for his skill in the use of the microscope; and during his residence at Kennebunk, although a devoted pastor in that village, he found time to make numerous important explorations and observations in the natural history of the vicinity. Failing in health a few years ago, he visited Europe, and on his return was appointed to the responsible post of secretary of the Boston Society of Natural History, in connection with Professor A. Hyatt, succeeding Mr. Scudder in charge of the business of the society. Apart from his scientific accomplishments, Mr. Swan was endeared to all his friends by personal qualifications of the rarest merits.—X., *in Harper's Weekly.*

## V. MISCELLANEOUS BIBLIOGRAPHY.

1. *A Report of Surgical Cases treated in the Army of the United States from* 1865 *to* 1871. Circular No 3. Surgeon General Office, Washington.—The reports of the medical and surgical cases occurring in the army, and presenting the condensed tabular statements of the results of each five years, have always been looked for with interest by the profession, and more or less carefully read. The report of surgical cases, however, which has just been issued as Circular No 3, is of more than

usual importance. Instead of the statistical tables of former years, this volume contains abstracts of more than a thousand cases of surgical operations, selected as among the most interesting and instructive, and presented with details sufficient to render them extremely useful. The capital operations seem to have been remarkably successful, and the small ratio of mortality in thigh amputations (38.5) is certainly exceptional. Of the cases of punctured wounds, those by arrows are not among the least interesting, on account of their novelty in the present age, and as having furnished the occasions for the earliest recorded triumphs of military surgeons of antiquity. Of the nine cases of lithotomy, all successful, four were for calculi having for their nuclei missiles of various kinds that had perforated and lodged in the bladder; one of these being an iron arrow-head, which singularly enough had entered the bladder through the obturator forarum. The volume has been compiled by Asst. Surgeon Otis, and is a very valuable contribution to surgical literature, besides being creditable to the skill of our army surgeons.

2. *Appleton's American Annual Cyclopædia and Register of Important Events of the Year* 1870. Vol. X, 1871. Royal 8vo, pp. 789.—This volume sustains the high character of its precursors, which of course are chiefly devoted to the great interests of politics, diplomacy and commerce of the world, with special reference to details of affairs specially interesting to Americans; it touches, in an intelligent and comprehensive manner, upon the important discoveries and researches made in various departments of science. Thus we find carefully prepared articles on the following subjects: "Astronomical Phenomena and Progress;" "Aurora Borealis;" "Chemical Examination of American Grapes and Wines;" "Chemistry;" "Earthquakes;" "East River Bridge;" "Electricity;" "Geographical Explorations and Discoveries;" "Metals;" "Storm Signals;" "Eclipse of the Sun in December, 1870." The Franco-Germanic War, the important political and ecclesiastical changes in Italy, and the census of the U. States for 1870, naturally occupy a large space. These annual volumes form a permanent and most convenient record of the world's progress, and are as essential to all reference libraries as they are convenient to men of research.

3. *Boston Journal of Chemistry:* James R. Nichols, M.D. ,Editor, assisted by Wm. J. Rolfe, A.M.—This monthly was established in 1866, and has now reached its 6th volume. It is "devoted to the science of home life, the arts, agriculture, and medicine," and its contents, presented under these heads, are interesting and instructive to a large class of readers. It numbers among its original contributors some of our first writers, who do good service in addressing, on matters of current interest in science, a larger body of readers, than is reached by any other American journal of like character. The papers by Prof. C. A. Young on an explosion in the sun, published in the last number of this Journal, and also that on a preceding page, giving magnetometer indications at the time of the explosion, were copied from this Journal. For the use of the cut on page 70 we are indebted to its editors.

4. *An Elementary Treatise on Heat;* by BALFOUR STEWART, LL.D., F.R.S., Professor of Natural Philosophy at the Owens College, Manchester. Second edition. 12mo, pp. xx, 415. Oxford, 1871. (Clarendon Press. New York: Macmillan & Co.)—We believe we were nowise in error in regarding the first edition of this little book as altogether the best manual on the subject of which it treats to be found in any language. It is gratifying therefore to find it so well appreciated that a second edition is already demanded. The author says in his preface that he has enriched his book by the addition of those discoveries in heat which have been made since the first edition appeared; and by giving some additional problems on "Sir William Thomson's applications of the dynamical theory of heat to the establishment of relations between the physical properties of bodies." The book is brought fully up to the times, therefore; and in saying this, we have in mind the fact that its author is one of the foremost thinkers of the day in the department of the conservation of energy. We find consequently in the book a wealth of thought as entirely original as it is invaluable. The chapter on the Theory of Exchanges is incomparable; and Book III, wherein is treated the nature and sources of heat and its connection with other properties of matter, most admirably exhibits the great power and clearness with which Professor Stewart writes.

5. *A Treatise upon Terrestrial Magnetism.* 8vo, pp. viii, 179. Edinburgh and London, 1871. (Wm. Blackwood & Sons).—The object of the author in writing this book was, as he states, to advance a new theory of his own to explain the phenomena of terrestrial magnetism. He assumes at the outset, 1st, that the earth is a great magnet; and 2d, that electricity is united with the matter of which it is composed. This electricity—being attracted by all matter and at all distances—is attracted by the matter of the sun. Hence there is most electricity in that part of the earth which is directly under the sun; lessening gradually from this point in all directions. Moreover, he assumes that when a ferruginous body moves through electricity of varying density, the same effects are produced as when a current passes round such a body. On this hypothesis he proceeds to account for the phenomena of terrestrial magnetism: 1st, it follows that a current would exist over the upper part of the earth's crust, even though there are in it non-conducting portions; 2d, the arrangement of the magnetic poles is as the hypothesis requires; 3d, it explains why the magnetic poles are so distant from the terrestrial; 4th, 5th and 6th, the secular, the annual, and the diurnal variations, are thus accounted for. The book is well written, but is apparently the work of an amateur in science, who unfortunately publishes it anonymously, assuming that this would ensure it a better reception.

6. *Sur les Tremblements de terre et les éruptions volcaniques dans l'Archipel Hawaien, en* 1868; par M. ALEXIS PERREY, Prof. Hon. de la Faculté des Sciences de Dijon. 64 pp. 8vo.—Prof. Perrey continues his valuable labors in connection with the subject

of earthquakes, and here presents a review of the facts relating to the great Hawaian earthquakes of 1868. The memoir was presented to the Soc. Imp. d' Agriculture of Lyons in February, 1860. Besides the above, Prof. Perrey has also published a "*Note sur les Tremblements de terre en* 1868, *avec Suppléments pour les années antérieures de* 1843 *à* 1867, in the Proceedings of the Belgian Academy, February, 1870.

7. *Uebersicht der seit* 1847 *fortgesetzten Untersuchungen über das von der Atmosphäre unsichtbar getragene reiche organische Leben,* von CHRISTIAN GOTTFRIED EHRENBERG. 150 pp. 4to, with two plates. Berlin, Abh. d. K. Akad. der Wiss. zu Berlin, 1871.—Prof. Ehrenberg has here given a very valuable review of the facts relating to organisms from dust showers and other atmospheric sources, adding also the results of new observations. Plate I contains numerous forms of organisms from recent dust showers; that of Ispahan in 1870; the Dardanelles to Sicily in 1869; Apulia in 1868; Janina in 1870; Island of Sora in 1869; Switzerland in 1867.

8. *Crustacea Amphipoda borealia et arctica,* Auctore AXEL BOECK. 200 pp. 8vo.—A prodromus in Latin of the large work, illustrated with 32 plates, soon to be published by the author. These Amphipod Crustaceans have their greatest diversity of forms in the cold latitudes of the globe; and hence, a work on Arctic and boreal species has a special interest. This prodromus contains full descriptions of all of the species, and a complete synonymy.

9. *Elbthalgebirge in Sachsen,* von DR. HANNS BRUNO GEINITZ. —The second number of the first part of this fine work has been just issued. It treats of the corals of the Lower Quader Sandstein (Upper Cretaceous), and is illustrated by three excellent plates, 11 to 13.

10. *Die Mineralogie, leichtfasslicht dargestellt;* by FRANZ VON KOBELL. 4th enlarged edition. 272 pp. 12mo, with five plates.—An excellent manual for the young student. It is brief and precise in its descriptions, simple in its treatment of the crystallograhic and physical branches of the subject, and convenient in its classification.

11. *Revue de Géologie pour les années* 1867 et 1868, par MM. A. DELESSE et M. DE LAPPARENT. 372 pp. 8vo. Paris, 1871. (Dunod, Editeur).—This is the seventh volume of this valuable review of the progress of geological science. It was nearly com pleted nine months since, but, like much else of science in France, was interrupted, as the preface says, by the two sieges of Paris. It treats at considerable length of rocks and their metallic contents, reviews also the more important memoirs on historical geology, and also, in the last chapter, on dynamical geology.

Die Reptilfauna der Gosau-Formation in der neuen Welt bei Wiener-Neustadt; von Dr. Emanuel Bunzel. 20 pp. 4to, with 8 plates. Abh. d. K. K. geol. Reichsanstalt, Abh. V. Heft 1. Vienna, 1871.

Die Cephalopoden-Fauna der Oolithe von Balin bei Krakau; von Dr. M. Neumayr. 54 pp. 4to, with 7 plates. Ib., Heft 2.

THE

AMERICAN

# JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

## ART. XII.—*Observations on Encke's Comet at the Dartmouth College Observatory;* by Prof. C. A. YOUNG.

THE spectrum of this comet was observed on Dec. 1st, 2d, 5th and 6th, and found to consist of three bright bands, of which the central one is by far the most conspicuous. The bands are pretty sharply defined at their lower (i. e., less refrangible) edge, but fade gradually toward their upper limit. There was no indication of resolvability into lines, but the light was too feeble to allow the use of great dispersive power, or of a very narrow slit. I think that with the power and adjustment employed, no lines nearer to each other than $b^{i}$ and $b^{iv}$ could have been distinctly separated.

No continuous spectrum could be detected, nor any difference, except in brightness, between the spectra of different portions of the comet.

After trying several arrangements, with dispersive powers ranging from one to five prisms, it was found that the best results were obtained with a chemical spectroscope having a single 60° prism, and collimator and telescope of such power and focal length as just neatly to divide the D lines.

In this instrument the eye-piece is provided with a bar crossing the center of the field of view parallel to the slit, while the telescope itself can be moved by a tangent screw so as to bring any portion of the spectrum to the edge of the bar. There is also the ordinary scale viewed by reflection from the surface of the prism.

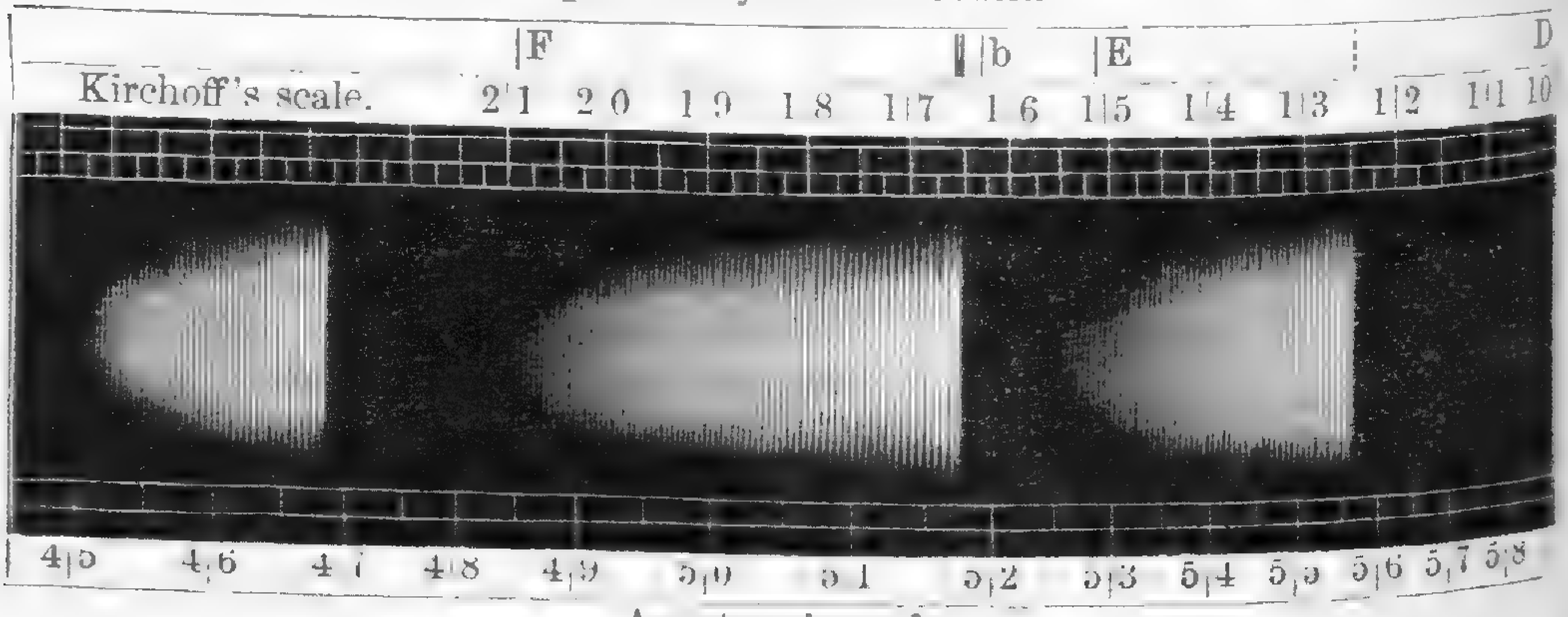
The observations were made in the following manner: By means of the tangent screw, the bar was so placed as to hide the whole band, whose position was to be ascertained, except a just visible line of light, and then, the scale being for the moment illuminated by a small Geissler tube, the corresponding division was read off at the edge of the bar. The value of the scale was determined by observing the readings corresponding to the lines in the spectrum of a Geissler tube containing hydrogen and mercurial vapor, each line, to avoid parallax, being brought to the edge of the bar before reading off. The spectrum of the tube was compared directly with that of sunlight by means of an instrument of high dispersive power, and thus the data were obtained for constructing a curve accurately representing the relation between the scale of my instrument and the map-scales of Kirchoff and Angström. By means of this curve the observed readings were finally reduced.

The precaution was taken to adjust the scale to a new reading, and to reverse the slit (which opens only from one side) several times during the observations, in order to reduce the chance of constant errors.

The following table presents the results of the observations, each evening's work consisting of from three to twelve sets of measures. The numbers given relate to the bright, comparatively well-defined, less refrangible edges of the bands.

| Date. | Kirchoff's scale. | | | Angstrom's scale. | | |
|---|---|---|---|---|---|---|
| | 1st band. | 2d band. | 3d band. | 1st band. | 2d band. | 3d band. |
| Dec. 1,- | 1225 | 1645 | 2270 | 5593 | 5174 | 4698 |
| Dec. 2,- | 1240 | 1650 | ---- | 5575 | 5172 | ---- |
| Dec. 5,- | 1245 | 1640 | 2265 | 5569 | 5178 | 4702 |
| Dec. 6,- | 1250 | 1645 | 2260 | 5563 | 5174 | 4706 |
| Means,- | 1240 | 1645 | 2265 | 5575 | 5174·5 | 4702 |

*Spectrum of Encke's Comet.*




Angstrom's scale.

The figure * gives an idea of the appearance of the spectrum and the position of its bands.

* The irregularity observable in the spacing of Angström's scale at the bottom of the diagram is no fault of the draftsman or engraver, but represents a fact. The irregularity, however, is really in the scale of Kirchoff, the prisms of whose

The spectrum of this comet appears to be the same with that of comet II, 1868 (Winnecke's comet), described by Mr. Huggins in the Philosophical Transactions for that year. No data are given in the paper by which to refer the scale of his instrument to that of Kirchoff, except such as can be deduced from inspection of the figure. The scale appears, however, to be the same as that used in his observations of star spectra (see Philosophical Transactions for 1864, p. 435). If so, D corresponds to 1000, E to 1252, $b^2$ to 1297·5, and F to 1483. Assuming these numbers, I find that the relation of this scale to that of my own instrument is very closely represented by a straight line, and that the readings 1094, 1298 and 1589, corresponding to the lower edges of the bands observed, give respectively wave-lengths of about 559, 517 and 469 millionths of a millimeter.

Dr. Huggins considers that he has satisfactorily identified this spectrum with that of carbon.

The brightest line falls in the *b* group, where also a strong line appears in the spectrum of common air under the influence of the electric spark; although quite probably merely accidental, it may also be worth noting that the principal line of the aurora spectrum (wave-length 5568) very closely coincides with the lowest band.

On the evening of Dec. 1st, at $6^h$ $04^m$ P. M., Hanover mean time ($5^h$ $45^m$ Washington time), the comet passed centrally over a star of the 9th magnitude.

My attention was called to it by the sudden appearance of a bright, narrow spectrum running longitudinally through that

instrument appear to have been several times disturbed and adjusted during the series of observations embodied in his map. I subjoin a table, which I have often found convenient, coördinating the two scales, derived from direct comparison of the maps.

*Comparison of the Scales of Angström and Kirchoff.*

| Ang. | K. | Diff. | Ang. | K. | Diff. | Ang. | K. | Diff. |
|---|---|---|---|---|---|---|---|---|
| 4300 | 2867 | | 5100 | 1747 | 145! | 5900 | 1000 | 69 |
| 4400 | 2693 | 174 | 5200 | 1611 | 136 | 6000 | 944 | 56! |
| 4500 | 2537 | 156 | 5300 | 1489 | 122 | 6100 | 895 | 49 |
| 4600 | 2397 | 140 | 5400 | 1392 | 97 | 6200 | 845 | 50 |
| 4700 | 2268 | 129 | 5500 | 1304 | 88 | 6300 | 799 | 46 |
| 4800 | 2147 | 121 | 5600 | 1219 | 85 | 6400 | 757 | 42 |
| 4900 | 2030 | 117 | 5700 | 1142 | 77 | 6500 | 717 | 40 |
| 5000 | 1892 | 138! | 5800 | 1069 | 73 | 6600 | 680? | 37 |

Below C (694 K) no accurate coördination of the scales seems possible, as only very few lines are recognizable on Angström's map.

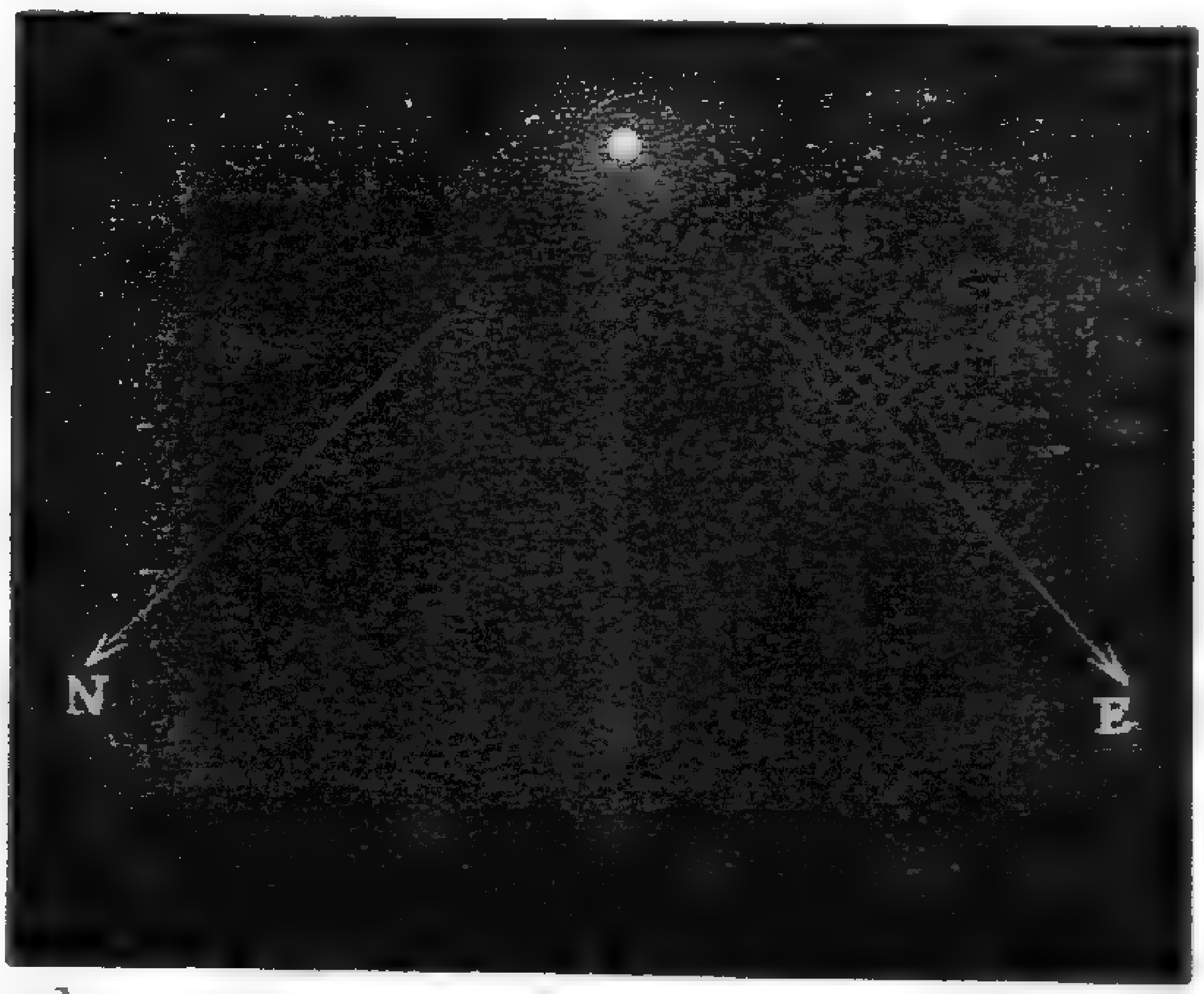
There is very great need of a new map of the solar spectrum equally minute and faithful in detail with that of Kirchoff, but constructed throughout on a consistent scale; and for this purpose I am convinced that a scale of *inverse wave-lengths*, as already proposed by Herschel and Stoney, would be incomparably the most convenient for practical use.

of the comet. On looking into the telescope with a power of 200, the star was for about thirty seconds of time so near the center of the comet that I should certainly have mistaken it for a nucleus but for the spectrum.

The star did not appear to be dimmed in the slightest degree.

On this night, and also on Dec. 2d, the comet appeared as a nebulous mass about 5′ or 6′ in diameter. It was much brighter in the center, though without any stellar nucleus; very indefinite in its outline, but on the whole rather more distinctly bounded on the side opposite to the sun, fanning out a little *toward* the sun—a very unusual occurrence in a comet. Other observers have, however, noticed the same thing in this comet during the last few weeks.

The comet was barely visible to the naked eye.




On the 5th, at 6 P. M., I detected a tail about 25′ long, of singular, one-sided conformation, which I have attempted to represent in the accompanying figure. One edge was pretty bright and well-defined, a rectilinear streamer of light directed at a position angle of about 43° (i. e., N. 43° E.) from the center of the comet. The other edge was curved in the usual parabolic form, but was very faint, indefinite and difficult to trace. On the 6th, the straight streamer could still be faintly seen, but the comet was so low and the air so hazy that nothing further could be made out.

The telescope employed in the above observations has an aperture of 9·4 inches.

Dartmouth College, Dec. 8, 1871.

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ART. XIII.—*Note on the occurrence of the "Primordial Fauna" in Nevada;* by J. D. WHITNEY.

AN interesting locality of fossils has recently been discovered by Mr. J. E. Clayton, and specimens have been placed in my hands for examination, through the kindness of Professor Joseph LeConte. These fossils indicate most unequivocally the Potsdam period of the Silurian age, since they belong to those most characteristic families, the *Lingulidæ* and the *Paradoxidæ.* The specimens contain a great number of individuals, but few species; and these much broken and closely compacted together. Among the fragments are several heads of *Agraulos* (*Arionellus* and *Arion* of Barrande, *Crepicephalus* of D. D. Owen), and the species seems to be the same *A. Oweni* which has been described by Meek and Hayden as occurring in the Big Horn Mountains. This is by far the most abundant species in the specimens obtained by Mr. Clayton; but there are also other fragments, one of which seems almost certainly to be a *Conocoryphe* (*Conocephalites* of Barrande), and others to belong to the genus *Paradoxides.* The class of brachiopods is represented in these specimens by two or more genera, all of the family of *Lingulidæ.* Among these I think that I am able to recognize the genera *Lingulepis* (Lingula) and *Obolella.* At all events, the character of this assemblage of fossils is thoroughly and peculiarly Primordial.

This is an interesting discovery, since it carries the Primordial fauna much farther west than it had been found before. The most western locality of Potsdam sandstone fossils previously described, is that in the Big Horn Mountains, at the head of Powder river, in longitude 107°, while that discovered by Mr. Clayton is near the 116th meridian. It is, indeed, wonderful to see the persistence of this grouping of forms which characterizes the lowest subdivision of the fossiliferous series, and which has been found recurring at so many points over the vast area of this continent, as well as on the other side of the Atlantic.

This persistence seems the more remarkable, when we consider the very different lithological character of the rocks in which these constantly recurring trilobites and brachiopods are found at various localities. In Bohemia they occur in argillaceous shales; throughout the United States, from New York to the Rocky Mountains, in the "Potsdam sandstone, or in shales or slates;" in Texas, and now in Nevada, in limestones.

This discovery will also indicate the necessity of caution in theorizing on the geological structure and age of regions which have only been hastily examined. It will not do to put down every red-sandstone group below the Trias in the far West as "Potsdam," for that subdivision may be much lower down, hiding itself as a modest limestone of a very neutral tint of color. It is not many years ago that the Great Basin was believed to be occupied by a mass of volcanic and metamorphic rocks, in which but few, if any, organic forms would ever be found. Every year, however, brings us some additional evidence of the existence of numerous fossiliferous localities, and we have already a pretty fair representation of almost all the groups from the Triassic down to the "Potsdam sandstone." The report of the 40th Parallel Survey will, no doubt, throw a great deal of light on the stratigraphy of the various formations existing in the Great Basin, of which we now know hardly anything more than the bare fact that they do occur in that extremely interesting region.

Among the specimens sent by Mr. Clayton are several small pieces of a mottled buff and gray limestone, filled with fragments of minute trilobites and brachiopods, and from a locality on Schell Creek, seventy-five miles northeast of White Pine, not far from lat. 40°, lon. 115°. These specimens also clearly demonstrate the existence of the Primordial fauna at that locality; but the fragments are so imperfect that I will not attempt to name any of them, unless it be one, which may be either *Agraulos Oweni*, or another species of the same genus closely resembling this. There are also many very minute brachiopods hardly 0·15 of an inch in diameter, which have a form not much different from that of *Lingulepis prima.*

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ART. XIV.—*Notice of the Address of Prof. T. Sterry Hunt before the American Association at Indianapolis;** by JAMES D. DANA.

IN a brief notice of the recent address of Professor Hunt, contained in the last volume of this Journal (p. 205), it is stated that, while the discussions show learning and research, and his review of the progress of opinions with regard to the Taconic and associated rocks is an able presentation of the subject, its conclusions are throughout open to doubts and objections. Since it is fairer to an author to make special, rather than general, criticisms, I propose to state here a part of the objections referred to in that remark. They are as follows:

1. That, while accepting the ordinary views with regard to most "pseudomorphs by alteration" (crystals chemically altered without a loss of form), he rejects them with respect to those that are silicates in composition; that is, he denies that the crystals of serpentine having the form of chrysolite, pyroxene, dolomite, etc., are pseudomorphs; and the same of those of steatite, having the form of hornblende, pyroxene, spinel, etc.; of those of pinite having the form of nephelite, scapolite, etc.; and so in other cases:—notwithstanding that (1) they bear positive evidence of change in having ordinarily no polarizing properties, and no other interior features or qualities conforming to the external form; that (2) the crystalline forms are just those presented by the species after which they are supposed to be pseudomorphs, and the idea of their being real forms of a single polymorphous species is wholly inadmissible, as pronounced by every crystallographer who has written on the subject; that (3) the pseudomorphs show all stages in the process of change from

* Prof. Hunt's address has been published in the American Naturalist for September, and, since then, in part, in "Nature." Those who would understand fully the criticisms here offered can, therefore, easily obtain a copy.

incipient to complete alteration, in the latter case not a trace of the original mineral remaining.

In his assumption, for it is little better, he opposes the views of every writer on pseudomorphs, excepting one—Scheerer; and Scheerer's chemical speculations, which are at the basis of his opinions, he rejects, like all other chemists.

This unwarranted assumption has a profound position in the system of views on metamorphism which Professor Hunt holds, and gives shape and intensity to his opinions of the views of others.

2. That, in commencing a paragraph with the sentence, "The doctrine of pseudomorphism by alteration, as taught by Gustaf Rose, Haidinger, Blum, Volger, Rammelsberg, Dana, Bischof, and many others [meaning thereby other writers on pseudomorphism], leads them, however, to admit still greater and more remarkable changes than these, and to maintain the possibility of converting almost any silicate into any other"—he grossly misrepresents the views of at least Rose, Haidinger, Blum, Rammelsberg, Dana; and that he completes the caricature in the closing sentence of the same paragraph, in which he says, "In this way we are led from gneiss or granite to limestone, from limestone to dolomite, and from dolomite to serpentine, or more directly from granite, granulite or diorite to serpentine at once, without passing through the intermediate stages of limestone and dolomite;"—part of which transformations, I, for one, had never conceived; and Rose, Haidinger, Rammelsberg and probably Blum and the "many others," would repudiate them as strongly as myself. Next follows a verse from Gœthe, that is made to announce his personal vexation with their "sophistries;" *alias* absurdities, as the context implies.

Professor Hunt's rejection of established truth alluded to under §1, here manifests its effects in leading him to misrepresent—although, unintentionally—the views of writers on pseudomorphism; and to add to his misrepresentation by means of the strange conclusion, that, because such writers hold that crystals may undergo certain alterations in composition, therefore they believe that rocks of the same constitution may undergo the same changes; as if it were not possible that external or epigenic agencies might reach and alter crystals under some circumstances of position, when they could not gain access to great beds of rock. Haidinger, the eminent crystallographer, mineralogist and physicist of Vienna, and one of the most prominent writers on pseudomorphism, never wrote upon the subject of the alteration of rocks at all, and this is true of others against whom the above charge is made by Mr. Hunt.

With a little clearer judgment, part at least of that vexation of spirit, which required the help of a great German poet, and the

German language, adequately to express, might have been avoided.

3. That he charges me with the opinion of Bischof, that "regional metamorphism is pseudomorphism on a grand scale:"—when I make no such remark, neither express the sentiment, in my Mineralogy of 1854, in which I give an abstract of Bischof's views and make my nearest approach to them; and when, if there was any occasion for a notice of my opinions, a critic of 1871 should have referred to the formal expression of them in my Manual of Geology, first published in 1863. The reader will there find the "diagenesis" of Gümbel, which Mr. Hunt takes occasion to commend, applied, as had been done by others, although Gümbel had not then announced it; and also other points discussed, with but a brief allusion to pseudomorphism.

The above remark by Mr. Hunt is not made with special reference in his address to magnesian silicates, or any other particular class of siliceous minerals; but, as the context shows, to rocks in general. I have held to views respecting the origin of serpentine which Prof. Hunt rejects, and have sustained them on the ground that the pseudomorphous crystals of serpentine show what transformations are chemically possible, and that hence they may possibly illustrate the changes which beds of rock have undergone. I have not applied this principle in accounting for the origin of ordinary metamorphic rocks, because, as above observed, crystals may often be reached by agencies which can never reach or affect rock-formations, and for various other reasons against it. But the case of serpentine has been regarded as somewhat different; and I have believed, and still believe, that extended beds of rock have been turned into this mineral by a method analogous to that which takes place in pseudomorphism. Had Mr. Hunt's statement been made a special one, restricted to this case, I should have had little objection to it. I may add that the method of origin for serpentine which I have deemed most probable (though perhaps not the only method) is one which he once advocated,—that of the alteration of beds of dolomite, or magnesian carbonate of lime, by waters containing alkaline silicates in solution; and it has appeared to me that the facts (1) that serpentine is commonly associated with beds of limestone or dolomite, (2) that chrysolite crystals are sometimes found in these rocks, and (3) that the forms of crystals of both dolomite and chrysolite occur among serpentine pseudomorphs, give strong support to this view.

Professor Hunt's opinion on this point in 1857 he thus expressed in a letter to the writer, sent for insertion in this Journal, where it appears in volume xxiii (1857), at page 437, as a conclusion to his brief statement:

"Suppose a solution of alkaline silicate, which will never be wanting among sediments where feldspar exists, to be diffused through a mixture of siliceous matter and earthy carbonate, and we have, with a temperature of 212° F, and perhaps less, all the conditions necessary for the conversion of the sedimentary mass into pyroxenite, diallage, serpentine, talc, rhodonite, all of which constitute beds in our metamorphic strata. Add to the above the presence of aluminous matter, and you have the elements of chlorite, garnet and epidote. We have here an explanation of the metamorphism of the Silurian strata of the Green Mountain range, and I believe of rock metamorphism in general." Again, in a letter dated July 6th, published in volume xxiv, at page 272, he says:

"I have already in a previous note indicated the manner in which I suppose these siliceous and argillaceous magnesites and dolomites to have been in certain parts of the formation transformed by the intervention of solutions of alkaline carbonates into silicates, such as talc, serpentine, chlorite, pyroxenite, etc. A further development of my views of the metamorphism of sediments, with the results of the investigation of a great many altered rocks, will appear in the Report of Progress of the Geological Survey of Canada for the last three years—now in press."

It should be added, that Professor Hunt acknowledges his change of opinion in his address. But, in view of it, some moderating of his positiveness of assertion would have been reasonable.

4. That he attributes the origin of *beds* of serpentine and steatite,—here following nearly Delesse,—to the alteration of beds of different hydrous magnesian silicates related to sepiolite (meerschaum), formed in the surface waters of an era—Paleozoic or earlier—while fossiliferous rocks were in progress:—when, as a matter of fact, no such sepiolite-like beds are known to occur anywhere in *unaltered* stratified formations of Paleozoic or pre-Silurian time, and they are found, of limited extent only, in some strata of comparatively recent origin. The hypothesis, although deserving of consideration, is therefore without any solid foundation. The doubts that have been recently thrown about the Eozoön affect unfavorably the hypothesis, since these supposed fossils have been made prominent in its support. The view, if true, would, as Professor Hunt implies, bring the making of serpentine and steatite rocks under the kind of metamorphism styled by Gümbel *diagenesis*, instead of that of epigenesis; making them a result of change without an addition of ingredients from any external source, like most other metamorphism, instead of through the agency of outside ingredients. But it wants facts to rest upon.

5. That he attributes an origin similar to that for serpentine and talc to beds of chlorite and hornblende:—notwithstanding the fact that chlorite schist and hornblende schist—the purest forms of any large beds of these minerals—are always more or less impure, and often graduate into clay slate on one side, and mica schist on the other; and, that these schists are thus so involved with others, that if one is derived from ordinary sedimentary beds, all must be.

6. That he devotes some pages to a "theory of envelopment" as a method of accounting for the silicate pseudomorphs referred to—beginning a paragraph with the sentence:

"By far the greater number of cases on which this general theory of pseudomorphism by a slow process of alteration in minerals has been based, are, as I shall endeavor to show, examples of the phenomenon of mineral envelopment, so well studied by Delesse in his essay on Pseudomorphs:"

While, in fact, this theory has almost nothing to do with the subject, since pseudomorphs of serpentine, steatite and other species, with regard to which there is the dispute, consist often of *pure* serpentine, steatite, etc., and therefore have no enveloper, and are not cases of envelopment. This theory supposes the material of the so-called pseudomorph to be an impurity taken up into a crystal in process of formation—a thing of common occurrence; and, if satisfactory, would account for the want of conformity between internal qualities and external form. It is unfortunate for it that, as just shown, it does not apply where it is wanted.

7. That he makes Delesse the author of the "theory of envelopment:"—when Delesse has not proposed any such theory for cases of ordinary pseudomorphism, but has simply commenced, and very judiciously, his work on Pseudomorphs (1859) by distinguishing the examples of mere impurity, or envelopment, in crystallization, in order to clear the way for the actual facts; and then gives a long list of admitted pseudomorphs, including in it nearly all kinds so recognized by other authors, and all that affect the question discussed by Prof. Hunt; *serpentine* occurring in the list as forming pseudomorphs after chrysolite, hornblende, garnet; *steatite* after pyroxene, hornblende, epidote, scapolite, mica, topaz, magnesite, dolomite, etc. In his work on metamorphism (1861), Delesse takes back none of his views on pseudomorphism; and in his late Reviews of the Progress of Geology, down to the last just out (1871), he reiterates the ordinary views with regard to pseudomorphism, and mentions the occurrence of other pseudomorphs consisting of talc, serpentine, etc.

8. That he cites Naumann as sustaining the "theory of envelopment:"—when this learned crystallographer and mineralogist has only commended Delesse's chapter on the envelopment of minerals in crystals, and presents in his Mineralogy (the last edition of which, that of 1871, is now before me) the subject of pseudomorphism in the usual way, *with nothing whatever on the theory of envelopment;* and, under the description of the species serpentine, he speaks of "large pseudomorphous crystals of serpentine from Snarum which still contain a nucleus of unaltered chrysolite."

There is hence no foundation for Mr. Hunt's statement that his views are "ably supported by Delesse," or any occasion for the "no small pleasure" he derived from Naumann's letter; or any warrant for the remark (p. 47) that Delesse and Naumann hold the "view" "that the so-called cases of pseudomorphism, on which the theory of metamorphism by alteration has been built, are, for the most part, examples of association and envelopment, and the result of a contemporaneous and original crystallization." These men of science are not to be counted upon for aid, countenance, or comfort; though claimed as friends, it has not been their fault, as they have always avowed the opinions of Haidinger and the "many others." It is a strange fact that, neither these claimed friends, nor the many announced opponents, with one or two exceptions, hold the views which Prof. Hunt has attributed to them in his address. We are glad to know that this is not the usual American method of dealing with authorities.

Gümbel and Credner are the other two claimed supporters of his views. They have sustained Mr. Hunt's opinions as regards the Eozoön and the origin of the serpentine constituting it. But whether they disagree with Haidinger and all others as to pseudomorphs of serpentine, and of other hydrous silicates, I cannot say.

9. That while setting down the Taconic rocks, and rightly, as Lower Silurian in age, he denominates the micaceous gneisses, diorites, epidotic and chloritic, steatitic and serpentinous rocks, talcoid mica schists, quartzites, and clay-slates (which are always without staurolite or andalusite), in fact, the whole range of metamorphic rocks, with small exceptions, between the Connecticut river and the great limestone formation of the Green Mountains (admitted to be Lower Silurian), as the *Green Mountain Series*, and makes the whole "*pre-Cambrian*" in age:—although the region has not been examined by any one stratigraphically with the care necessary for a positive opinion; and although there are gneisses, mica schists, and chloritic talcoid (or mica) schists in the Taconic series, and therefore of admitted Lower

Silurian origin, which are closely like those of his Green Mountain Series.

10. That he denominates, in like manner, the gneisses, mica schists (said to be richer in mica than those of the Green Mountain Series), hornblendic gneisses and schists, micaceous and clay-slates containing andalusite, cyanite, or staurolite, and certain limestones, existing east of the Connecticut river, as a *White Mountain Series*, and makes these a newer "pre-Cambrian" than the Green Mountain Series:—when there is the same want of stratigraphical evidence as to age as in the former; and when Prof. C. H. Hitchcock's discoveries of Helderberg corals (Lower Devonian, according to Billings, or else upper beds of the Upper Silurian) at Littleton, not far north of the western extremity of the White Mountains, makes it more probable that part of the White Mountain Series of beds are of Helderberg age rather than pre-Silurian; and his discovery of labradorite rocks on the southwestern margin of the White Mountains, wholly unlike any of the so-called White Mountain Series, shows further that a vast amount of study in the field is needed before the dictum of any one respecting the age of New Hampshire rocks is worth much.

It is now proved that there are labradorite rocks in Waterville and Albany, N. H., on the borders of the White Mountain region, which are *probably* of *Laurentian* age; that on the other side of the White Mountain line, but 25 miles to the north-northwest, there are fossil-bearing, metamorphic rocks of the *Helderberg* (upper or lower) period; that 100 miles south-southwest, in Bernardston, Mass., or central New England, there are other fossil-bearing metamorphic *Helderberg* rocks, some of the well-preserved crinoidal stems (as the writer has seen, as well as read of in the account of Prof. Hitchcock) *an inch in diameter.* Who then knows whether all, or any, of the long intermediate periods of geological time, from the Laurentian to the Devonian, are represented in the New Hampshire metamorphic rocks lying between these limits? When observation has given positive knowledge, we may then have several "White Mountain Series."

11. That he has relied, for his chronological arrangement of the crystalline rocks of New England and elsewhere, largely on lithological evidence, and commends this style of evidence;—when such evidence means nothing until tested by thorough stratigraphical investigation. This evidence means something, or probably so, with respect to Laurentian rocks; but it did not until the age of the rocks, in their relations to others, was first stratigraphically ascertained. It may turn out to be worth something as regards later rocks when the facts have been care-

fully tested by stratigraphy. A *fossil* is proved, by careful observation, to be restricted to the rocks of a certain period before it is used—and then cautiously—for identifying equivalent beds. Has any one *proved* by careful observation that crystals of staurolite, cyanite, or andalusite, are restricted to rocks of a certain geological period? Assumptions and opinions, however strongly emphasized, are not proofs.

It is no objection to stratigraphical evidence that it is difficult to obtain; is very doubtful on account of the difficulties; may take scores of years in New England to reach any safe conclusions. It must be obtained, whatever labor and care it costs, before the real order and relations of the rocks can be known. Until then, lithology may give us guesses, but nothing more substantial.

Mr. Hunt's arguments with reference to the White Mountain Series, as urged by him in 1870, will be found in this Journal, II, l, 83. Both there, and in his address, may be seen the kind of evidence with which he fortifies, or supplements, that based on the character of the rocks. Direct stratigraphical investigation over the region itself, in which all flexures, faults, and unconformabilities have been thoroughly investigated, is not among the foundations of opinion which he brings forward.

He endeavors to set aside the objection to his views suggested by the existence of Devonian or Helderberg rocks in central and northern New England; but he presents, for this purpose, only some general considerations, of little weight, instead of definite facts as to the extent and variety of the metamorphic strata that are part of, because conformable to, these Helderberg beds. Had he studied up these stratigraphical relations with the care requisite to obtain the truth, and all the truth, perhaps he would not longer say—it is "contrary to my notions of the geological history of the continent to suppose that rocks of Devonian age could in that region have assumed such lithological characters." Notions often lead astray.

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## Art. XV.—*On the Age of the Quartzites, Schists, and Conglomerates of Sauk County, Wisconsin*; by Roland Irving, M. E., Professor of Geology, Mining, and Metallurgy at the University of Wisconsin.

Through the central portion of the county of Sauk, Wisconsin, run two ranges of hills or ridges, having an east and west trend, and a height varying from a mere rise above the general prairie to an altitude of five hundred feet. The width from north to south never exceeds three or four miles, and in places is much less than one mile. The total lengths from east to west, or rather, the exact points at which the peculiar rocks which make up the ridges give place to the ordinary country rock, are not as yet accurately known. These lengths, however, seem to be from fifteen to twenty miles.

The rock material of the ridges is mainly a hard dark-colored quartzite; with this in some places are siliceous and talco-siliceous schists, and two or three kinds of conglomerate. The dip of the strata, which, though in some places obscure, is in others very marked—and can *everywhere* be determined by careful observation—is *uniformly* toward the north. The angle varies from 20°–25° in the south range, to 75°–80° in the north.

The occurrence of these bold ridges in the midst of a prairie country, together with the marked contrast between their upturned and metamorphosed layers and the entirely undisturbed strata of the Potsdam and Calciferous epochs, which for miles around form the country rock, has caused much speculation and discussion. From time to time, during the past twenty years, brief notices have appeared in various journals and reports, but no careful investigation of the localities in question seems ever to have been attempted. In most of these notices, or rather in most of those that are not absurdly inaccurate in their statements and wild in their ideas, the main point under discussion has been the relative age of the metamorphic strata. Do they, or do they not, antedate the Potsdam period? Are they the results of local metamorphism on the Potsdam sandstones, or are they the remnants of pre-existing rocks? The advocates of the former theory have had the last word in the discussion.

The facts recorded in the present article are the results of a series of visits made to the localities by the writer, during the months of September, October and November of this year (1871), and they will, I think, be seen to prove beyond all doubt or cavil, that the quartzites and schists antedate entirely the Potsdam epoch, i.e., are either Huronian or Laurentian in age.

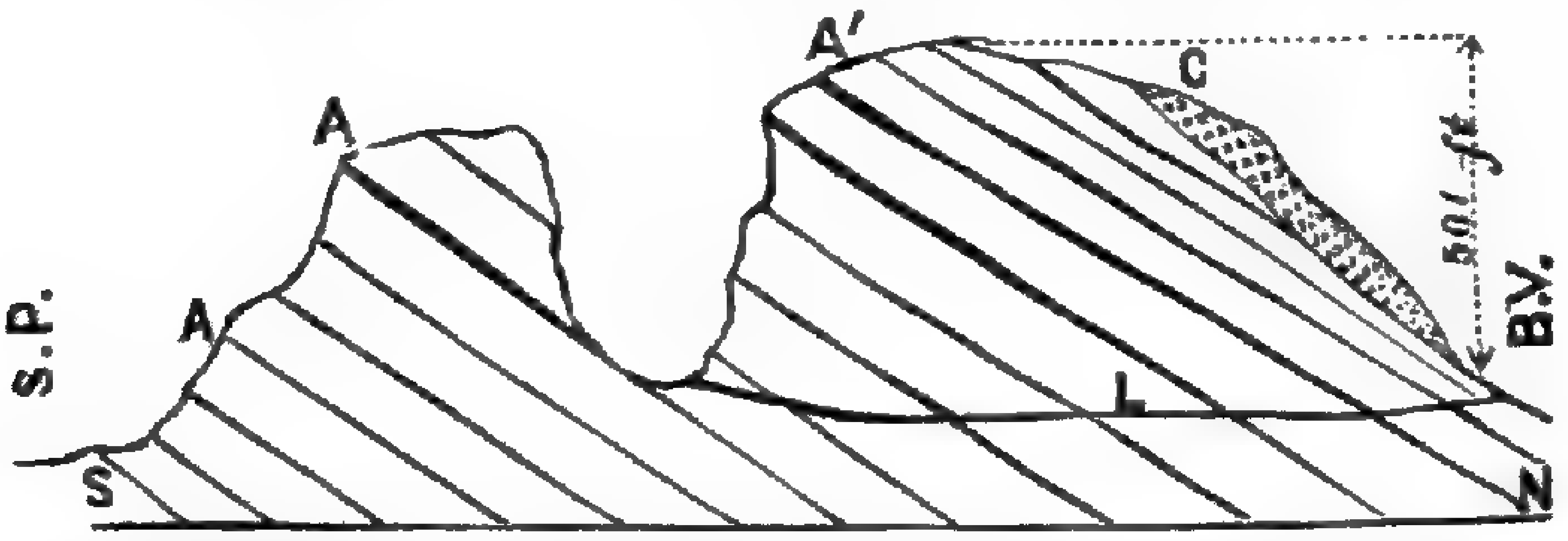
Of all of the notices mentioned, none are more than brief mentions and only a few seem to have any value at all. Dr. Shumard, in Owen's report on Wisconsin, Iowa and Minnesota, makes the first mention of the quartzite. He gives no opinion. Dr. James G. Percival, in the report of progress of the Wisconsin survey for 1856, refers again to the quartzites, calling them merely "metamorphic sandstones," but intimating that they result from a change on the Potsdam sandstones. Mr. James Hall, in his report of progress to the governor of Wisconsin for 1860, gives by far the most accurate description I have been able to find. He refers the quartzites unhesitatingly to the Huronian—but gives no proofs whatever. His pamphlet did not fall into my hands until after my own investigations were entirely completed. In the first volume of his final report, Mr. Hall again mentions the quartzites, but still more briefly, expressing the same opinion as before, and still giving no proofs. In 1864 there appeared in this Journal (II, vol. xxxvii, p. 226) an article by Mr. Alexander Winchell of Michigan, in which he describes, among others, some fossils from the conglomerates overlying the quartzites; and upon them bases his claim that the quartzites are a downward continuation of the Potsdam sandstones. He himself never visited the localities. Finally, Mr. James H. Eaton of Beloit College, in a paper read before the Wisconsin Academy of Science, in February, 1871, expresses the same opinion, though on somewhat different grounds. The foregoing list includes everything of any value that has been published on the subject.

The accompanying map includes those portions of the two ridges where most of my observations have been made.

I. The South Range, to which my attention was first directed, presents, on approaching it from Sauk Prairie on the south, a bold, and, in places, precipitous rise from the plain of from 350–450 feet. The northern side of this ridge has, however, in all places as yet studied, a much more gradual slope down to the valley of the Baraboo river, this slope being in many places determined by the northward dip. Running entirely through this ridge is a deeply cut valley, which has at first, for about two miles, a direction slightly north of west, and then turns due north quite abruptly. This northern end holds the Devil's Lake, which entirely fills the valley from side to side. Throughout its whole length the sides of this cleft are precipitous masses of quartzite rising everywhere more than four hundred feet above the bottom, and reaching at the lake an altitude of 501 feet above its level, and of 1,474 feet above the sea. The bottom of the valley is covered with a heavy mass of Drift material, and the lake is held in its position by low Drift hills at its northern and southeastern extremities. The bottom of the lake itself seems to be in a Drift sand, and is over most of its area about thirty feet below the surface of the water. The lake has no outlet; but draining as it does a very small amount of surface, the extraordinary evaporation caused by reflection from the cliffs above, together with the high winds of Wisconsin, is quite sufficient to account for its maintenance of level; whilst the character of the surrounding rock shows readily the reason for its not becoming saline.

The great exposures of cliff at this locality, and the deep rock cuttings on the newly-opened railroad, afford most excellent opportunities for study. The change of direction, too, of the valley, gives facilities for approaching the rocks from different sides, not elsewhere easily obtainable.

The rock here is mainly a hard, dark-colored, very compact quartzite, though the colors vary from a very light grey in places to deep brownish-red. The bedding joints of the quartzite are in some places rather obscure, but the railroad cuttings have so far exposed them, that with a little care I was able readily to ascertain the dip. This on both sides, and throughout the whole length, of the valley, is uniformly about 20°–25° a little west of north. Some of the writers mentioned, and notably Winchell, have described this valley as corresponding to an old anticlinal axis, but the uniform dip of the strata throughout its length proves of course that this is not the case.




SECTION 1.—North and South through the south range on section, line 1 of map. A, quartzites; A′, quartzites with some schists; C, conglomerate; S P, Sauk Prairie; B V, Baraboo Valley; L, level of Lake.

The quartzite, although often looking massive, show in many places on weathered surfaces the lamination and cross-lamination of more modern sandstones. Many of the fallen masses show, too, on exposed surfaces of lamination, the most distinct ripple markings I have ever seen. On the shallow sandy bottom at the north end of the lake below, may be found their very counterparts. Between the beds of quartzite, in many places, are thin layers of a schist principally siliceous, but having always some talcose material. These correspond apparently to the clayey or shaly layers between the beds of sand now represented by the quartzite. In some places these layers seem to be merely a thinly laminated quartzite, with talcose films covering the laminæ; in others the talcose material pervades and gives character to the whole mass, the siliceous material, however, always being present.

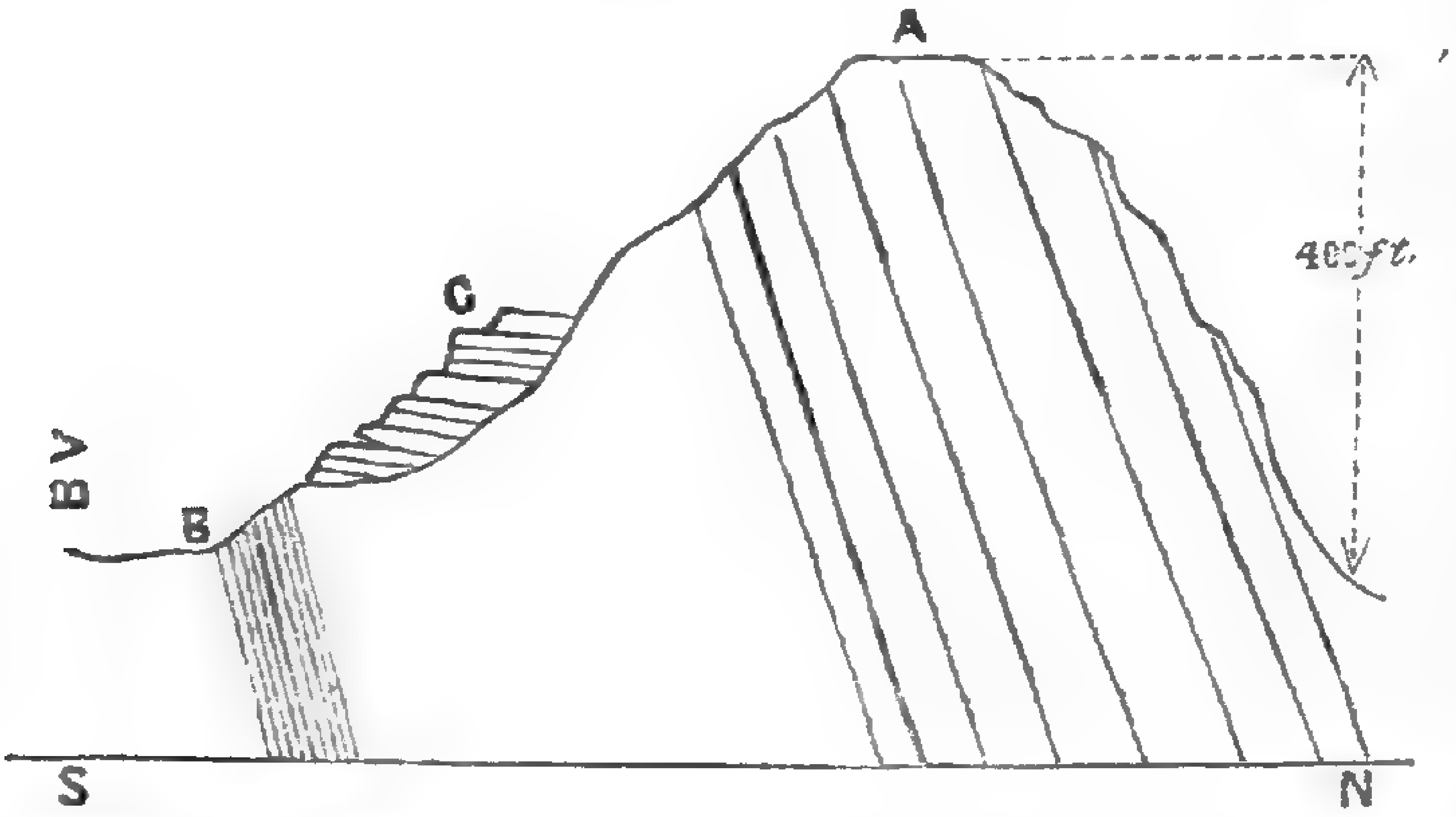
The most remarkable feature of this locality is, however, the very striking system of vertical joints which everywhere intersect the quartzite. The bearings of these joints, taken in some fifty or sixty different localities, I found to be uniformly N.E. and S.W. and S.E. and N.W., the variations in a few places being evidently due to local displacement. On the cliff sides, and more especially about the lake, these joints, together with the bedding joints, have so cut the rock into separate blocks, that these have from time to time been thrown down the bluff by frost and atmospheric agencies in huge rectangular masses, weighing by calculation from seventy-five to two hundred tons apiece.

2
3
4
5
6
7
N
W
E
S
NORTH RANGE
NORTH RANGE
BARABOO NARROWS
Detached Ridge of hor. Sandstone
Pecks Prairie
BARABOO VALLEY AND RIVER
CHICAGO & N. W. R. R.
SOUTH RANGE
DEVILS LAKE
VALLEY
SOUTH RANGE
Sauk Prairie
CHICAGO & N. W. R. R.
Wisconsin River

In many places along the north flank of this ridge and lying always above the quartzite, are outcrops of a conglomerate, containing pebbles unmistakably from the quartzite below, always rounded, and in size varying from a few lines to four or five inches in diameter. In some few places there seems to be a second conglomerate in which the sandy cement itself appears altered to a quartzite. This is a point, however, deserving of further investigation. There are also places where distinct layers of coarse and fine conglomerate occur, the latter always above and graduating into a simple sandstone.

In this conglomerate are found in one locality just north-east of the lake, the Potsdam fossils described by Mr. Winchell in the article referred to, viz: *Scolithus linearis* Hall, *Orthis Barabuensis* Hall, *Delphinocephalus Minnesotensis* Owen, &c. I have examined a collection of these fossils from the above locality in the possession of Dr. Lapham of Milwaukee, and have seen the fossils and quartzite pebbles in the same fragments side by side.

II. The observations on the North Range were made about the Lower Narrows of the Baraboo river and westward from there about half a mile. This north range seems to be less continuous both as to elevation and as to the character of its rock material. I am told by Dr. Lapham that it seems rather to be made up of detached masses of metamorphic rocks. The rising ground, however, never entirely disappears, and the quartzite seems to be found as far to the east and west as in the south range. At the Baraboo Narrows the metamorphic rocks are in great force, the cliffs on either side the river, which here makes a direct cut through the range from south to north, being as much as four hundred feet in height. The body of the bluff on the west side is made up of heavy beds of quartzite, with, in places, intercalated beds of a metamorphic conglomerate, and of a talcose schist like that in the south range. These beds all stand at a very high angle, between 75°–80° from the horizontal, the dip being north with possibly a slight inclination to the east. At the bottom of the hill on the south side is an exposure of a peculiar light-colored siliceous schist, entirely different from any of the other rocks of the series. An old shaft sunk some thirty feet on the schist, affords most excellent opportunity for examination. The total thickness seen was about twelve feet, the layers varying in thickness from a few lines to four or five inches. Very thin films of a talcose material sometimes appear between the layers. Directly above this schist, I found a horizontal undisturbed sandstone, laid open for some distance by quarrying. The beds are generally a foot or two in thickness. In the loose pieces near by are found *Scolithus linearis*, and I was assured by residents of the fossiliferous nature of the sandstone in places to which we did not have time to go. The sandstone is, of course, the Potsdam of the surrounding valleys. Section 2 will serve to give a clear idea of the structure of this bluff.




SECTION 2.—Through North range at W. Bluff of Baraboo Narrows. A, thick-bedded dark colored quartzites, with some talco-siliceous schist; B, siliceous schist; C, horizontal sandstone; B V, Baraboo Valley.

The narrow detached ridge just to the westward, represented on the map, is also made up of horizontal Potsdam sandstone. There are many other such detached ridges along the Baraboo valley, bearing the same relation to the quartzite ranges and showing the same horizontality of strata.

The following arguments in favor of the priority of these rocks to the Potsdam period will, I think, after what has been said, be admitted as valid. I give them in the order in which they became apparent to me.

1st. *The limited area of disturbance;* the undisturbed Potsdam and Calciferous strata being found north, south, and between the ridges, and in close proximity to them.

2d. *The absence of any anticlinal axes.* Dipping as the rocks do uniformly to the north, in order to place them in the Potsdam category, we must imagine a metamorphism of the strata accompanied by a great fault, having on one side the unchanged sandstones, and on the other the tilted quartzites and schists, an idea new, I think, to geology.

3d. *The occurrence of rounded pebbles of quartzite in the conglomerate on the north side of the south range.* To suppose this conglomerate, which by its fossils is unmistakably Potsdam, to be of the same period as the quartzites below, we must suppose that period to have lasted long enough to cover the deposition of the quartzites as sandstones, their metamorphism, and the rounding of the pebbles by beach action, before the formation of the conglomerate; not to speak of the time sufficient to erase all signs of an anticlinal.

4th. *The occurrence of horizontal sandstones resting unconformably on the flanks of the tilted strata.* This last is, of course, absolutely conclusive as to the *north range*, but lest it might be claimed that the two are independent, I have given the others.

Mr. Winchell argues, that, since Mr. Hall states that the fossils I have mentioned as occurring in the conglomerate are restricted to the Middle Potsdam, either this statement must be untrue or the quartzite must be the downward continuation of this formation. This argument, however, loses all force when we regard these ranges as high ridges in the Potsdam seas, never having been entirely covered by these seas, but having merely had the new sandstones and conglomerates deposited about their flanks. The place where these fossils were found must be *at least* 200 feet above the base of the sandstones of the surrounding country. A single glance at Dr. Lapham's geological map of Wisconsin will show this. The conglomerate is by no means necessarily the *base* of the Potsdam because it rests immediately on Huronian or Laurentian rocks.

In the final report of Mr. Hall already referred to, he mentions a low hill north of Baraboo, in which the middle of the hill is quartzite, and the flanks conglomerate and sandstones graduating upward into calcareo-sandy layers, without giving any further explanation. This statement, before somewhat unintelligible to me, now throws further light on my own results.

To my mind, these ridges were unquestionably islands in the Potsdam sea, and a more beautiful illustration, than is furnished by the sandstones and conglomerates of wave action on a rocky coast, can hardly be imagined.

There are several more of these scattered quartzite ranges in Wisconsin, all but one of them occurring within the Potsdam and Calciferous areas. During the coming season, I hope to be able to make a connected study of them.

University of Wisconsin, November 18th, 1871.

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## Art. XVI.—*On Canon Moseley's views upon Glacier-motion*; by William Mathews, President of the Alpine Club.*

The argument by which Canon Moseley attempts to prove that the descent of glaciers by their weight alone is a mechanical impossibility, as contained in his communication to the Royal Society, read January 7, 1869, may be stated in the following propositions:—

1. In every transverse section of a glacier every particle of ice is, at the same moment of time, moving over and alongside its neighbors.

2. The absolute motion of any point in the surface of a glacier is proportional to its distance from the nearest side, and to its height from the bottom of the channel.

* From the L., E. and D. Phil. Mag., Dec., 1871.

3. This differential motion can only take place by the process which, in mechanics, is known by the name of shear.

4. The resistance which ice offers to shearing, or its shearing-force, as ascertained by experiment in the shearing-apparatus devised by Canon Moseley, is not less than 75 lbs. per square inch.

5. But in order that the Mer de Glace may descend by its own weight, at the rate at which Professor Tyndall observed it descending at the Tacul, its shearing-force per square inch cannot be more than 1·3193 lb.

I propose in the present communication to examine these propositions.

The first has been challenged more than once in the course of the controversy, without eliciting any rejoinder from Canon Moseley, no doubt from the absence of any materials available for the support of the hypothesis. The fact is, that while we have numerous observations of the absolute motion of various points of the surfaces of glaciers, observers do not appear to have been sufficiently alive to the importance of attending to the differential motion of determining the law of its variation from molecule to molecule, and of ascertaining whether it is continuous or not.

Observations of this kind are by no means easy to make, and require to be conducted with great care and delicacy, errors which might safely be disregarded in a determination of average daily velocity becoming serious when relative and not absolute motion is the object of investigation. These errors arise from the difficulty of boring with the augur vertical holes in the ice, of driving the stakes vertically into the holes that have been bored, of renewing the holes in the same vertical when the glacier has melted away from the stakes, and from the constant tendency of the stakes to heel over to the southward in consequence of their heated faces enlarging the holes in the direction of the sun.

During a short tour in the Alps in the autumn of 1870, I attempted, in concert with my friend, Mr. A. A. Reilly, to make some observations upon differential motion, and selected the side of the Great Aletsch Glacier as the field of our operations.

By means of a well defined station on the right bank of the glacier, and a well-defined object on the left bank, we ranged out a line between 60 and 70 yards long. We drove our first stake into the ice 20 feet from the station, as near to the edge of the glacier as we could conveniently get it. I shall denote this stake by 0. We had intended to stake out the line every ten yards; but, from certain local difficulties, we were obliged to drive in stake 1 at a distance of nine yards from 0. Stake 2 was eleven yards from 1; and the remaining four stakes were placed at successive distances of ten yards each. The line between 0 and 1 was staked out into nine subdivisions of three feet each, and the space between 5 and 6 into five subdivisions of six feet.

Our work was completed in the afternoon of Monday, the 22nd of August; and the line was re-examined on Wednesday, the 24th, after an interval of forty-eight hours.

In the first place, the spaces between the stakes were carefully remeasured, with the following results:—

| Number of stake. | August 22. Distances. ft. | in. | August 24. Distances. ft. | in. |
|---|---|---|---|---|
| 0, | | | | |
| 1, | 27 | 0 | 26 | 10 |
| 2, | 33 | 0 | 33 | 0 |
| 3, | 30 | 0 | 30 | 0 |
| 4, | 30 | 0 | 30 | 4 |
| 5, | 30 | 0 | 30 | 0 |
| 6, | 30 | 0 | 30 | 0·5 |
| | 180 | 0 | 180 | 2·5 |

We were surprised to find that during the two days' interval the space between 0 and 1 had been shortened by two inches. It is not probable that this was due to an error of observation, as the difference was found to be distributed over most of the subdivisions. The elongation of the space between 3 and 4 was due to the widening of a crevasse which crossed the line obliquely in that part.

The following are the absolute and relative motions of the stakes during the two days' interval:—

| Number of stake. | Absolute motion. inches. | Relative motion. inch. |
|---|---|---|
| 0, | 2·50 | |
| 1, | 3·00 | 0·50 |
| 2, | 4·00 | 1·00 |
| 3, | 5·25 | 1·25 |
| 4, | 3·50 | −1·75 |
| 5, | 4·50 | 1·00 |
| 6, | 5·00 | 0·50 |

These figures show an increase of differential motion in proceeding from the edge of the glacier to a point about thirty yards distant, and a subsequent decrease in proceeding toward the center, with a relative regression of the ice in the neighborhood of stake 4, as indicated by the negative sign. The greatest differential motion is between stakes 3 and 4. It amounts to no more than ·875 inch in twenty-four hours over a distance of 360 inches, or about $\frac{1}{411}$ of an inch in twenty-four hours in points one inch apart. Between 5 and 6 it is only $\frac{1}{1440}$ of an inch for the same time and space.

The displacements of the stakes intermediate between 0 and 1 and 5 and 6, were also determined. Each intermediate stake was found to share in the differential motion.

The measurements were confined to a breadth of 60 yards in a part of the glacier where the distance from side to center was not less than 600 yards, and consequently only exhibit the deportment of the side ice. It was important to supplement them by examining a glacier in the central portion of the stream; and, I being obliged to return home, Mr. Reilly devoted three weeks to this purpose, and has generously placed his notes at my disposal.

The spot selected for his first operations was a part of the Glacier of Bionassay, where the stream is very slightly inclined, and the central portion nearly level from side to side and free from crevasses. The width of the glacier at this part was 320 yards, for 200 yards of which, measuring from the left bank, the surface was composed of "avalanche-ice without veined structure," the remaining 120 yards being ordinary glacier-ice.

Mr. Reilly bored the first hole about 70 yards from the right bank of the glacier, and ranged, with a theodolite, a line 170 yards in length, terminating about 80 yards from the left bank. This line was divided into seventeen equal spaces by holes bored 10 yards apart; the line was ranged and staked on the 7th of September. The holes were deepened from time to time as the glacier surface melted, and the final measurements made on the 27th, after an interval of twenty days.

The results are exhibited in the following Table—the motion on each side of No. 10, where the velocity was greatest, being exhibited in parallel columns, the negative signs indicating relative regressions of the ice at the points to which they refer:—

| Right moiety. | | | Left moiety. | | |
|---|---|---|---|---|---|
| Stations. | Absolute motion. | Relative motion. | Stations. | Absolute motion. | Relative motion. |
| | ft. in. | in. | | ft. in. | in. |
| 0, | 11 6·50 | | | | |
| 1, | 10 11·60 | −6·90 | | | |
| 2, | 11 4·25 | 4·65 | | | |
| 3, | 11 3·00 | −1·25 | 17, | 11 0·50 | |
| 4, | 11 7·25 | 4·25 | 16, | 11 3·00 | 2·50 |
| 5, | 11 6·75 | −0·50 | 15, | 11 7·00 | 4·00 |
| 6, | 11 5·25 | −1·50 | 14, | 11 6·50 | −0·50 |
| 7, | 11 6·50 | 1·25 | 13, | 11 8·50 | 2·00 |
| 8, | 11 6·00 | −0·50 | 12, | 11 7·50 | −1·00 |
| 9, | 11 9·00 | 3·00 | 11, | 11 7·00 | −0·50 |
| 10, | 11 10·00 | 1·00 | 10, | 11 10·00 | 3·00 |

Here we have a superficial area of ice 170 yards in width moving through a space of nearly 12 feet in twenty days, with an advance of the center during that interval only 10 inches in excess of the sides, the differential motion at the side being 7 inches, and at the center 1 inch in a width of 360 inches; so that two points an inch apart would in twenty-four hours move past each other to the extent of a little less than the $\frac{1}{1000}$ of an inch at the sides, and the $\frac{1}{7000}$ of an inch at the center of the area under consideration.

Mr. Reilly has not supplied me with any note of the motion of the edge of the glacier during the interval; but as the edge of the Great Aletsch was found to move at the rate of only an inch and a quarter in twenty-four hours, it probably did not exceed 2 feet. We shall therefore be justified in saying that while, in the right-hand moiety of the glacier, a differential motion of 10 inches is distributed over a width of 100 yards from the line of maximum velocity, a differential motion of at least 100 inches must be distributed over the remaining 70 yards up to the edge of the glacier.

Two of the thirty-feet spaces were staked out into subdivisions of 2 feet each. Each of the intermediate stakes exhibited a differential motion, with occasional negative signs—the greatest relative displacement observed being 2·25 inches in the twenty days, equivalent to the $\frac{1}{213}$ of an inch in twenty-four hours for points 1 inch apart.

During the intervals of his labors on the Glacier of Bionassay, Mr Reilly ranged a line across the Mer de Glace, on the Chamouni side of the Montanvert. His measurements on this line during a period of nineteen days indicate a motion very similar in its character to that of the Glacier of Bionassay. The length of this line from the left-hand edge of the glacier to the point of maximum velocity was about 1000 feet. The central 500 feet had an absolute motion of 18 feet 7·75 inches at its left-hand extremity, and of 21 feet 2 inches at its right, equivalent to a mean daily motion of about 12 inches. Its total differential motion was 28·25 inches, equivalent to a mean daily differential motion of about 1·5 inch, or $\frac{1}{4600}$ of an inch for points 1 inch apart. The nearest station to the edge of the glacier was about 165 feet distant from it; and at this station the absolute motion in nineteen days was found to be 10 feet 11·25 inches. This would indicate a marginal motion of about 4 feet, and would leave us 14 feet 6 inches of differential motion to distribute over the lateral 500 feet of the line, or six times as much as that of the central moiety.

The law of variation of the differential motion indicated by the observations above described is not new. It appears clearly from the measurements made by Professor Tyndall on the Mer de Glace, described in a communication to the Royal Society, read May 20, 1858, and published in vol. cxlix of the Philosophical Transactions. But nowhere is it brought out with more striking prominence than in the observations made by Agassiz upon the Unter-Aar Glacier, from 1842 to 1845, as described in Chapter XII. of the *Nouvelles Etudes* and in plate 4 of the accompanying atlas, where curves showing the motion, for three consecutive years, of a series of points originally in a straight line, are plotted to scale. The diagram exhibits the very small motion of points close to the side, whence the curves extend with *their concavity downward* as far as the point of maximum differential velocity, where they become convex, and gradually increase in curvature up to about one-fourth of the width of the glacier, whence they sweep across to the corresponding point on the opposite side in a curve so flattened as to be scarcely distinguishable from a straight line.

The above considerations lead to the following conclusions upon the five fundamental propositions of Canon Moseley.

1. It is probable that every molecule of a glacier moves with a very slow differential motion, which, whenever the ice is continuous, is continuous from molecule to molecule, and from moment to moment of time.

2. The hypothesis that the differential motion is uniform from center to side is wholly contrary to fact. The semisurface of every glacier may be roughly divided into two equal longitudinal strips, through the lateral of which from 80 to 90 per cent. of the differential motion is distributed, while the central strip moves downwards almost like a rigid body, with a large reserve of gravitating force capable of affecting the sides.

Canon Moseley is of opinion that this divergence between theory and fact greatly strengthens his position; but he has not made good this part of his case.

3, 4. The Canon has failed, as it seems to me, to establish any analogy between the disruption of adjacent surfaces of a solid body in a shearing-machine and the slow relative displacements of the molecules of a glacier. He has yet to prove that, because he was obliged to employ a force of 75 lbs. per square inch to shear asunder adjacent surfaces of a solid cylinder of ice through a space of 1 inch in half an hour, it would require as great a force to produce the relative displacements which occur in an actual glacier,—the latter having been shown, from the observations above described, to range for molecules the tenth of an inch apart, and an interval of twenty-four hours, from the $\frac{1}{3133}$ to the $\frac{1}{70,000}$ of an inch.*

5. On the other hand, the slow continuous displacements of the molecules of a glacier are *undistinguishable in kind* from the displacements of the molecules of an ice-plank, supported at its extremities and allowed to subside under the influence of its weight, displacements which require for their production, as I have shown in the Philosophical Magazine for November, 1871, a force considerably less than $1\frac{1}{3}$ lb. per square inch—less, therefore, than the very force which the Canon considers sufficient to shear the Mer de Glace if it descends by its own gravitation.

* This objection has been forcibly urged by Mr. Ball in the Philosophical Magazine for July, 1870.

ART. XVII.—*The Hot Springs and Geysers of the Yellowstone and Firehole Rivers;* by F. V. HAYDEN. With maps.

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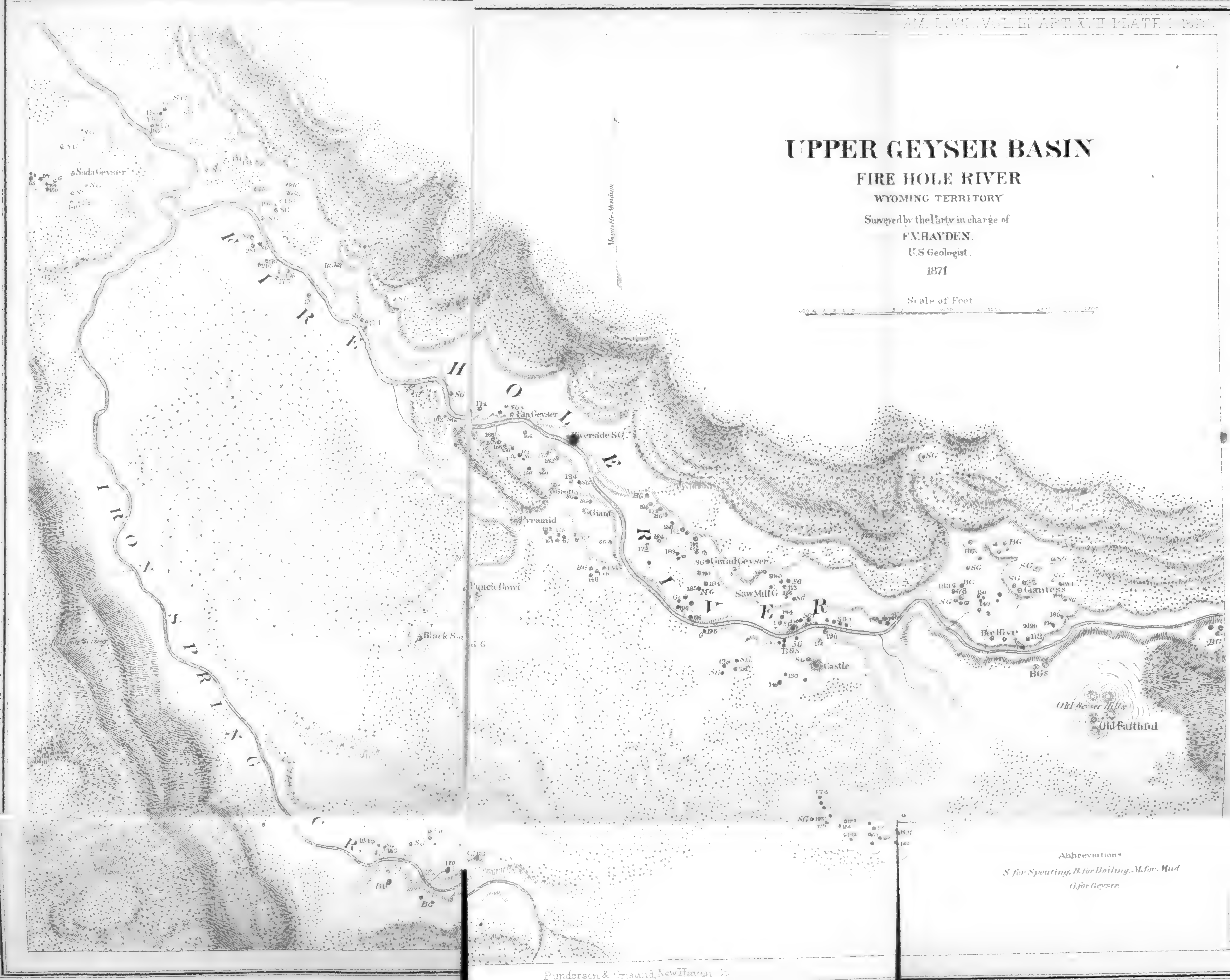
WE shall not attempt in this article to do more than to give a brief description of the hot springs and geysers of this wonderland. Their origin does not differ from that of similar springs which have been so often described in Iceland, New Zealand, and on a small scale in other portions of the world. But it was not until comparatively recent date that it was known that such a wonderful region existed in our own country. For eighteen years past the writer has heard various accounts from Indians, trappers, guides, &c., of the singular spouting springs and mountains of sulphur in the vicinity of the Yellowstone Lake; but the difficulties of access to an unknown country, and its remoteness from settlements, have prevented an examination of the region by competent persons. The party under the command of Col. Wm. F. Reynolds, U. S. Engineers, in 1859 and '60, endeavored to enter the Basin by way of the Wind River Mountains, but failed on account of the ruggedness of the mountains and the depth of snow. Our guide, Mr. James Bridger, the best mountain man the West has ever produced, was quite familiar with the country, and frequently entertained us with marvelous descriptions of the wonders of that great Basin. The rapid settlement of Montana has now rendered it an easy matter to explore this strange region; and last year Gen. Washburn and party, escorted by Lieut. Doane, U. S. A., gave us the first glowing and impressive accounts of the country.

Before entering upon a description of the hot springs, it may be well to present a brief summary of the principal geological features of the Yellowstone Basin. We may remark at once that nine-tenths of the area is covered with volcanic material in some form. The basis rocks are the usual metamorphic granitoid series of the country, with basalts and basaltic conglomerates in every variety. The sedimentary rocks belong to the Carboniferous, Jurassic, Cretaceous and Tertiary ages. It is doubtful whether any unchanged rocks older than the Carboniferous occur there. The Triassic is probably wanting. The sedimentary rocks occur in patches, covering very restricted areas, yet presenting evidence that, up to the period of the Eocene Tertiary inclusive, they once extended uninterruptedly over all the country. In the Yellowstone valley, as in the valleys of all the streams of the West, there is a chain of lake basins that must have existed during the Pliocene period. Below the first cañon near the mouth of Shields river, there is one of these basins ten miles long, and on an average four miles wide. Between the first and second cañons there is a basin about 20 miles long, and on an average four miles in width, with the modern Pliocene marls and sands covered by a floor of basalt in some places. There was a continuous chain of these lakes, of greater or less size, to the source of the river; thence it expanded out into an immense double lake, of which only a remnant now remains. The Yellowstone Lake is now about 22 miles in length from north to south, and has an average width of about 10 or 15 miles from east to west. This lake was once much larger than at present, and it was partially connected with another lake about 30 miles long and 20 wide, which terminated at the commencement of the Grand Cañon, at the Upper Falls of the Yellowstone.

Warm springs are not uncommon in the valley of the lower Yellowstone, but the temperature is seldom higher than 60° or 80°. It is not until we reach the Gardiner's river, a small branch flowing into the Yellowstone from the west side, that the true hot springs commence in their full force. This point is located about midway between the second cañon and the Grand Cañon opposite the third cañon. In ascending the Yellowstone valley, our trail left the main river and turned up the valley of Gardiner's creek About three miles above its junction with the Yellowstone we found the valley bottom covered with a thick calcareous crust, the deposits of hot springs, which are now extinct; but flowing swiftly from beneath this crust, is a stream of hot water six feet wide and two feet deep, with a temperature of 132°. A little distance farther up is a group of four placid springs, with nearly circular basins, 6 to 10 feet in diameter, and two to three feet deep. A number of invalids are living in tents near these springs, bathing and drinking the water; and they were enthusiastic in their praises of its curative effects, especially for cutaneous diseases.

The chart accompanying this paper gives the localities and temperature of these springs. Near this last group of springs we ascended a high semi-wooded hill, with here and there a grove of pines. A system of terraces has been formed on the slope of the hill, each from 200 to 300 feet in height, and these terraces were covered with a thick deposit of lime. The surface of the first and second was fast decomposing, and the springs were nearly extinct. One only reached a temperature of 140°. After ascending the hill among the pines, about three-fourths of a mile from the river bottom, we came suddenly upon one of the most remarkable exhibitions of the hot spring deposits that we have seen in this land of wonders. In the distance it looks like a vast glacier of snow and ice, and on that account we have named it the White Mountain. Indeed the different terraces can be compared for their wonderful beauty only to a



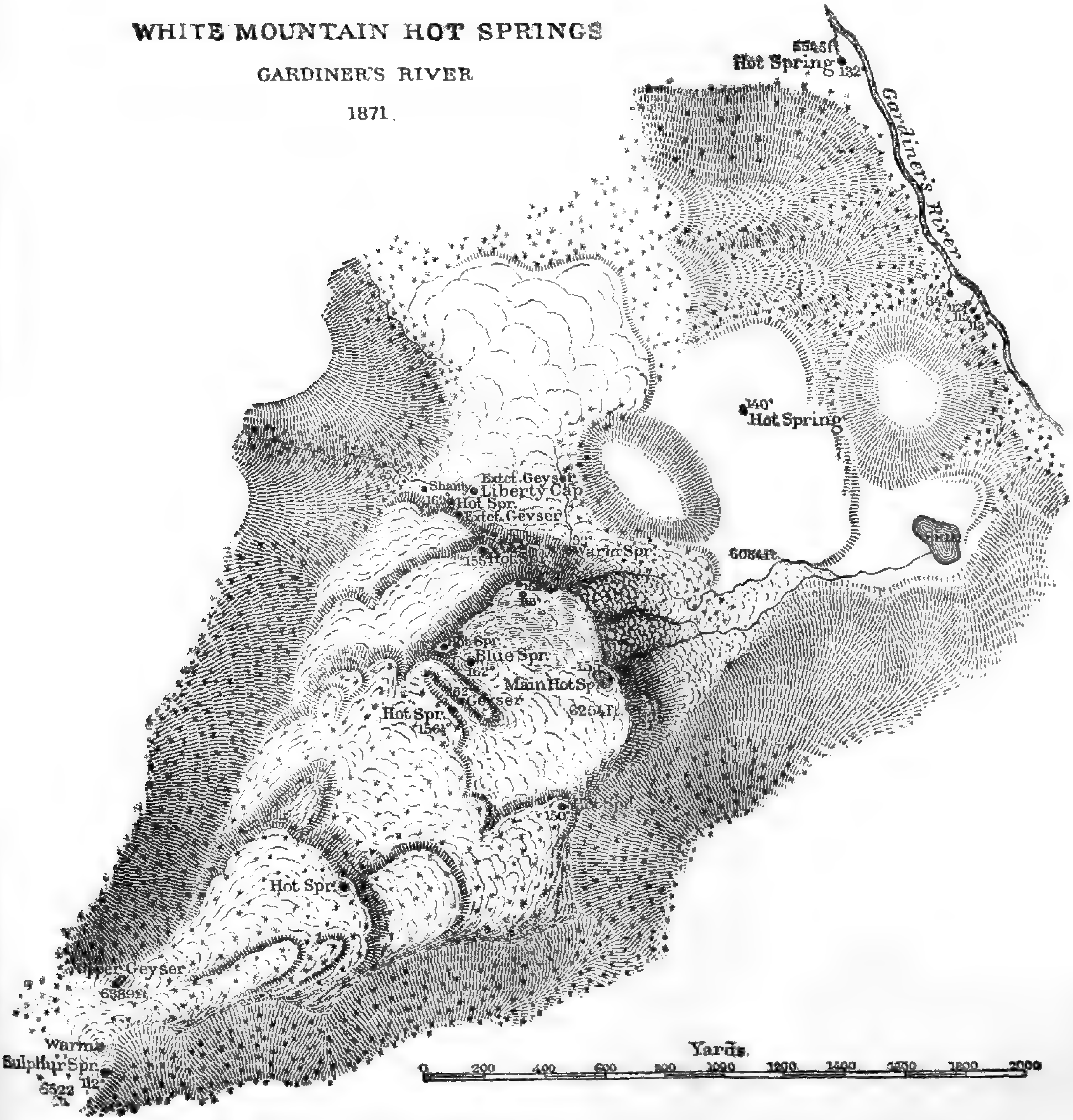
UPPER GEYSER BASIN
FIRE HOLE RIVER
WYOMING TERRITORY
Surveyed by the Party in charge of
F.V. HAYDEN.
U.S. Geologist.
1871
Scale of Feet
Magnetic Meridian
FIRE HOLE RIVER
IRON SPRING CR.
Soda Geyser
Fan Geyser
Riverside S.G.
Grotto
Giant
Pyramid
Punch Bowl
Black Sd
Grand Geyser
Saw Mill G
Castle
Giantess
Bee Hive
Old Geyser Hills
Old Faithful
Abbreviations
S. for Spouting. B. for Boiling. M. for Mud
G. for Geyser
Pundersen & Crisand, New Haven

(Plate I.)

**WHITE MOUNTAIN HOT SPRINGS**

**GARDINER'S RIVER**

**1871.**



frozen cascade. The main portion of the area occupied by these deposits is two miles square, or four square miles, and if the reader can conceive numberless springs flowing out from the mountain side and spreading over the surface, and the water slowly congealing into ice, he may have some conception of the wonderful architectural beauty of these terraces. But let us pass along the west side of this beautiful structure, and examine it in detail. We find, first, a broad flat terrace, on which are plainly visible the remains of once active springs. Old chimneys, irregular openings, like entrances to caverns, which extend beneath the crust, are numerous, and greatly excite the curiosity. How thick this crust is, it is not easy to determine, but it is probably from 20 to 50 feet, and underneath it, it is supposed that the surplus water from the active springs above flows down to the river. A little farther up we come to a series of basin-like pools, varying in diameter from 4 to 8 feet, with water from one to four feet deep, having semi-circular rims most beautifully scolloped; and underneath these rims are rows of small stalactites, with every variety of ornamentation on the surface. These continue for about fifty yards, gradually ascending, when we come to an abrupt declivity of about one hundred and fifty feet, rising in steps formed of these exquisitely moulded pools, of every size and variety. Upon the terrace above are numbers of the active springs, with basins twenty to fifty feet in diameter, some of them with several centers of violent ebullition in the same basin. The temperature of these springs at the point of outflow varies from 150° to 162°. As the water flows from the basin down the declivity from one of the beautiful pools to the other, it loses a portion of its heat, and one may find a bathing pool with any desired temperature.

These beautiful rims are higher in proportion to the steepness of the descent, and the architecture is consequently varied and attractive. Upon this lower terrace, springs are continually dying out and others are breaking out anew, and during the past summer one of them burst through the crust and now has a basin about fifteen feet in diameter. There are also several extinct geysers, or more properly speaking, springs once spouting, which at this time have entirely ceased. One of these curious cones we called the "Liberty Cap." It is a circular deposit of carbonate of lime 50 feet high, and about 25 feet in diameter at the base, looking in the distance somewhat like a conical column. The layers of deposit are arranged on the almost vertical sides of the cone like the straw on a thatched roof, or hay on a stack. This was probably a continuous spouting spring building up its own basin around it by hydrostatic force, until it reached a certain height, when that force ceased, and it closed itself up at the top in a cone-like point. The water then continued to flow through apertures in the sides until it ceased entirely. There are many examples of these rounded cones.

Upon the terrace, down about midway on the side of the mountain covered with this deposit, the principal portion of the active springs are now located; and here is presented another picture to the eye which transcends any description in words. It is only through the eye that the mind can form any adequate conception of it. Here the wonderful transparency of the water first attracts attention and excites wonder; we looked down into the clear depths and saw with perfect distinctness the minutest ornament upon the inner sides of the basin, and the exquisite beauty of the coloring and the variety of forms baffles any attempt to portray them, either with pen or pencil. And then, too, around the borders of these springs, especially those of rather low temperature, and on the sides and bottoms of the numerous little channels of the streams that flow from these springs, there is a striking variety of the most vivid colors. I can only compare them to our most brilliant aniline dyes. Various shades of red, from the most brilliant scarlet to light purple; also yellow, from deep bright sulphur through all the shades to light cream color; then also various shades of green. All these colors are rendered very vivid by the water. These springs also are full of a kind of vegetation, which under the microscope prove to be composed of Diatoms, among which Dr. Billings discovers Palmella and Oscillaria. There are also in the quiet springs, and in the little streams that flow from the boiling springs, great quantities of a fibrous silky substance, apparently vegetable, which vibrates at the slightest movement of the water, and has the appearance of the finest quality of cashmere wool.

I have mentioned only a few of the attractive features about these springs, which so charm the visitor. There is neither time nor space in an article of this kind to describe all.

Above this middle terrace are one or two other localities about three hundred feet farther up on the sides of the mountain. Here most of the springs have become extinct, a few occurring here and there on a small scale, where they formerly existed of the largest size. Now the surface is covered with the remains of an exhibition of natural architecture that must have been on even a more beautiful and grander scale than any of the others. Here we find a splendid series of those semi-circular basins, rising in steps to the very summit; but the rich scolloped borders, resting upon rows of stalactites, are now fast going to decay under atmospheric influences. A few small springs send up streams of water in jets two to four feet high. The orifices are lined with a light cream-yellow substance, evidently a mixture of lime and sulphur, covering the sides of the declivity, over which the water flows with this brilliant coating. There are also a number of chimneys, with walls from four to ten feet in height. Some of them are nearly circular at base, with an aperture at top of a foot or more, lined inside with a coating of carbonate of lime, which is hard, smooth and like porcelain in luster. The oblong mounds vary from a few feet to one hundred yards in length, ten to twenty feet in height, and fifteen to twenty feet around the base. These generally have a fissure along the summit, in some of which the waters can be heard seething and boiling like a cauldron. These fissures all have the same beautiful white porcelain lining, and in some of them the brilliancy is greatly intensified by the precipitation of vivid yellow sulphur in acicular crystals, but so delicate that they disappear at the touch. On the east side much of this deposit has been reduced to a fine powder, so that the surface is as white as snow. A qualitative analysis made at the springs, shows that the water contains sulphuretted hydrogen, lime, soda, alumina, and a slight amount of magnesia. Carbonate of lime predominates over all other elements in the deposits, and they may therefore be called calcareous springs.

There are two classes of springs in the Yellowstone valley, one in which lime predominates, the other, silica. With the exception of the White Mountain Springs, on Gardiner's river, and one or two of not much importance, the other springs of the Yellowstone and Firehole Basins are siliceous. They may be divided again into intermittent, boiling and spouting, and quiet springs. Those of the first class are always above boiling point during the period of action, but during the interval the temperature lowers to 150°. Those of the second are always at the boiling point, and some of them throw the water up two to six feet, by regular pulsations. The springs of the third class may have once been geysers, but are now quiet, and have a wide range of temperature, from 188° to 80°. Where the temperature is reduced below 150°, great quantities of the sesquioxide of iron are deposited by the water, lining the inside of the funnel and covering the surface wherever the water flows. These are designated as iron springs on the chart.

An interesting question now arises in regard to the probable time required for the deposition of this material. The position of the active springs is continually changing. Taken in the aggregate, these springs have been in constant operation during our present period. The center of activity may have removed and returned to its present position several times. I have not the data to estimate with any degree of accuracy the period of any one era of deposition. Around the springs which are now active are dead pines standing from six to eighteen inches in diameter, buried in the calcareous deposit four to six feet.

From such evidence as I could gather, I should estimate that under favorable circumstances, at least six feet of the deposit have been precipitated within the space of one century.

There is another interesting feature connected with these hot spring deposits, and that is the great antiquity as well as compactness of some of them. Upon the summits of mountains 1500 to 2000 feet above the river, and having evidently been lifted up by the forces that elevated the whole range, is a bed of regularly stratified limestone, varying in thickness from 50 to 150 feet, very hard, white and yellowish-white, and appearing in the distance like very pure Carboniferous limestone. It is evident that this bed of limestone extended over a large portion of the valley at one time, for immense masses have broken off and are scattered all over the sides of the mountain, even down to the river. Near the margin of the mountain there is a belt a mile long and a fourth of a mile wide, covered with the masses of limestone broken from the main bed. This rock is so hard that it would make excellent as well as remarkably beautiful building material, and could be converted into the whitest of lime. We may ask the question whether the geological structure of this region has anything to do with the calcareous character of this deposit. On the side of Gardiner's river opposite the hot springs, there is a bluff extending about six miles composed of 1500 feet, in the aggregate, of Upper Cretaceous and Eocene Tertiary strata, with some irregular intercalated beds of basalt. A thick bed of basalt upon the summit rests unconformably on the Tertiary beds. This group of strata inclines northeast at a moderate angle. This group undoubtedly extended across the river, southwestward over the area now occupied by the hot springs. Underneath the hot spring deposit beds of older date incline in the same direction, the angle of dip increasing as we ascend the mountains. The entire side of the mountain is covered either with basalt or a thick deposit of local detritus, but here and there we find an outcrop of arenaceous limestones full of Jurassic fossils. We therefore know that beneath this calcareous deposit there are at least 1500 feet of Carboniferous limestones. If the origin of the heat that so elevates the temperature of the waters of these springs is as deep seated as is generally supposed, then the heated waters have ample play for their powers in dissolving the calcareous rocks beneath.

As a general rule, the groups of hot springs are in the lower valleys, either along the margins of streams or nearly on a level with them. In the case of those just described, Gardiner's river is 5,545 feet elevation, while the summit of the upper terrace, as shown on the chart, is 6,522 feet, so that the upper springs are nearly a thousand feet higher upon the sides of the mountain than those along the immediate margin of the river. Near the head of the East Fork of the Yellowstone there are two or three localities where these calcareous deposits cover limited areas. At one locality near the margin of the stream, there is a very instructive mound, about fifty feet high, with a broad base of 150 feet, rising more gradually to the summit, which is broad, mammiform. The deposit was originally made in thin layers overlapping each other like a thatched roof. This was undoubtedly at one time a spouting spring. It commenced with a very moderate force, nearly overflowing its basin, and building up about 10 feet in thickness of thin, nearly horizontal layers; then it commenced gradually rising until it reached a height of about 50 feet, when it closed itself up at the summit and died out. There is not a sign of water in it at the present time, and none of the springs in the vicinity are above the temperature of ordinary spring water.

We must omit an account of the basaltic columns exposed in the cañons of the Yellowstone and Gardiner's river, and of the great cañons, falls, cascades, and other wonders of this unique region, and pass to the hot springs of the upper basin. A few springs are seen at the mouth of Tower Creek, at the lower end of the Grand Cañon, but it is not until we pass the range of mountains which forms the north wall of the upper basin, about 20 miles above the Lake, that the great hot spring district of the Yellowstone commences. There is here an area, within the drainage of the Yellowstone, 40 miles in length, and on an average 15 miles in width, that either is at the present time, or has been in the past, occupied by hot springs. The old deposits cover the region, and here and there are groups of active springs, mere remnants of what formerly existed. The Grand Cañon is a deep channel 1,000 to 1,500 feet in depth, carved out of the basaltic rocks and hot spring deposits, and on the sides of the walls may be seen the irregular fissures which communicate from the surface with the heated interior. Resting upon an irregular surface of basalt are immense deposits of silica of all colors, every shade of red, yellow and white; much of the deposit is as white as snow. The remarkable beauty as well as grandeur of the great cañon is largely due to the exquisite delicacy and variety of colors arising from the former action of hot springs.

On the west flank of Mount Washburn there is a remarkable group of springs in a constant state of action at the present time. Alum, sulphur, soda and common salt are found upon the surface in considerable quantities. Sulphuretted hydrogen is emitted from the springs in such quantities as to fill the air, rendering it oppressive with sulphurous odor. This group extends across the Yellowstone to the eastward for several miles.

(Plate II.)

## SULPHUR AND MUD SPRINGS
## CRATER HILLS

Yellowstone River. 8 Miles below the Lake

The springs, which are now in active operation, are only a few out of hundreds which once covered the entire area, but which are now dead or dying out.

The two groups, which I will notice next, are called the Sulphur and Mud Springs (see the accompanying charts). The largest group is found on the east side of the Yellowstone, at Crater Hills, eight miles below the Lake. This district covers an area of about half a mile square, and is sometimes called the "Seven Hills," from the fact that there are here several mounds of siliceous deposits from extinct springs, varying in height from 50 to 150 feet. The old craters of dead and dying springs, and the immense quantity of the siliceous deposits, show that the present active springs represent only the last stages of what must have been at some period in the past a magnificent group. Even those which now remain excite intense astonishment. All around the base and high up on the sides of the hill are numbers of vents from which steam is constantly issuing, and around the edges and inside the orifices a layer of sulphur of the most brilliant yellow color has been precipitated. On the west side, one of these jets produces a sound like that of a locomotive, which can be heard for a long distance. The surface is fairly riddled with little steam vents, and the crust sends forth a hollow sound beneath the tread; and on removing this shelly covering at any point, hot vapors come forth, while its under surface is encrusted with the most beautiful crystals of sulphur.

The springs at this point are either boiling, mud, or quiet springs. The principal boiling spring is near the base of the hills, and is in a constant state of violent ebullition, sending up a column of water two to four feet. It has a basin about 15 feet in diameter, and gives forth such a column of steam that I could not approach it except upon the windward side. The rim of this spring is a marvel of beauty. It is composed of silica, but scolloped and covered over with the most delicate bead-work, and upon the pure white silica is deposited a thin layer of sulphur of the most delicate cream color. One large quiet turbid spring had a basin of 30 by 50 feet, and a temperature of 163°.

But perhaps the most interesting objects here are the mud springs, which are of every size, from an inch in diameter to twenty feet. One of the largest has a basin about 20 feet in diameter, and is filled with fine light-brown mud, which is in a constant state of agitation, the surface covered all over with puffs like hasty pudding. Others send forth a thud-like noise every second, with an impulse at longer intervals that throws the mud up several feet. The water in the vicinity, as well as the mud, seems to be thoroughly impregnated with alum; a small stream that flows from this group of springs is called Alum

(Plate III.)

## SULPHUR AND MUD SPRINGS

**Yellowstone River. 6 Miles below the Lake**

creek. In the valley of this stream are hundreds of little mud or turbid water vents, which keep up a simmering noise, showing the nature of the earth beneath the crust. Several of our party broke through the thin covering, and were severely scalded by the hot mud.

Two miles above, on the same side of the Yellowstone, is another group of springs, which, like those just noticed, are boiling, turbid, placid or mud springs. Besides, there are the geysers, to which I will just allude. One of these is a true intermittent spring, and throws up a column of water ten feet in diameter, for fifteen to thirty feet. The crater becomes filled with boiling water; suddenly immense columns of steam shoot up with a rumbling noise, the water overflows the basin, and then a column of water is thrown up for the space of ten or fifteen minutes, when it quiets down and the basin is nearly empty. This operation was performed eight times in twenty-six hours. Upon the side of the hill bordering the river is one of the most terrific mud cauldrons we saw during the trip. A large column of steam is constantly ascending, 500 feet or more, from a deep funnel-shaped basin, 25 feet in diameter; when the wind carries away the steam for a moment, the thin black mud may be seen about 20 feet below the rim in the most violent state of agitation, with a noise like distant thunder. The ground as well as the trees for a horizontal distance of 200 feet around were covered with the mud which had been ejected at some of its periodical outbursts. It would require a volume to describe these springs in detail.

[To be continued.]

## Art. XVIII.—*Notes on Granitic Rocks.*—Part III; by T. Sterry Hunt.

(Continued from vol. i, p. 191.)

**Contents of Sections.—§ 32, Laurentian gneisses; § 33, Pyroxenites and limestones; § 34, Absence of mica-schists; § 35, Classes of veins; § 36, Granitic veinstones; § 37, Similar veins in Norway; § 38, Minerals of granitic veins; § 39, Evidences of concretionary origin; banded structure; § 40, Incrustations of crystals; § 41, Skeleton-crystals; § 42, Rounded crystals; § 43, Quartz crystals in metalliferous veins; § 44, Types of veinstones; feldspathic; § 45, Calcareous veinstones; § 46, Order of succession of minerals; § 47, Attitude of the veins; § 48, Calcareous veinstones in higher rocks; § 49, Supposed eruptive limestones.**

§ 32. It was mentioned at the close of the second part of this paper that the third part would be devoted to the consideration of the granitic veinstones found in Laurentian rocks. The stratified rocks of this ancient gneissic series, as I have elsewhere pointed out, differ considerably from those of the White Mountain series, which, with their veinstones, have been treated of in the second part of this paper, § 16—§ 23.*

The Laurentian series, the Lower Laurentian of Sir William Logan, as studied by him in a region to the north of the Ottawa, the only area in which it has yet been examined in detail, appears to consist of an alternation of conformable gneissic and calcareous formations. The latter are three in number, each from 1000 to 2000 feet or more in thickness, and separated by still more considerable formations of gneiss and quartzite; a mass of gneiss of great but unknown thickness forming the base (Geology of Canada, page 45). The gneissic rocks of the series are very firm and coherent, reddish or grayish in color, often very coarse-grained and granitoid, sometimes with but obscure marks of stratification; and frequently porphyritic from the presence of large cleavable masses of reddish orthoclase, occasionally with a white triclinic feldspar. They are often hornblendic, and sometimes contain small quantities of dark-colored mica. A white granitoid gneiss, composed chiefly of orthoclase and quartz, sometimes contains an abundance of red iron-garnet. The latter mineral is often disseminated, or forms subordinate beds in the quartzites of the series.

§ 33. With the crystalline limestones of the calcareous parts of the series are often found strata made up of other minerals to the entire exclusion of carbonate of lime, by an admixture of which, however, they graduate into the adjacent limestones. These beds generally consist of pyroxene, sometimes nearly pure, and at other times mingled with a magnesian mica, or with quartz and orthoclase, often associated with hornblende, serpentine, magnetite, sphene and graphite. These pyroxenite rocks are generally gneissoid or granitoid in structure, and sometimes very coarse-grained. They occasionally assume a great thickness, and are then often interstratified with beds of granitoid orthoclase gneiss, into which the quartzo-feldspathic pyroxenites pass by a gradual disappearance of the pyroxene. The limestones often include serpentine, pyroxene, hornblende, phlogopite, quartz, orthoclase, magnetite and graphite; so that the same minerals are common to them and to the pyroxenic strata, which may be looked upon as marking the transition between the gneissic and the calcareous parts of the series.

* A good example of a large vein of this kind of intersecting rocks, apparently of the White Mountain series, may be seen in the Ramble in the Central Park in the city of New York. Its place is marked by a great erratic block perched directly over the vein.

The banded structure described in § 21 is well shown in a narrow granitic vein which I owe to Prof. Haughton of Trinity College, Dublin, got from Three Rock Mountain near that city. It consists of white orthoclase, with quartz and some mica and garnet, and exhibits near the middle two bands of prisms of black tourmaline pointing towards the centre, which is filled with a coarsely crystalline orthoclase.

These strata, marked by the predominance of calcareous and magnesian silicates, appear, so far as known, to accompany each of the limestone formations of the Laurentian, sometimes, however, developed to a greater and sometimes to a less extent.

§ 34. I have elsewhere called attention to the fact that the highly micaceous schists and the argillites of the Green Mountain and White Mountain series of rocks, are, so far as known, wanting in the Laurentian, and with them the characteristic minerals of the latter series, staurolite, andalusite and cyanite. There are, however, beds of a highly micaceous rock in the Laurentian, which contain an unctuous magnesian mica with a pyroxenic admixture; these are very unlike the mica-schists composed of a non-magnesian mica and quartz, with orthoclase, which abound in the White Mountain rocks. These magnesian beds belong to the calcareous horizons in the Laurentian series, at which also occur the most numerous veins and the principal minerals of economic value. It is also along these horizons, marked by softer rocks, that the valleys and the arable lands of the Laurentian areas are chiefly found, and for this reason, also, the mineralogy of these parts is better known than that of the harder gneissic portions. The above observations on the lithological character of the stratified rocks are important on account of the relations between these and the included veins, in which the characteristic minerals of the gneissic and calcareous rocks are often found associated.

§ 35. The history of these veins, as seen in the Laurentian rocks of the Laurentides in Canada, the Adirondacks of northern New York, and the Highlands of southern New York and New Jersey, has been discussed at length by the author in an essay on The Mineralogy of the Laurentian Limestones, in the Report of the Geological Survey of Canada for 1863–69, pages 181–223.* In this essay, which will be frequently referred to in the present paper, the veinstones found in the Laurentian rocks have been noticed under three heads: 1st, Metalliferous veins carrying galenite, blende, pyrite and chalcopyrite in a gangue of calcite, sometimes with barytine and fluorite: these, which are of Paleozoic age or still younger, cut the Potsdam sandstone, the Calciferous sandrock, and probably also the overlying Trenton limestones. 2d, Quartzo-feldspathic veins with muscovite, tourmaline, zircon, etc. These veins I have described as passing by insensible gradations into the third class, in which calcite and apatite, with pyroxene, phlogopite and other calcareous and magnesian silicates predominate, though frequently accompanied by quartz and orthoclase. These veins are older than the

* This essay is reprinted, with some additions, in the Report of the Regents of the University of New York for 1867, Appendix E. The reader's attention is called to the note on the Hastings rocks at the close of this reprint.

Potsdam sandstone, which rests upon their eroded outcrops, and sometimes includes worn fragments of apatite derived from them.

§ 36. It is these last two classes which it is proposed to consider in the present paper under the name of granitic veinstones. In justification of the extension of the term granitic to the whole of this series of veins, it must be repeated that it is not possible to draw a line of distinction between those in which quartz and orthoclase are the characteristic minerals, and those in which calcite, apatite, pyroxene and phlogopite prevail, sometimes to the entire exclusion of quartz and feldspar, both of which minerals are, however, frequently intermixed with the preceding species in the same aggregate. In one example, in Burgess, Ontario, the sides of a large vein are occupied by a mixture of calcite and apatite, while the center is filled by a vertical granite-like layer of reddish orthoclase, with a little quartz and green apatite. Of another vein in the township of Lake in Ontario, one portion was found to consist of calcite with yellow phlogopite, while an adjacent part consisted of quartz, with brown tourmaline, bismuthine, native bismuth, and graphite.

§37. The resemblance between the minerals of these Laurentian veinstones and the same species brought from Norway, was noticed so long ago as 1827, by Dr. William Meade (this Journal I, xii, 303). Daubrée, in his account of the metalliferous deposits of Scandinavia, published in 1843 (Ann. des Mines, IV, iv, 199, 282), has given us a careful description of the veins from which these minerals are derived. From this, together with the observations of Scheerer and Durocher, we are enabled to compare these veinstones with those of the Laurentian rocks in North America, and show, as I have, in the essay referred to, done in detail, and for each principal species, the great similarity which exists between the two. In the so-called Primitive Gneiss formation of Scandinavia, these veins occur either in gneiss or in a gneissoid rock consisting of various admixtures of pyroxene, hornblende, garnet, epidote and mica, the whole associated with crystalline limestones. The veins which abound in the gneiss near the iron mines of Arendal in Norway, according to Daubrée, though occasionally containing calcite, apatite, hornblende and scapolite, are sometimes destitute of all calcareous and magnesian minerals, and become granite-like aggregates of orthoclase and quartz. He hence describes these veins, as a whole, though frequently abounding in lamellar calcite, as essentially granitic in character. As already noticed in § 8, Daubrée agrees with Scheerer in regarding these veinstones as produced by a process of secretion, in opposition to Durocher, who looked upon them as having been formed by igneous injection.

§ 38. The principal mineral species known in the corresponding veinstones of the Laurentian rocks of North America are the following: *calcite*, *dolomite*, fluorite, *apatite*, *serpentine*, chrysolite, *chondrodite*, *wollastonite*, *hornblende*, *pyroxene*, *pyrallolite*, gieseckite, *scapolite*, petalite, *orthoclase*, oligoclase, *albite*, *muscovite*, *phlogopite*, seybertite,* *tourmaline*, *garnet*, idocrase, *epidote*, allanite, zircon, spinel, chrysoberyl, corundum, *quartz*, *sphene*, rutile, menaccanite, *magnetite*, *hematite*, *pyrite* and *graphite*. To which may be added some rarer species, such as tephroite, willemite, franklinite, zincite, warwickite, found in a few localities only, and others of less importance. Of the above list, those species whose names are in italics have been recognized as constituent minerals in the stratified rocks in which the veins occur, as pointed out by me in the essay already noticed.

The most important species in these veinstones are calcite, quartz, orthoclase, phlogopite, pyroxene, apatite and graphite, of which some one or more will generally be found to prevail in the veins in question. The greater part of the species named in the first list were observed by Daubrée in the veins near Arendal, and to these he adds axinite, gadolinite, and more rarely beryl and leucite;† while in the island of Utoë, associated with iron ores, crystalline limestones. and hornblendic rocks passing into gneiss, are similar granitic veinstones containing orthoclase and quartz, with tourmaline, cassiterite, and in the middle of the veins, petalite, spodumene and lepidolite. This association is the more worthy of notice, as the only other known locality of petalite (if we except the castor of Elba) is in the crystalline limestone of Bolton, Massachusetts, where it occurs, probably in a veinstone, with scapolite, hornblende, pyroxene, chrysolite, spinel, apatite and sphene.

§ 39. Evidences of the concretionary origin of these granitic veinstones of the Laurentian rocks appear in their banded structure, their drusy cavities, the peculiar incrustations and modes of enclosure often observed in the crystals, and finally

* The species seybertite (clintonite or xanthophyllite) has acquired a new interest from the recent announcement by Jeremejew (*ante* page 57), that the variety found in the Schischimskian Mountains in the Urals is the gangue of diamonds, which are found abundantly in microscopic crystals imbedded in its laminæ. The seybertite of this region (the xanthophyllite of G. Rose) is described as occurring in talcose slate with serpentine (which also include diamonds), while in the Laurentian rocks it is only known in calcareous veinstones with spinel, pyroxene, graphite, etc.

† For a notice of the occurrence of leucite in these veins, and also in veins in Mexico, see the author's Contributions to Lithology (this Journal, II, xxxvii, 264). According to Garrigou, this rare species occurs both well crystallized and in compact porphyroid masses, in dioritic rocks (ophites) at Lusbé in the valley of Aspé, in the Pyrennees (Bull. Soc. Geol. de Fr., II, xxv, 727).

in the rounded forms of certain crystals, which show a process of partial solution succeeding that of deposition. A banded arrangement of the materials parallel to the sides of the vein is often well marked. Thus, while the walls may be coated with crystalline hornblende, or with phlogopite, the body of the vein will be filled with apatite, in the midst of which may be found a mass of loganite, or of crystalline orthoclase mixed with quartz, filling the center of the vein, as already noticed in § 36. In other instances portions of the vein will be occupied by crystals of apatite, pyroxene or phlogopite imbedded in calcareous spar, which in some other part of the breadth of the vein, or in its prolongation, will so far predominate as to give to the mass the aspect of a coarsely crystalline lamellar limestone. Prisms of apatite are often observed extending from either side toward the center of the vein, which in some cases may be filled with calcite or another mineral, and in others is a vacant space lined with crystals. Drusy cavities of this kind a foot in breadth and several feet in length and depth, are sometimes met with in these veins in Ontario.

§ 40. Further evidence of concretionary origin is seen in the manner in which the various minerals incrust each other. Thus small prisms of apatite are enclosed in large crystals of phlogopite, in pyroxene, in quartz, and even in massive apatite; crystals or rounded crystalline masses of calcite are imbedded in apatite and in quartz, and well-defined crystals of hornblende (pargasite) in pyroxene. In another example before me, small crystals of hornblende are implanted on a large crystal of pyroxene, and both, in their turn, are incrusted by small crystals of epidote. Crystalline graphite in like manner is enclosed alike in orthoclase, quartz, calcite, phlogopite and pyroxene.

§ 41. Another noticeable evidence of the concretionary origin of these veins is the phenomenon already referred to in § 25, where the external skeleton or frame-work of a crystal is complete, while the space within either remains empty, or is filled with other minerals, often unsymmetrically arranged. This condition of things is rendered intelligible by the formation of similar hollow crystals during the cooling of certain saline solutions, as for example potash-nitrate. Small hollow prisms of red and green tourmaline, closely resembling the hollow niter crystals, are common in the well-known granitic veinstone of Paris, Maine. I have elsewhere referred to the formation of such moulds or skeleton-crystals as having taken place in vein-cavities, and as serving to explain many cases of enclosure of mineral species (Address to the A. A. S., Indianapolis, 1871. Amer. Naturalist, vol. v, page 491). In addition to the examples there cited, the Laurentian veinstones afford some curious cases. Thus a prism of yellow idocrase half an inch in diameter, from a vein in Grenville, Ontario, composed chiefly of orthoclase and pyroxene, is seen when broken across to consist of a thin shell of idocrase filled with a confused crystalline aggregate of orthoclase, which encloses a small crystal of zircon. In like manner large crystals of zircon from similar veins in St. Lawrence County, New York, are sometimes shells filled with calcite.

§ 42. The rounded forms of certain crystals in the Laurentian veinstones, was, I believe, first noticed by Emmons, who observed that crystals of quartz imbedded in carbonate of lime from Rossie, New York, have their angles so much rounded that the crystalline form is nearly or quite effaced, the surface being at the same time smooth and shining. This appearance is occasionally observed in other localities, and is not confined to quartz alone, crystals of calcite and of apatite sometimes exhibiting the same peculiarity. At the same time the orthoclase, scapolite, pyroxene and zircon, which are associated with these rounded crystals, preserve all their sharpness of outline, as was observed by Emmons for the orthoclase in contact with the crystals of quartz just described. He suggested that the rounded outlines of these crystals were due to a partial fusion, although he did not overlook the fact which renders this explanation untenable, that the species presenting rounded angles are much less fusible than those which, in contact with them, preserve their crystalline forms intact (*Geology of the First District of New York*, pages 57–58). These facts are well shown in the apatite-veins of Elmsley and Burgess, Ontario, where the crystals of apatite rarely present sharp or well defined forms; but, whether lining drusy cavities or imbedded in the calcite or other minerals of the veinstone, are most frequently rounded or sub-cylindrical masses, while the pyroxene and sphene, which often accompany them, preserve their distinctness of form. This rounding of the angles of certain crystals appears to me nothing more than a result of the solvent action of the heated watery solutions from which the minerals of these veins were deposited; the crystals previously formed being partially redissolved by some change in the temperature or the chemical constitution of the solution. Heated solutions of alkaline silicate, as shown by Daubrée, are without action on feldspar, as might be expected from the fact observed by him of the production of crystals of feldspar, as well as of pyroxene, in the midst of such solutions. These liquids would, however, doubtless attack and dissolve apatite, which is in like manner decomposed by solutions of alkaline carbonate, and these latter at elevated temperatures dissolve crystallized quartz. That this solvent process has been repeated during the filling of the veins is seen by a specimen in my possession, which shows crystals of calcite previously rounded and enclosed in a large crystal of quartz, the angles of which are also nearly obliterated. From the alternations in the deposited mineral matters in many veinstones, as well as from what we know of the changing composition of mineral springs, it is evident that the waters circulating in the fissures now occupied by veins, must have been subject to periodical variations in composition.

§ 43. In the *Geology of Canada* (page 729), I have noticed an example of rounded quartz crystals in the veins at the Harvey Hill copper-mine in Leeds, Quebec. Large terminated prisms of limpid colorless quartz are there found imbedded in compact erubescite, their angles being much rounded, while their faces are concave, and have lost their polish, retaining only a somewhat greasy lustre. A thin shining green layer, apparently of a silicate of copper, covers the surfaces of the ore in contact with the crystals. From the mode of their arrangement in certain specimens, it is evident that these prisms of quartz, lining drusy cavities, were partially dissolved previous to the deposition of the metallic sulphide.

§ 44. Some of the more important types of Laurentian veinstones may now be noticed. Those made up of quartz with orthoclase, muscovite and black tourmaline, often with zircon, are not unfrequent in the Laurentian gneiss, though so far as yet observed less abundant than in the gneisses and mica-schists of the White Mountain series. It is true, as already pointed out, that from the greater softness of the enclosing rocks the veins of the latter series are often weathered into relief (§ 20), and are thus rendered more conspicuous than those in the harder Laurentian gneisses. Among other examples of this first type of granitic veins may be mentioned those in Yeo's Island among the Thousand Isles of the St. Lawrence, and the well known vein in Greenfield near Saratoga, remarkable for affording crystals of chrysoberyl. A frequent type among the Laurentian granitic veins is characterized by great cleavable masses of reddish or reddish-brown orthoclase, with quartz and but little mica. With these are sometimes associated equally large masses of white or pale-colored albite; these veins are sometimes of great size, 100 feet or more in breadth. The perthite of Thompson, well known as a cleavable feldspar made up of alternate thin plates of reddish-brown orthoclase and white albite, forms with quartz a large granitic vein; while the peristerite of the same author is an opalescent or chatoyant albite which occurs with quartz in another vein in the same region. Some of the veins of red orthoclase include large cleavable masses of dark green hornblende, occasionally with magnetite. A remarkable vein about eighty feet in width, in Buckingham, Quebec, is composed entirely of reddish-white orthoclase and cleavable magnetite, the latter in masses sometimes two or three inches in diameter, scattered through the feldspar.

§ 45. The veins hitherto noticed occur in gneiss, but on the river Rouge one consisting of large masses of quartz and albite is found in crystalline limestone. A remarkable vein described by Sir William Logan in Blythefield, Ontario, traverses alternate strata of limestone and gneiss, and has a breadth of not less then 150 feet. It consists in great part of a coarsely cleavable pale green pyroxene (sahlite), with a dark green hornblende, phlogopite and calcite. Portions of the veinstone, however, consist of an admixture of orthoclase, quartz and black tourmaline, showing the transition from the calcareous to the feldspathic type of veins. In Ross, Ontario, a vein holds large isolated crystals of white orthoclase imbedded with black spinel, apatite and fluorite in a base of lamellar pink carbonate of lime. One of the most remarkable of these composite veins is in Grenville, Quebec, and was formerly worked for graphite. It cuts a crystalline limestone, itself holding graphite and phlogopite, and has afforded not less than fourteen distinct mineral species, viz: calcite, apatite, serpentine, wollastonite, pyroxene, scapolite, orthoclase, oligoclase, garnet, idocrase, zircon, quartz, sphene and graphite. An adjacent vein abounds in phlogopite, with pyroxene and zircon. A not less remarkable vein is that described by Blake in Vernon, New Jersey (this Journal, II, xiii, 116), in which calcite, fluorite, chondrodite, phlogopite, margarite, spinel, corundum, zircon, sphene, rutile, menaccanite, pyrite and graphite occur. Some of these contain barytine, and in one case I have observed natrolite, both seemingly filling cavities, and of later origin than the other minerals. The remarkable zinciferous minerals, franklinite, zincite and dysluite, found in the Laurentian limestones of New Jersey, appear from the descriptions of H. D. Rogers to belong to calcareous veinstones. Granitic veins are found traversing the magnetic-iron ore beds of the Laurentian series. I have described one in Moriah, New York, which includes angular fragments of the magnetite which forms its walls, and consists of a cleavable greenish triclinic feldspar, with quartz crystals having rounded angles, octahedrons of magnetite, allanite, and a soft greenish mineral resembling loganite.

§ 46. As regards the order of deposition of minerals in these veins, we find apatite enclosed alike in calcite, in quartz, in phlogopite, in spinel, in graphite and in pyrite. On the other hand, apatite sometimes includes rounded crystals of calcite or of quartz; and graphite, which itself encloses apatite, is found included alike in quartz, in orthoclase, in pyroxene and in calcite, in such a manner as to lead us to conclude that its crystallization was contemporaneous with that of all these minerals; while from the other facts mentioned it would appear that the order of deposition was subject to variation and to alternations. In a vein in Grenville, large prisms of a white aluminous pyroxene (leucaugite) penetrate great crystals of phlogopite, while at the same time small crystals of a similar mica are completely imbedded in the crystallized pyroxene. Many facts relating to the association of various species in these veinstones will be found in my essay, but the subject is one which still demands careful study. The banded structure of these veins is well shown in some of those which contain graphite. This mineral, though sometimes irregularly disseminated through the veinstone, frequently occurs in sheets or layers alternating with orthoclase, quartz or pyroxene, parallel to the walls of the vein and exhibiting a peculiar structure due to the formation of successive layers of crystalline lamellæ more or less nearly perpendicular to the plane of deposition.

§ 47. The veins hitherto noticed, whether feldspathic or calcareous, are generally vertical, or nearly so, and in most cases traverse the stratification. Of many of them which have been explored to some extent for apatite, mica and graphite, it is noticed that they are subject to great changes in dimension as well as in mineral contents. They often appear to occupy short irregular fissures, and in some cases are to be described as more or less completely filled geode-like cavities rather than veins.

§ 48. In the reprint of my essay, already mentioned, several veins are noticed in the county of Hastings, Ontario, in rocks which were at that time referred by the Geological Survey of Canada to the Laurentian, but have since been found to belong to a younger series. Such are the veins containing argentiferous fahlerz with mispickel, and that holding native gold with a quasi-anthracitic form of carbon, both from Madoc, and also the vein already noticed as occurring in the township of Lake (§ 36), which contains in one part bismuthine with tourmaline, quartz and graphite, and in another part calcite with phlogopite. This latter vein occurs in an impure limestone, associated with quartzite and micaceous schists, and belonging to a series unconformably overlying the Laurentian, and resembling the rocks of the White Mountain series (this Journal, II, 1, 83). It will be noticed that this vein is lithologically similar to those of the Laurentian, which are not improbably of the same age. Calcareous veinstones like those already described, are not unknown in the White Mountain rocks in Maine, where are found on a small scale aggregates of crystallized pyroxene, idocrase and sphene, and others of calcite with hornblende, apatite and graphite (§18), closely resembling the Laurentian veinstones of New York and Canada.

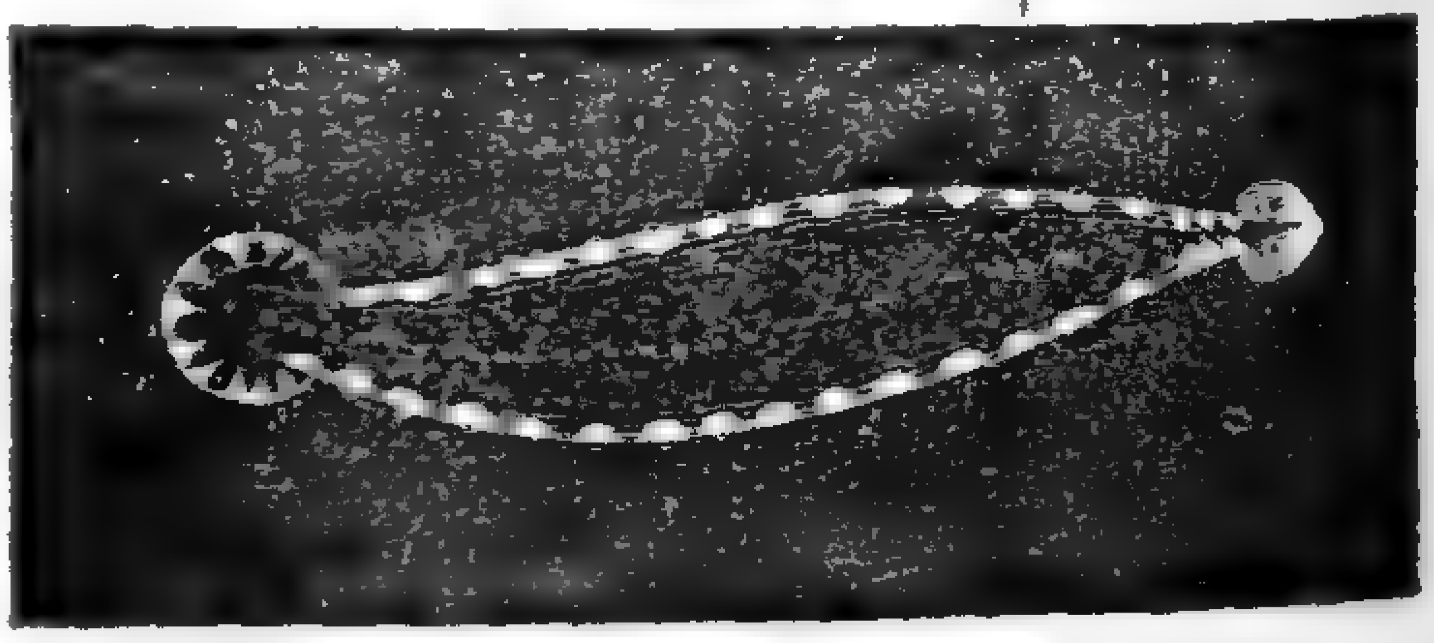
§ 49. The various minerals of these calcareous veinstones are generally described as occurring in crystalline limestones, though C. U. Shepard, H. D. Rogers and W. P. Blake have each recognized the fact that these mineral species, with their calcareous gangue, belong to true veins. Emmons, however, failed to distinguish between these veinstones and the stratified limestones of the series, which, as already stated, often contain disseminated many of the same species, though in a less perfectly crystallized condition than in the veinstones. Since the latter are clearly seen like dykes to traverse the gneiss, Emmons was led to look upon them as eruptive; and generalizing from this, he declared that all the crystalline limestones of northern New York were non-stratified rocks of eruptive origin (*Geol. of the First District of New York*, 1842, pages 37–59). This view of Emmons was to a certain extent adopted by Mather, who while maintaining the stratified character of the crystalline limestones of southern New York, admitted the existence of eruptive limestones. Von Leonhard had already, in 1833, asserted that limestones have sometimes come from the interior of the earth in a liquid state, like other igneous rocks, and a similar view was at that time maintained by many other geologists. Among others we find Rozet asserting the eruptive origin of the crystalline limestones which are associated with gneiss in the mountains of the Vosges (Bull. Soc. Geol. de Fr., iii, 215–235). In support of this view could be urged the dyke-like form of the calcareous veinstones, which other observers, like Emmons, confounded with the bedded limestones. The nature and origin of this misconception, were, I believe, first pointed out by me in a communication to the American Association for the Advancement of Science in August, 1866 (*Can. Naturalist*, II, iii, 123), and subsequently more at length in the essay so often referred to (*Report Geol. Survey of Canada*, 1863–69, p. 182). It was there shown that many of these calcareous veinstones are nearly free from foreign minerals, and so closely resemble in lithological characters the stratified limestones, that the different geognostical relations of the two alone enable us, in some examples, to distinguish between them. In this connection I called attention to the great dykes of granular limestones found traversing gneiss near Auerbach in the Bergstrasse, which Bischof has described as true veinstones. These endogenous concretionary limestones are in fact to the stratified limestones, what endogenous granitic veins are to gneiss rocks.

ART. XIX.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XVII.—*Descriptions of North American fresh-water Leeches;* by A. E. VERRILL.

*Cystobranchus vividus*, sp. nov. Figure 1.

Body elongated, somewhat depressed, tapering both ways, but most so anteriorly. Surface smoothish, but with minute, hemispherical hyaline vesicles. Length in extension about one inch; breadth in middle ·10 to ·12 of an inch. Head excentrically pedicellate upon a slender neck, small, disk-like, rounded in front, or somewhat heart-shaped with the rounded point forward. Ocelli four, small, brownish, placed near the attachment of the neck, on each side, those in the anterior pair farther apart. Acetabulum large, well-rounded, as wide as the body, disk-shaped, and attached nearly centrally. Male organ, when protruded, elongated, conical, acute, placed just behind the fourth pair of large lateral white spots.

Fig. 1. $\frac{2}{1}$



Color of back dusky brown or purplish brown, finely specked with stellate points of darker brown, and with three irregular rows of conspicuous, small, round, opaque white spots along the upper surface of the back. Sides with a row of about 16, larger and more conspicuous, semicircular, white spots along the margin, each consisting of a cluster of 3 to 9 small round spots, enclosing a more transparent area in which a diaphanous pulsating vesicle or enlarged vessel may be seen to protrude at each dilation. Lower surface of body light grayish, specked with darker and often with obscure transverse bands of whitish; acetabulum similar in color to the body, with small round white spots, the margin more or less radiated with lighter and darker. Upper surface of head similar to the back, the sides and front lighter.

West River, near New Haven, on *Fundulus pisculentus*, November and December, 1871,—F. S. Smith; Savin Rock, in salt water, among eel-grass,—Prof. J. E. Todd.

This very active species lives in both fresh and salt water.

The transparent lateral vesicles referred to are probably organs of respiration, analogous to the much more highly developed branchial appendages of *Branchiobdella*.

*Ichthyobdella Funduli*, sp. nov.

Body smooth, distinctly annulated, subterete, thickest at about the posterior third, tapering considerably toward the head, and slightly posteriorly. Length about ·75 of an inch;

greatest diameter about ·08. Head small, rounded in front, scarcely explanate, and separated only by a slight constriction from the body. Ocelli two, distinct, well separated, placed near the posterior part of the head; two others, very small and scarcely distinguishable in my specimens, are placed in front of these. Acetabulum scarcely wider than the body, obliquely attached, sessile, and scarcely separated by a constriction from the body. Color light green, finely specked with dark green and brown points.

West River, on *Fundulus pisculentus*, Nov. and Dec., 1871,—F. S. Smith; near New Haven, on the same fish,—Prof. J. E. Todd.

This species differs greatly, in the form and arrangement of the acetabulum and head, from the typical species of the genus, and when living specimens can be carefully studied, may require separation.

*Ichthyobdella punctata* Verrill, from Lake Superior, described in the December number of this Journal, is the only other species of this genus known to me from the fresh-waters of this country, but others probably exist. In addition to the characters mentioned for the last species, the specimen has a median pale dorsal line and a row of eight spots on each margin, alternate with the dark punctate bands.

## Clepsine Savigny.

This genus is very abundantly represented in our waters, both in individuals and species. Although but two recognizable species have hitherto been described from this country, several others are very frequently met with, and are widely distributed. They are most frequently found adhering to the under surfaces of floating logs and old pieces of boards, or beneath the loosened bark of submerged branches and trunks of decaying trees. Occasionally they adhere to the lower surface of turtles or other animals, but they seldom, if ever, suck blood. They feed upon insect larvæ, small worms, etc. Most of the species are elegantly, and some are quite brilliantly colored, but the colors are often quite variable in the species, and cannot be relied upon for distinguishing them, without other characters of more importance. When disturbed, these species curl themselves up after the manner of "pill-bugs" and certain insect larvæ. The young adhere in a group to the posterior part of the lower surface of the body of the parent, by means of the posterior sucker, and before quitting the parent usually present the essential characters and often nearly the pattern of color of the adult, though paler.

Section A. Ocelli 2, separate or confluent.

Subsection *a*. Back smooth.

### *Clepsine parasitica* Diesing.

*Hirudo parasitica* Say, Major Long's 2nd Expedition to the source of St. Peter's River, Lake Winnepeek, etc., vol. ii, p. 266, 1824.

*Clepsine parasitica* Diesing, Systema Helminthum, vol. i, p. 450, 1850.

Body smooth, but distinctly annulated, much depressed, broad, tapering anteriorly to the obtusely rounded head, broad and emarginate posteriorly, with a broad round posterior sucker or acetabulum, about half of which is exposed behind the end of the body. Length in extension 3 inches; greatest breadth ·3 to ·5 of an inch, according to the degree of extension. Ocelli usually united into one inconspicuous spot, placed near the anterior margin of the head; two or three other minute black spots, somewhat resembling ocelli, sometimes occur along the margins of the head anteriorly.

Upper surface variegated with green, yellow, and brown; the ground-color is usually dark greenish brown, with a broad median vitta of pale greenish yellow, which at intervals expands into several large irregular spots; unequal, oval, and rounded spots are also irregularly scattered over the back. The entire margin is surrounded by a series of alternating square spots of dark green and yellow. Lower surface longitudinally striped with numerous purplish brown and black lines, the margin spotted like that of the upper side.

West River, near New Haven, on lower side of floating wood, and at Norway, Maine,—A. E. Verrill; frequent in the lakes of the North-western States, adhering to the sternum of tortoises, —Say.

This species is one of the largest and most conspicuously colored of the genus.

### *Clepsine picta*, sp. nov.

Body smooth, much depressed, broad posteriorly, somewhat tapering anteriorly, about 2·50 inches long in extension; varying in greatest breadth, from ·25 to ·30 of an inch. Acetabulum large, rounded. Ocelli two, close together, and sometimes confluent, surrounded by a triangular white area, which extends backward. Color of upper surface dark brownish green, finely variegated with orange; toward the margins the green becomes brighter; a row of semicircular orange spots, centered with flesh-color or white, extends along each margin; small, distant, flake-white spots are scattered over the upper surface, and arranged in about five irregular longitudinal rows. Acetabulum varied with green and orange, the green forming rays toward the margin, alternating with salmon-colored spots. Lower surface darker than the upper, deep greenish on the central part.

Another variety agrees in most respects with the preceding, but has a median brown line along the back, interrupted by about six, irregular, light green blotches, the last one largest and elongated; the rest of the back purplish brown, varied with greenish, the colors appearing as if in fine checks, owing to lighter and darker lines running in both directions; a row of rounded light green spots on each side, midway between the dorsal line and margins, and a row of flesh-colored, semicircular spots, alternately large and small, along the margin. Acetabulum varied with light purple and flesh-color. Lower surface pale bluish with lighter lines.

A young specimen, about ·75 of an inch long, had the same pattern of color; but the upper surface was lighter, reddish brown, and the dark brown lobes of the intestine were visible through the integuments.

Other variations of color were observed. In some the blotches interrupting the median brown line were dull orange and the marginal spots were orange-yellow; the sides of the back were orange-brown, thickly specked with dark brown and with a row of small pale green spots on each side; lower surface plain purplish brown; and there was a whitish spot in front of the ocelli. In one specimen the dorsal brown line was not interrupted, and the back was finely variegated with green, orange, and flesh-color, the green in stellate specks, with a row of small white spots on each side; the marginal spots pale orange-yellow.

Whitneyville Lake and West River, near New Haven, common, on submerged or floating wood, and beneath dead bark,—A. E. Verrill.

*Clepsine modesta*, sp. nov. Figure 2.

Body in extension elongated, tapering and very slender anteriorly, broader and obtusely rounded posteriorly. Length 1·5 inches in extension. Back smooth, faintly annulated, translucent. Head small, obtuse, whitish. Ocelli two, black, near together. The general color above is pale purplish brown, or purplish flesh-color with minute specks of brown, and very small round spots of dull yellow, and often of light green; margins and a median dorsal line pale. Acetabulum moderately large, whitish. Auditory vesicle or "cervical gland" placed near the head, small, rounded, slightly prominent, conspicuous, deep brown, surrounded by a whitish circle. Lower surface pale purplish. The attached young, about ·3 of an inch long in extension, were slender, whitish, and sub-diaphanous, with the brown intestine showing through posteriorly.

Fig. 2.

West River and Whitneyville Lake, with the preceding, common.

Subsection *b*. Back papillose.

*Clepsine ornata*, sp. nov.

Body somewhat depressed, rather broad and obtusely rounded posteriorly, in extension tapering, but not slender, anteriorly, about 1·25 inches long. In contraction elliptical, and about ·20 broad in the middle. Back with a median papillose dorsal carina, and two similar ones midway between it and the margins. Head broad, acuminate, whitish in front and at the margin. Ocelli united into a single, small, transverse spot, situated at the edge of the white area. Acetabulum moderately large, round, about half of its breadth exposed behind the end of the body.

A dark green line passes along the median carina, interrupted anteriorly by several transverse orange vittæ, and farther back by some pale orange spots; the first of the transverse spots or vittæ is pale orange, and is just behind the white area of the head; this is followed by a transverse greenish brown one, which is succeeded by a longer transverse orange one; farther back is another transverse vitta, or band, of the same color. The posterior part of the back and upper side of acetabulum are flesh-color, specked with pale orange and purplish. The papillæ of the lateral carinæ are partly orange and partly brown. The margin is pale purplish, with conspicuous squarish spots, alternately bright green and orange. The rest of the upper surface is variegated with bright green and pale brown, and specked with darker brown. Lower surface pale green, with a median light line; the margins colored as on the upper side.

The attached young, June 6th, were about ·12 of an inch long, and very slender in extension. Anteriorly they were purplish red with bright red specks, and with a median row of red points, while several median white spots occupied the positions of the large transverse orange spots of the adults. Posteriorly the branched lobes of the intestine gave a greenish color to the body. Ocelli closely united into a transversely triangular or bilobed spot of bright red.

West River, on the lower sides of submerged wood and pieces of boards.

*Clepsine papillifera*, sp. nov.

Body decidedly convex above, broad and obtusely rounded behind; in extension long, slender, and tapering anteriorly. Length, when extended, about 1 inch; greatest breadth, in contraction, about ·20 of an inch. Back covered with small, distant, subconical papillæ, arranged in transverse rows, of which the anterior contain about three papillæ, and the posterior ones eight or nine. Head small, narrow, subacute, white in front. Ocelli two, distinct, but close together, black, placed at the posterior edge of the white area. Color above obscure yellowish brown, produced by alternating narrow lines of flesh-color and olive-brown, which are crossed by fine longitudinal lines of dull olive-green, giving a checkered appearance under the microscope. The dorsal papillæ are specked with opaque white at the tips, and usually surrounded by a darker spot of olive green at the base.

West River and in small tributary streams, among the stems of water plants and on floating wood, common,—A. E. Verrill.

*Variety b.* Specimens taken in Whitneyville Lake, Oct, 4th, carrying young, differ considerably from the preceding, and may prove distinct. These have the form of body, head, and ocelli as described, but the tubercles of the back are less numerous, forming a single median row anteriorly, which becomes double posteriorly, where there is also a row on each side, midway between it and the margin. The general color above is dull greenish yellow, transversely and longitudinally lined with lighter; the tubercles are dark brown, and small flesh-colored spots are scattered over the back, but form rows posteriorly. Lower surface lighter.

*Variety c.* One specimen, perhaps distinct, has the ocelli united into a single spot, and the back covered with numerous small, scattered papillæ. The color was not recorded.

Section B. Four ocelli.

No American species belonging to this section are known to me.

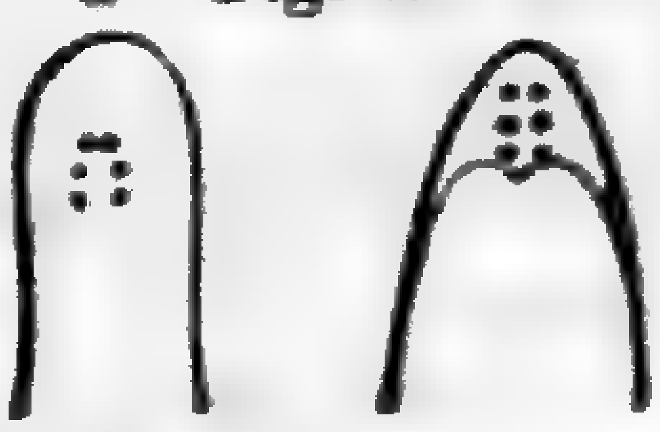
Section C. Six ocelli.

Sub-section *a.* Back smooth.

*Clepsine pallida*, sp. nov. Figure 3, *a;* head enlarged.

Body depressed, broad and obtusely rounded posteriorly, tapering, but not very slender, anteriorly; about 1 inch long in extension, and ·15 of an inch broad in contraction. Back smooth, somewhat convex. Head obtuse, with six ocelli, those of the anterior pair nearer together. Acetabulum rather small. Intestine whitish, showing through the integuments, with two large anterior lobes and about six smaller lateral ones. Auditory vesicle very distinct. Color above pale yellowish, with scattered blackish specks and with a median light line, interrupted by a row of distant, small, black spots. Beneath pale flesh-color.

*a* Fig. 3. *b*



West River, with the preceding,—A. E. Verrill.

Sub-section *b*. Back papillose.

*Clepsine elegans*, sp. nov. Figure 3, *b*; head enlarged.

Body depressed, strongly annulated, broadly rounded posteriorly, tapering, but not slender, anteriorly. Length in extension about 1·25 inches; breadth in contraction ·20 of an inch. Acetabulum moderately large, projecting considerably beyond the posterior end of the body. Head small, obtusely pointed, white in front and along the edges. Ocelli six, the three pairs close together, on the white area of the head, those of the middle pair largest, black. Back covered with distant, slightly elevated, yellow papillæ. Color olive-green, thickly specked, especially toward the margins, with purplish-brown, and with dark-brown transverse lines corresponding with the intervals between the annulations; anteriorly there is a pale yellowish-green median line; a slight distance from the middle there is, on each side, a narrow black line extending the whole length, and between these and the margins there are other faint longitudinal lines. Along each margin there is a row of about six, sulphur-yellow spots, and a few smaller raised yellow spots are scattered over the back, the anterior ones often becoming greenish. Lower surface pale green specked with brown, and with a light median and two black longitudinal lines, corresponding to those above.

West River, with the two preceding,—A. E. Verrill.

This is a very active species. It adheres firmly by means of its posterior sucker, but when much disturbed quickly rolls itself into a ball. One of the specimens, taken June 6th, carried about a dozen slender young ones, of a pale pink color.

In addition to the preceding species, *Clepsine oniscus* Diesing (Blainville sp.) and *Clepsine swampina* Dies. (Bosc sp.) have been indicated from North America. The first has not been described sufficiently to be recognized, all the characters mentioned applying equally to nearly every species of the genus.

*Clepsine swampina* Diesing is thus described. "Body subelliptical, depressed, anteriorly narrowed, above transversly sulcated, below plumbeous. Ocelli six, two closely approximate. Acetabulum orbicular. Length 6–7 lines, width 3 lines."

Carolina, upon the surface of tortoises and frogs,—Bosc.

*Liostomum coccineum* Wagler.

Isis, 1831, p. 533; do. 1832, p. 53; Diesing, Sitzungsb. der kais. Akad. der Wissenschaften, xxxiii, p. 495, 1859.

This genus is remarkable in having no ocelli, and no folds, lobes, nor plications within the mouth and œsophagus.

Mexico,—Karwinsky.

*Nephelis quadristriata* Grube.

Famil. des Annel. pp. 110 and 149; Diesing, Sitzungsberichte der kaiserlichen Akad. der Wissenschaften, Math.-Naturwiss. Classe, xxxiii, p. 496, 1859.

Body in extension 2 to 4 inches long by ·12 to ·25 broad, slender, subterete, tapering to the anterior end; in contraction broader and somewhat depressed posteriorly, the sides rounded. Posterior sucker large, nearly as wide as the body, to which it is broadly attached. Mouth rather large, suborbicular, the upper lip a little expanded, rounded in front, wrinkled within, smooth externally and not distinctly annulated. The œsophagus has the three longitudinal folds slightly prominent, rounded at their exterior ends. Six ocelli were all that could be distinguished; of these those of one pair, situated on the front of the first segment, are much the largest; two pairs of much smaller, inconspicuous ones, are placed well apart on the sides of the buccal segment. Anal orifice large, with a raised border, situated a little in advance of the posterior end of the back.

Color above brownish-black, dark-brown, fuscous, or dark cinereous, with four longitudinal rows of irregular, nearly confluent, black spots, intermingled with light-brown or grayish spots, which often also form the center of the black spots. Lower surface plain brown or fuscous, usually a little lighter than the back.

New Haven and Farmington, Conn.,—A. E. Verrill: Falmouth, Mass.,—Dr. Edw. Palmer. This species is very common in the fresh waters of New England.

*Nephelis lateralis* Verrill.

*Hirudo lateralis* Say, Long's Second Expedition, vol. ii, p. 267, 1824; Diesing, Syst. Helm., vol. i, p. 474.
*Nephelis lateralis* Verrill, this Journal, ii, p. 451, 1871.

The original specimens, described by Say from the waters between Rainy Lake and Lake Superior, were dull livid with "a few very remote minute black points, and a rufous line along each side;" the "six ocular points are placed in a regularly curved line."

A specimen from New Haven appears to belong to the same species. This was 3 or 4 inches long in extension, and ·15 to ·25 wide; rather slender and subterete anteriorly, somewhat depressed posteriorly, with the margins rounded. Head obtusely rounded in front, not very distinctly annulated. Ocelli six, distinct, with faint indications of another pair on the first segment; the front pair on the first segment are very distinct and much larger than any of the others, well separated, round and blackish; the two pairs on the sides of the buccal segment are very small and well separated. Acetabulum as wide as the body when extended, with a circular row of blackish sub-marginal spots. The three folds of the œsophagus are about as in the preceding species. The color above is dull dark orange-brown, with numerous fine longitudinal lines, alternately darker and lighter, and with many small irregular black spots scattered unevenly over the surface, except along the middle of the back; an obsure reddish line passes along each side near the margin, apparently due to an internal vessel showing through the integuments. Lower surface plain, dull orange-brown, somewhat lighter than the back. Head light flesh-color.

Whitneyville Lake,—A. E. Verrill.

*Nephelis marmorata* Verrill.

***Hirudo marmorata*** Say, op. cit., p. 267.
(?) ***Nephelis punctata*** Leidy, Proc. Acad. Nat. Sci. of Philad., 1870, p. 89.

This species, found by Say associated with the preceding, appears to differ in no important particulars, and may be only a differently colored variety of the same species. It is described as blackish or fuscous, with irregular whitish or light colored spots; beneath pale, generally immaculate, but sometimes with confluent black spots. Ocular points six, in a regularly curved line.

When a larger series of living specimens from various localities can be studied, the three preceding forms, admitted here as species, may prove to be mere varieties of one species, no less variable than the *Nephelis vulgaris* of Europe. The agreement in the number and arrangement of the ocelli is very close in the three forms.

The leech described by Dr. Leidy from the vicinity of Philadelphia, and Beverly, N. J., appears to differ in no essential characters. It was blackish olivaceous above, the annuli minutely punctate with yellowish olivaceous or dusky white, and narrowly bordered with the same; beneath grayish.

*Nephelis fervida* Verrill, described in the December number of this Journal, from Lake Superior, appears to be quite distinct from any of the preceding, judging from the preserved specimens. The eight ocelli are all small and nearly equal. The color when living was bright brick-red, but the preserved specimens show many faint longitudinal lines of brown.

Egg-capsules, apparently of this species, were found in August by Mr. Smith, attached to the leaves of *Nupha*, in a small lake near Simmon's Harbor. These are broad oval or elliptical, above smooth and convex, translucent yellowish brown, with a thin, flat, lighter border, each end prolonged slightly into a short tubular neck, with a terminal orifice. Lower surface flat. Each contained two, three, or more young leeches, mostly upwards of half an inch long, plain whitish, with eight distinct black ocelli. The largest capsule was ·45 of an inch long by ·35 wide, including the margin; the smallest was ·37 long by ·30 wide.

NEPHELOPSIS, gen. nov.

Body broad and flattened behind the clitellus, rounded and tapering in front of it. Upper lip large, dilated, wrinkled and radiately sulcated beneath; œsophagus with three broad folds as in *Nephelis.* Intestine simple, resembling that of *Trocheta.* Ocelli eight in the typical species. External male organ expanded at the end into a disk-like form with a raised margin and depressed center, in which there is a four-lobed orifice as in *Trocheta.* The internal male organs resemble those of *Aulastomum* and *Hirudo*, the testicles being rather large rounded or pyriform vesicles, apparently but eleven on each side.

This genus has a remarkable combination of the characters of *Nephelis*, *Trocheta* and *Aulastomum.* In general habit and form of body it is much like *Trocheta*, but there are no maxillæ.

*Nephelopsis obscura*, sp. nov.

Body much elongated in extension, depressed posteriorly, distinctly annulated, a little rugose anteriorly, in contraction. Length in extension 4 to 5 inches; breadth ·25 to ·35 of an inch. Head obtusely rounded in front. Ocelli eight; two pairs on the first ring near the front, the inner pair larger, well separated; two pairs on the sides of the buccal segment, small, distant, the upper pair a little below the level of the outer pair of anterior ones. Inner surface of the upper lip very rugose, the sulcations and folds diverging outwardly. Mouth large; folds of the œsophagus broad, prominent, the outer end pointed, triangular. Anal orifice large, with raised borders, on the dorsal surface, a little in advance of the posterior sucker, which is large, rounded, the disk expanded and considerably larger than the pedicle. Clitellus much thickened; male organ short, protruded as a low truncate cone, with disk-shaped end. When examined by transmitted light, a row of eleven rather large translucent, pyriform spots may be seen midway between the dark intestine and the flattened margin, which appeared to correspond with the testicles. Color, above and below, dull, dark brown, umber-brown, or fuscous, usually with numerous obscure, narrow, longitudinal stripes of lighter and darker brown.

Madison, Wisconsin, very abundant in the lakes near the city,—A. E. Verrill.

This species was taken in May, 1870, when numerous egg-capsules were also found attached to the stones along the shores.

*Aulastomum lacustre* Leidy.

Proceedings Acad. Nat. Sciences of Philadelphia, for 1868, p. 229.

This species, well described by Dr. Leidy, has 10 ocelli; eight in the upper lip, the last pair separated by an annulus from the others. Male aperture in the 24th annulus; female orifice in the 29th. Œsophagus capacious, with twelve folds. "Jaws thin, small, when at rest included in pouches formed by an eversion of the mucus membrane. Teeth 12 in number to each jaw, bilobed at base." Color throughout olive-green, closely maculated everywhere with confluent spots of a darker hue of the same color. A variety was lighter green with fewer spots of black.

Twin Lake, Minnesota, and Lake Superior,—Leidy.

### SEMISCOLEX Kinberg.

**Ofversigt af Kongl. Vet. Akad. Förhandlingar, xxiii, p. 357, 1867.**

According to Kinberg this genus has the following characters: maxillæ wanting; pharnyx with a transverse sulcus below the posterior margin of the buccal segment, and below that provided with longitudinal sulci; habit of *Hirudo*.

#### *Semiscolex juvenilis* Kinb., loc. cit.

This, the typical species, has a smooth body with a narrow median dorsal fascia, and a series of spots on each side. Cephalic lobe a little elongated, three-annulate; ocelli eight, with the fourth pair on the second segment of the body; abdominal orifice in the 26th segment; segments 97; length $40^{mm}$. Montevideo, in fresh-water.

The following species, although evidently allied to *Semiscolex*, differs decidedly in the structure of the cephalic lobe and pharynx, and in having ten ocelli. These characters seem to be of generic value.

### HEXABDELLA, gen. nov.

Body depressed posteriorly. Cephalic lobe prolonged, composed of four segments, with three longitudinal folds beneath, followed by three transverse fleshy lobes, or folds; below these the œsophagus is furnished with six longitudinal plications. Ocelli ten; the fourth pair on the buccal segment, the fifth on the second segment behind the buccal. Anus dorsal, at the posterior end of the body. Acetabulum round, separated from the body by a deep constriction.

#### *Hexabdella depressa*, sp. nov.

Body strongly annulated, broad and much flattened posterior to the clitellus, tapering and somewhat rounded in front of it. Length, in partial contraction, 1·50 inches; breadth ·40. Head, or cephalic lobe, somewhat elongated, rounded in front, with four annulations, the first or terminal one oval, separated from the following by a decided depression, or fossa. Ocelli ten; the first pair, near together on the posterior edge of the first cephalic segment, the second pair on the second, and the third on the third segment, form a nearly regularly curved line; those of the fourth pair are on the sides of the fifth or buccal segment; and those of the fifth are on the seventh segment, or the third of the body. Cephalic lobe divided beneath into three broad lobes by two deep sulcations, each lobe subdivided into smaller ones by less marked, divergent grooves. Behind each of the three lobes there is an elevated, transverse, rounded, fleshy lobe or fold; behind these, and separated by a deep groove, there are six well-marked plications in the œsophagus. Anus with elevated, crenulate borders. Male organ between the 24th and 25th segments of the body. Acetabulum round, of moderate size. Color of the preserved specimen, dark slate-brown, above, with few irregularly scattered remote black spots, and with still fewer, small, white specks. Beneath lighter slate-brown, with very few black spots, toward the margins.

Near New Haven,—A. E. Verrill.

DEMOCEDES Kinberg, loc. cit., p. 356.

This genus, according to Kinberg, has "three muscular, compressed, edentate maxillæ," with the habit of *Hirudo*. The two species first named by him are from Port Natal and have 10 ocelli. The remaining species has but 8 ocelli, and is described as follows.

*Democedes maculatus* Kinberg, loc. cit., p. 356.

Body tuberculose, with minute tubercles, cinereous, with irregular black and white spots; cephalic lobe 5- or 6-annulate; ocelli 8; fourth pair on the buccal segment; abdominal orifices in the 25th and 30th segments; segments 94; length $88^{mm}$.

Wisconsin,—Kumlin.

MACROBDELLA, gen. nov.

Body strongly annulated, stout, broad, depressed throughout, tapering but little. Cephalic lobe large, rounded in front, composed of five segments, its lower surface rugose with longitudinal sulcations, and at the base having a transverse fold, which forms sockets for the protection of the maxillæ, when retracted. Maxillæ three, stout and prominent, the outer edge denticulate, with about 50 to 60 teeth. Nine plications within the œsophagus. Stomach voluminous, divided into several compartments, with very large and irregular dilations or pouches on each side. Ocelli ten. Male orifice between the 26th and 27th* segments behind the mouth; vulva between the 31st and 32nd. Anal opening dorsal, in advance of the posterior sucker.

This genus has a remarkable combination of the characters of several diverse genera. It has, like *Bdella*, sulcations on the

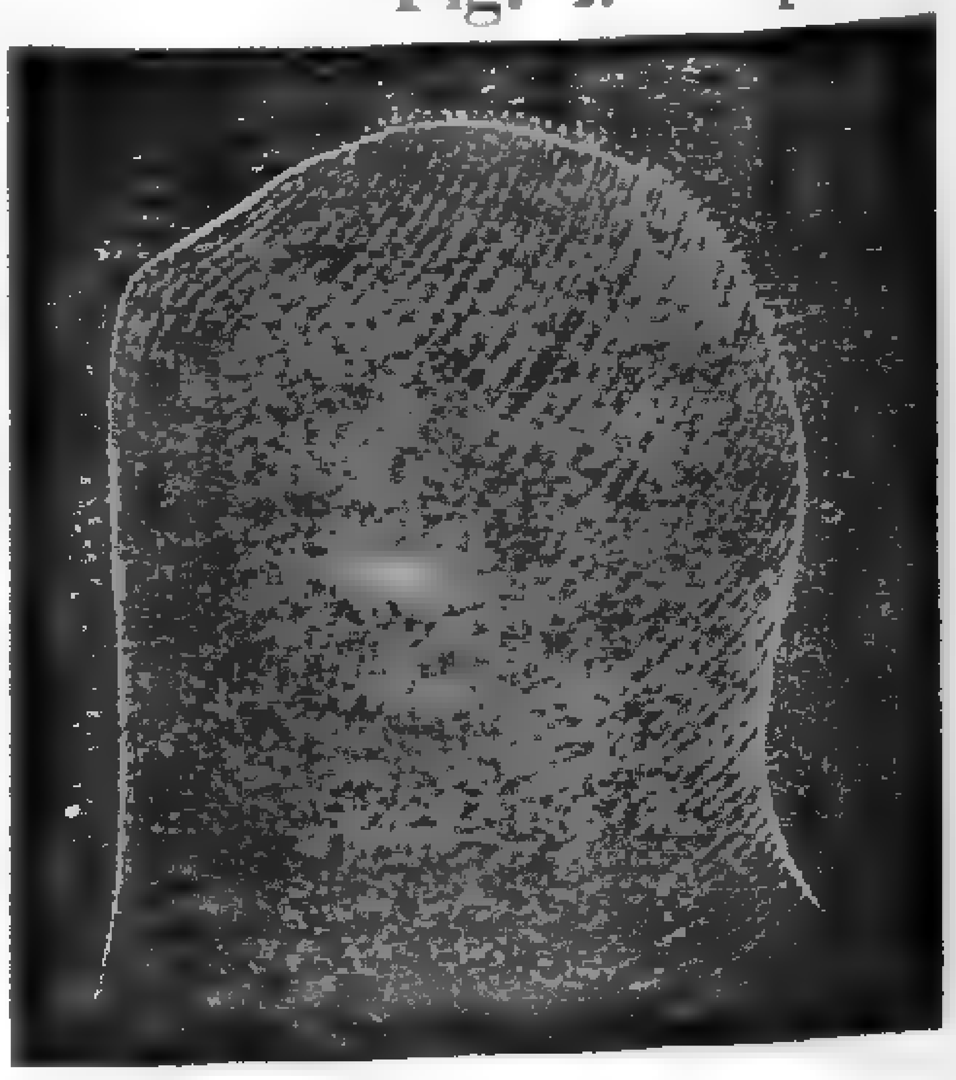
* Leidy says that the male orifice perforates the 25th annulus, but he apparently excludes the buccal segment from his count.

cephalic lobe, beneath; maxillæ similar to those of *Hirudo*, but more prominent: a plicated œsophagus, similar to that of *Aulastomum;* a stomach most like that of *Hæmopis;* internal reproductive organs similar to those of *Hirudo;* while the external male organ is more like that of *Hæmopis*. The genus differs from all the others, however, in the situation of the genital orifices, in the form of the maxillæ, the number of plications in the œsophagus, etc. It includes one of the stoutest, largest, and most powerful of the leeches hitherto described.

*Macrobdella decora* Verrill. Figure 4; a maxilla.

*Hirudo decora* Say, Long's Second Expedition, vol. ii, p. 268, 1824; Diesing, Systema Helm., i, p. 474; Leidy, Proc. Phil. Acad. Nat. Sci., 1868, p. 230.

Fig. 4. $\frac{20}{1}$



Body large, stout, broad, considerably depressed throughout; in extension much elongated and gradually tapering anteriorly, strongly annulated. Length of the larger specimens 12 inches or more; greatest breadth upwards of an inch. Head rounded in front, the cephalic lobe capable of considerable dilation, consisting, apparently, of five segments. Ocelli ten: the first pair between the second and third segments; the second on the third: the third on the fourth; the fourth pair on the sixth or buccal; and the fifth on the ninth segment, or fourth behind the mouth. Cephalic lobe rugose and wrinkled beneath, and with conspicuous longitudinal sulcations, of which three, corresponding with the maxillæ, are deepest; posteriorly with a conspicuous semicircular fold, surrounding and partially concealing the maxillæ, when retracted into their fossæ. Maxillæ thick, very prominent, higher than broad, outer edge rounded in front, and finely and closely denticulate (figure 4). Below each maxilla, in the œsophagus, is a broad plication or fold, which divides into two a short distance beyond; alternating with these are three simple narrower folds, making nine in all. External male organ stout, conical, the broad wrinkled base rising from the 24th to the 30th segments; the terminal portion smoother, with six sulcations; the orifice small, with six lobes. Female orifice also with small lobes, surrounded by a slightly elevated area, formed upon the 31st and 32nd segments; posterior to these there are conspicuous rugose elevations on the 36th and 37th, and on the 38th and 39th segments, with less marked ones on two or three of the previous and following segments; corresponding to these rugosities, there are well developed internal glands.

The reproductive organs are here described from preserved specimens of large size, taken in the breeding season, in spring. At other seasons and in smaller specimens, these charac ers are not so obvious. Acetabulum large, separated from the body by a well-marked constriction.

Color above, dark livid brown, or olive-green, with a median dorsal row of about 20 to 22 bright or pale red spots, which are sometimes obsolete, and a row of rounded black spots near each margin, corresponding in number and nearly in size with the red ones. Lower surface bright or dark orange-red, or reddish brown, sometimes with black spots near the margins.

Vermilion River,—Say; Norway, Maine; in many lakes and streams in other parts of Maine; and in streams and ponds near New Haven,—A. E. Verrill; Minnesota,—Dr. Leidy.

This species is very common and widely diffused in the fresh-waters of the northern United States. Its range northward and southward is unknown. It is the only true blood-sucking leech known to me from the Atlantic States. It is capable of drawing blood from the human skin, but ordinarily subsists upon frogs and tadpoles. It often attaches itself to the throat, and speedily kills them, even when of large size. It is frequently used instead of the imported leeches by physicians, and is equally efficacious.

The following species, which I have not seen, have been described from North America:

*Hirudo ornata* Ebrard, Nouv. Monog. Sangs., p. 55. North-western America.

*Hirudo* (?) *Costaricensis* Grube and Œrs.; Diesing, op. cit., p. 509. Costarica,—Œrsted.

*Hirudo Billberghi* Kinberg, op. cit., p. 356, 1867. Montevideo. This species is described as having eight ocelli, with the genital orifice in the 28th segment. It probably belongs to some other genus.

*Oxyptychus striatus* Grube, Fam. d'Annel., p. 110, 148; Diesing, op. cit., p. 510. Montevideo,—Burmeister.

*Centropygus Jocensis* Grube and Œrst., 1857; Dies., op. cit., p. 511. St. Joce, Central America,—Œrsted.

## SCIENTIFIC INTELLIGENCE.

### I. Chemistry and Physics.

1. *On a new double salt of Thallium.*—For the purpose of preparing thallous platino-cyanide, Friswell mixed hot solutions of thallous carbonate and potassium platino-cyanide. In a few moments, while the solution was yet warm, tufts of splendid bronze-green dichroic crystals began to grow from the walls of the beaker. These were collected, and dried at 100°. By trans-

mitted light they are magnificent crimson-red in color, while by reflected light they are of an intense bronze-green, with a metallic luster so strong as easily to be mistaken for brass chips. Upon examination, this salt proved not to be the platino-cyanide in question, but a compound of thallous carbonate with thallous platino-cyanide, having the formula $Tl_2PtCy_4$, $Tl_2CO_3$. Its formation may be represented thus:—

$$K_2PtCy_4+(Tl_2CO_3)_2=Tl_2PtCy_4, Tl_2CO_3+K_2CO_3.$$

Treated with warm nitric acid, it effervesces, leaving a pink residue of thallous platino-cyanide. It is nearly insoluble in cold water, and dissolves with difficulty in hot. It may be recrystallized from a hot solution of thallous carbonate. Its aqueous solution is colorless, and yields no absorption bands to spectroscopic examination. The crystals are cubes, sometimes so united together as to produce needles.

Thallous platino-cyanide—obtained by decomposing barium platino-cyanide with thallous sulphate—occurs in yellowish-white crystals, entirely destitute of any dichroic properties.—*J. Ch. Soc.*, II, ix, 461, July, 1871. G. F. B.

2. *On Aurine.*—DALE and SCHORLEMMER have made an examination of commercial aurine—obtained by the action of concentrated sulphuric acid and oxalic acid upon phenol. They find that this aurine (called also yellow coralline) is a mixture, and have succeeded in separating from it the pure coloring matter. When crystallized from hot acetic acid—its best solvent—it is obtained either in the form of splendid chrome-red needles, with an adamantine luster, having the composition $C_{24}H_{18}O_8$, $(H_2O)_2$; or in smaller dark-red needles having a steel-blue reflexion, with the composition $C_{24}H_{18}O_8$, $2\frac{1}{2}(H_2O)$. Both lose their water at 160°, and assume a fine beetle-green luster, producing the anhydrous compound $C_{24}H_{18}O_8$. By heating the red solution of this substance in an alkali, with granulated zinc, it is reduced, becomes colorless, and gives, with acids, a white crystalline precipitate, crystallizing from acetic acid in thick monoclinic prisms, having the formula $C_{24}H_{20}O_4$. Pure aurine heated with zinc-dust, yields benzol and other bodies having a higher boiling-point. —*J. Ch. Soc.*, II, ix, 466, July, 1871. *Ber. Berl. Chem. Ges.*, IV, 574. G. F. B.

3. *On the preparation of Camphoric acid.*—WREDEN proposes the following method for preparing camphoric acid:* A solution of about 150 grams of camphor in two liters of nitric acid of specific gravity 1·27 (two volumes commercial acid diluted with one volume water) is heated on the water-bath in a capacious narrow-necked flask, until no more nitrous fumes are produced. The flask should be furnished with a wide glass tube narrowed at its lower end, to convey the fumes into a chimney. This tube may be fastened to the flask by a plaster of paris luting. With the above quantity of materials, the process is terminated in 50

[* Slides for the microscope, prepared with this substance in the same way as salicin, are magnificent objects with polarized light.—G. F. B.]

hours, and the yield from 1·5 kilograms camphor is from 725 to 805 grams crystallized camphoric acid.—*Ber. Berl. Chem. Ges.*, iv, 570. July, 1871. G. F. B.

4. *On the Synthesis of Oxaluric acid.*—By the action of ethyloxyoxalyl chloride upon urea, HENRY has succeeded in forming oxaluric acid. The reaction takes place according to the equation:—

$$C_2O_2 \left\{ \begin{matrix} Cl \\ OC_2H_5 \end{matrix} \right. + CO \left\{ \begin{matrix} H_2N \\ H_2N \end{matrix} \right. = HN \left\{ \begin{matrix} C\ O\ -H_2N \\ C_2O_2-OC_2H_5 \end{matrix} \right. + HCl.$$

These bodies act upon each other at ordinary temperatures with evolution of great heat. No hydrochloric acid gas is evolved, it being combined with the urea; hence twice the quantity of urea required by the above equation must be used. A hard crystalline mass results, from which after cooling, the excess of urea is extracted by water or alcohol. The residue recrystallized from boiling water yields ethyl oxalurate in the form of fine, white, silky needles, which are tasteless and anhydrous, slightly soluble in cold, more so in hot water, easily soluble in acids, alkalies, and ammonia. Heated to 160° to 170° it melts, evolving oxamethane and leaving cyanuric acid. Boiling with water decomposes it, yielding oxaluric acid. Heated with alcoholic ammonia to 100° it yields oxaluramide.—*Ber. Berl. Chem. Ges.*, iv, 644, July, 1871. G. F. B.

5. *On the Coloring matter of Cochineal.*—LIEBERMANN and VAN DORP have recently studied the chemical characters of the coloring matter of cochineal. They commenced their investigation with the nitrococcusic acid of De la Rue, which they prepared by adding finely-pulverized carmine gradually to nitric acid of specific gravity 1·37, so long as active evolution of red vapors took place. By moderate evaporation, the entire mass solidified in crystals of oxalic and nitrococcusic acids. Recrystallization from water containing nitric acid, gave the latter substance pure, in large silvery plates. This acid, when heated in sealed tubes with water to 180°, evolves carbon dioxide and yields a new substance, as a yellow oil while hot, but solidifying on cooling in long yellow needles, having the composition of trinitrocresol, $C_7H_4(NO_2)_3OH$. In properties, it agrees with the trinitrocresol obtained by Duclos from the cresol of coal tar, fusing at 104°, and yielding a potassium salt which crystallizes from water in yellow needles. The nitrococcusic acid is therefore one of the isomeric trinitrocresotic acids, though which one cannot be determined till they have all been prepared and examined. From this relation of nitrococcusic acid to cresol, it is clear that the coloring matter of cochineal contains a benzol residue combined with methyl groups.

To obtain that part of the carmine molecule which yielded the nitrococcusic acid, free from the action of the nitric acid, this carmine was warmed with concentrated sulphuric acid. At 120° the yellow color of the solution passed into violet, with the evolution of $CO_2$ and $SO_2$. After prolonged heating to 140° or 150°, the whole was poured into water, when the new coloring matter was precipitated in brown flocks. After washing and drying it was extracted with alcohol and the extract evaporated. The coloring matter thus obtained, which the authors call Ruficoccin, is difficultly soluble in cold water, readily so in alcohol, giving a yellow fluorescent solution, partially volatile, giving a red vapor condensing to yellow-red needles, and colors mordanted cloth like cochineal though less brilliantly. Its formula is $C_{16}H_{12}O_6$. From the mode of its production and its behavior, the authors believe it to be a derivative of dimethylanthracene and assign to it the formula:

$$C_{14}H_2 \left\{ \begin{array}{l} (CH_3)_2 \\ (OH)_4 \\ O_2'' \end{array} \right.$$

This view is strengthened by the fact that when the vapor of ruficoccin is passed over ignited zinc-dust, a hydrocarbon of high fusing point is produced, which sublimes in white plates and forms with picric acid a red compound. From the production too, of succinic acid when carmine-red is fused with potassium hydrate, as observed by Hlasiwetz and Grabowsky, and its analogy to the coloring matters of logwood and Brazil wood, the authors think it not improbable that it is either a derivative of succinic acid itself or of an acid decomposable into it by fusion with potassium hydrate.—*Ber. Berl. Chem. Ges.*, iv, 655, July, 1871. G. F. B.

6. *On the Betaine of the Phosphorus Series.*—Some time ago, Scheibler discovered a new base in the beetroot, to which he gave the name betaine. It proved to be identical with oxyneurine, a base obtained from neurine, which Liebreich had derived from protagon. Neurine, being trimethyl-oxethyl-ammonium chloride, gives oxyneurine by oxidation and subsequent removal of hydrochloric acid, thus:—

(1) $(CH_3)_3(C_2H_5O)NCl + O_2 = (CH_3)_3(C_2H_3O_2)NCl + H_2O.$

(2) $(CH_3)_3(C_2H_3O_2)NCl - HCl = C_2H_2(CH_3)_3NO_2.$

Oxyneurine is therefore trimethylated glycocoll. Hofmann having produced, by the action of triethylamine upon monochloracetic acid, a triethylated glycocoll, and by the action of triethylphosphine, a similar body containing phosphorus in place of nitrogen, MEYER at his suggestion undertook the production of trimethylated glycocoll containing phosphorus, by acting on monochlor-acetic acid with trimethyl-phosphine. The reaction takes place at ordinary temperatures but was completed by heating in sealed tubes for five or six hours to 100°. The platinum double chloride afforded on analysis the formula $[C_2H_2(CH_3)_3PO_2HCl]_2PtCl_4$. Treated with $H_2S$, it yielded the simple chloride, from which the sulphate was prepared; this, by treatment with barium hydrate, yielded the pure base as a mass of splendid radiating crystals. It was neutral in its reaction, very hygroscopic, and readily formed salts. The iodide is quite soluble in water and crystallizes in beautiful plates. This base therefore, there can be little doubt, is the oxyneurine or betaine of the phosphorus series.—*Ber. Berl. Chem. Ges.*, iv, 734, August, 1871.

G. F. B.

## II. Geology and Natural History.

1. *Geological Survey of Ohio. Report of Progress in* 1870; by J. S. Newberry, Chief Geologist. Including Reports by E. B. Andrews, Edward Orton, J. H. Klippart, Assistant Geologists; T. G. Wormley, Chemist; G. K. Gilbert, M. C. Read, Henry Newton, W. B. Potter, Local Assistants. 568 pp. 8vo. Columbus, 1871.—This Annual Report of the Ohio Survey is not a mere statement that something has been done, but an extended series of Reports on the results obtained, giving details as to the surveys carried forward, the observations made, and some of the conclusions reached, thus making a volume of real scientific value.

It opens with a general Report of Progress, by Dr. Newberry, the head of the Survey, announcing, among other things, that it is proposed to have the final Report consist of two volumes on Geology and Paleontology, one on Economic Geology, and one on Agriculture, Botany and Zoology. He also states that a Geological Map, on a large scale, is in preparation, to accompany the volumes on Geology; and that a surveying party is in the field for the improvement of the topographical map of the State, which is to serve as its basis.

Dr. Newberry mentions the interesting fact that the valleys of the streams of Ohio "are all cut far below the present stream beds. The valley of the Beaver is excavated to a depth of over 150 feet below the present water level. The trough of the Ohio is still deeper. The Tuscarawas at Dover is running 175 feet above its ancient bed. The borings made for oil, along the streams of the region, afford many remarkable facts bearing on this subject."

The structure of the Lower Coal Measures in Northeastern Ohio is particularly described; and, in connection, he observes that the noted *fish-bed of Linton* is connected with the coal seam, which he numbers (counting from below) 6. The coal lies under the Mahoning sandstone, in the valley of Yellow Creek, and is the "Big Vein" of Salinville, Hammondsville, Linton, and New Lisbon, being 4 to 7½ feet in thickness; at the mouth of the Creek this seam is underlaid by four inches of cannel, and in this last are the remains of fishes and amphibians—twenty new species having been afforded by the bed. The fishes are mostly species of Cœlacanthus and Eurylepis, with one of Palæoniscus, two of Rhizodus, and many spines and teeth of sharks. Dr. Newberry observes, respecting the original condition of the place:—

"All these animals were apparently the inhabitants of a lagoon in the coal marsh. While it continued to be a lagoon, carbonaceous mud, derived from the decomposition of the soft parts of the plants growing in the water and the surrounding marsh, accumulated at the bottom, with innumerable remains of the various animated forms that for ages lived and died in the water above. There came a time, however,—after enough of this carbonaceous mud had gathered to form a layer of cannel four inches thick—

when, just as so many of our little lakes are 'growing up' now, the lagoon was closed and ultimately all filled up by the peat that formed its margin. This peat produced the ordinary cubical coal which composes the mass of the seam."

The Report of E. B. Andrews relates to the Second Geological District, the southeastern quarter of the State. Prof. Andrews first speaks of the occurrence of large boulders, one of a hundred tons, in the eastern part of Fairfield Co., others in Perry Co. and Vinton Co., and alludes to the locality of boulders of white quartz, "some as large as a nail keg," near Ashland, in Boyd Co., Kentucky; stating that this is the most southern point where he has seen regular drift boulders. They are on the high hills, bordering the river, at least 200 feet above the bed of the stream.

Under the head of the several geological formations of this part of the State, the results of his recent observations are next given, including numerous sections, and a large amount of valuable detail with regard to the coal beds, limestones, etc. Prof. Andrews shows that the beds of coal, as well as of intermediate rocks, are often quite limited in lateral extent, and well illustrates the point in many carefully made sections. The number of coal beds consequently is not the same in different regions, but is constantly varying. The facts throw much light on the varying conditions of the great Carboniferous marshes of Ohio.

This notice will be continued in our next number.

3. *Geological Survey of California.*—A letter from the State Geologist of California to the Governor of the State, recently published, gives an account of the progress of the work during the years 1870–71. A notice of some of the important results have already appeared in this Journal, viz: of the publication of one part of the map of Central California, on a scale of six miles to an inch, embracing about one-third of the area of the State, and the completion of the first volume of the Ornithology of California, comprising the land birds of western America, west of the Rocky Mountains and north of Mexico. Besides these results, as we learn from the letter, the great map has been so far finished, through the topographical labors of Mr. C. F. Hofmann and his assistants, that the second quarter of the map is already drawn, and the engraving will be finished in February next; the third is also drawn, and will be given to the engraver on the completion of the second; the fourth is about two-thirds drawn, and only the field work for the remaining third is yet to be done. The whole map may therefore be finished two years from the present time—the engraving of each part requiring a year.

Prof. Whitney announces that a smaller map of the State, on a scale of 18 miles to the inch, has been prepared for immediate publication, for the use of the State, and for reference in connection with the publications of the Survey. It is already in the engraver's hands, and "it is hoped that it will be completed before the adjournment of the Legislature." This map will be made the basis of the preliminary geological map of the State. The cuts for the second volume of the Ornithology are well advanced toward completion, and will probably be finished in the spring. Drawings have been begun for the volume on Conchology, under the charge of Prof. P. P. Carpenter. Mr. Lesquereux has been engaged to describe the fossil plants, the extent of the collections of which have been greatly increased. Dr. Leidy has made preliminary reports on the vertebrate fossils, and will go forward with the volume whenever the State is ready for its publication; the species are of great interest, embracing, as "later Tertiary" species, the elephant, mastodon, rhinoceros, tapir, camel, llama, several species of the horse family, bison, elotherium, and many other extinct species. The Botanical volume has been making progress under Professor Brewer. The geological investigations have been continued along the Sierra and elsewhere, preparing the way for the final reports. These will make two volumes, one on general geology and the other on the mines and useful minerals, or economical geology.

The survey under Professor Whitney has performed its work thoroughly and faithfully, and produced volumes of reports unsurpassed in excellence in the country. Large appropriations to it, to hasten on the completion of the field labors and the publications, would contribute to the honor and best interests of the State, as well as to the progress of science throughout the country.

The United States ought to have a complete geological map of its whole territory; and, in this land of independent States, it is the duty of each State to furnish its part in as accurate a form as the science of the country admits of. The completion of the survey of California has been earnestly desired, in order that the western border of the map may be finished out; and the country at large will have reason to rejoice if this Pacific State does not fail of its part of the duty.

3. *Note on the discovery of fossils in the "Winooski marble" at Swanton, Vt.;* by E. Billings, F.G.S., Palæontologist of the Geol. Surv. Canada.—A few days ago Mr. Solon M. Allis, of Burlington, Vt., visited our museum and informed me that he had a specimen of the Winooski marble of Swanton which contained some fossils. Since then he has sent it to me. It contains, abundantly, a species of *Salterella*, which I believe to be the *S. pulchella* described in my Pal. Foss., vol. i, p. 18. This marble, both at Swanton and St. Albans, seems to underlie the Georgia slates. It is generally of a reddish, mottled color, but sometimes gray or greenish. The limestone at the straits of Belle Isle, in which *S. pulchella* is found, is also red, gray and greenish; and is, I have no doubt, of the same age. At this latter locality it overlies a red or brownish sandstone, conformably, which holds *Scolithus linearis.* I consider the Belle Isle sandstone to be the "Quartz rock" of the Green mountains of Vermont. In that case, the limestone at Belle Isle occupies, stratigraphically, the position of the Stockbridge limestone as represented by Dr. Emmons in his American Geology, part 2, p. 19. On page 19 of the same work, Dr. E., speaking of the Stockbridge limestone, says: "It is reddish at Williamstown and

is intimately blended with silex." In his Report on the Second Geological District of New York, in 1838, page 232 he gives a section of the rocks at Burlington combined with one of the strata at Port Kent. He there notices a gray limestone (at Burlington) of which he says:—"It is a stratum, which in Berkshire county, and other parts of the country, has generally been placed among the primary rocks; it is identical with the limestone at the base of Saddle mountain, and which covers more or less of the western flank of the Green Mountains." If the limestone to which he alludes is one of the gray varieties of the Winooski marble, then he is most probably right. I believe Mr. Allis's fossils are the first that have been found in the Winooski marble.

Montreal, Dec. 21st, 1871.

4. *Yale College Expedition to the Rocky Mountains and Pacific Coast.*—The second scientific party from Yale College, in charge of Professor O. C. Marsh, which left New Haven in June last to make explorations in the Rocky Mountains and on the Pacific Coast, returned to this city on the 14th of January. This party, like that of the previous year, was a private one, consisting of Professor Marsh and ten recent graduates of the College.

The special object of the expedition was to study the extinct vertebrates of the far west, and the first investigations were made in July and August in the Cretaceous deposits of southwestern Kansas, where numerous new species of birds, reptiles and fishes were discovered. During September and October, the Tertiary beds of Wyoming and Idaho were examined, and a large number of new fossil mammals, birds, reptiles and fishes were collected. The remainder of the autumn was spent in eastern Oregon, where many new and interesting Tertiary mammals were found. After a short visit to California the party returned east, some by land, and others with Professor Marsh via Panama.

The Expedition was in all respects successful, and the more important scientific results will soon be made public.

5. *Discovery of a tooth of a Mastodon in Massachusetts*; by E. Hitchcock. (From a letter to one of the editors, dated Amherst, Jan. 12, 1872).—I have seen and identified a mastodon's molar, which was found in the town of Colerain, Mass. It was shovelled out of a muck bed, on the farm of Elias Bardwell, just as the ground was frozen for the winter; and in the spring he promises me to make more thorough search for the remainder of the skeleton.

Colerain is a north border town in our state. I believe that no mastodon remains have ever been found before in Massachusetts.

6. *Mineral Resources of North Carolina*; by Dr. F. A. Genth, Consulting Chemist and Geologist. 32 pp. 8vo. Philadelphia, 1871. (From the Journal of the Franklin Institute).—Dr. Genth has labored much in the gold regions of North Carolina, and made various chemical investigations of the minerals. This memoir contains the results of his researches. No better authority on the subject of his paper exists in the country.

7. *Final Report of the United States Geological Survey of Nebraska, and portions of the Adjacent Territories*, made under the direction of the Commissioner of the General Land Office, by F. V. Hayden, U. S. Geologist. Ex. Doc. No. 19, House of Representatives, 42d Congress. Ordered to be printed March 23d, 1871. 264 pp. 8vo, with several lithographic plates of fossils and a geological map.—This very valuable Report was communicated to the Commission of the General Land Office, by Dr. Hayden on the first of March, 1868. It contains Reports of the Geology of different counties of the State, with a chapter on the coal fields of Colorado, (including a general review of the facts connected with the Lignite formations west of the Mississippi), and a brief account of the geological formations along the route of the Union Pacific Railway, Eastern Division. Dr. Hayden observes in his introductory remarks, that the State of Nebraska, while over three hundred and sixty miles in average length from north to south, and one hundred and seventy in average width, presents to view the rocks of only three geological formations—the Upper Carboniferous, the Cretaceous and the Tertiary. The Carboniferous beds thin out in their western extension and almost disappear in the region of the Rocky Mountains. The thickest coal beds are 12 to 30 inches thick.

The larger part of the volume is occupied by the Paleontological Report of Mr. F. B. Meek, in which details of sections and descriptions and figures of fossils are given with Mr. Meek's usual thoroughness and fidelity, and the facts connected with the age of the beds are described at length. Mr. Meek shows that instead of being part Permian, as some have urged, the beds belong to the Upper Coal-measures, and contain precisely the same group of fossils that are found at that horizon throughout the West, and eastward to Virginia. He also discusses the question of age on the broader ground of the affinities of the species and genera, independent of their known range in this country.

There are eleven plates of figures of fossils, and they include nearly all the Upper Coal-measure invertebrate species; with a few exceptions all are from Mr. Meek's drawings. Following this Report, there is a short paper by O. H. St. John on fossil fishes from the Upper Coal-measures of Nebraska, and another by S. H. Scudder on the Orthoptera collected in Nebraska.

8. *Miers, Contributions to Botany, Iconographic and Descriptive, detailing the Characters of Plants that are either new or imperfectly described, to which are added Remarks on their Affinities.* 4to. London: Williams and Norgate. 1851–1871.—In continuation of the two former quarto volumes, entitled Illustrations of South American Plants, we have the present collection of three volumes, the text of which is a reprint of papers contributed, at various dates within the last twenty years, to the Annals and Magazine of Natural History, with indexes, preface, etc.; the illustrations now added consisting of 154 quarto plates, lithographed from Mr. Miers' own excellent drawings. Still another

volume is before us, a collection of the Memoirs which our author has published in the Transactions of the Linnæan Society of London between the years 1839 and 1869, fourteen papers, illustrated by twenty-two plates. The earlier papers of this last series are those upon *Burmanniaceæ*, and upon his remarkable new family of *Triuriaceæ;* the most elaborate are the papers on the seed, etc., of *Clusiaceæ* and *Magnoliaceæ* (which we had occasion to notice at the time). Among the later memoirs is that in which still another genus of *Burmanniaceæ* is established (and the penetration of pollen-tubes to ovules denied), that upon *Crescentia;* that upon *Gœtzia* and *Espadea* (taken as distinct genera), with a good figure and discussion of the Cuban plant, of most uncertain relationship, and one in which three new genera of *Verbenaceæ* are described.

Returning to the other series of "Contributions," the first volume comprises the elaborate articles of Mr. Miers upon *Olacaceæ* and *Icacinaceæ;* those upon *Canellaceæ, Winteraceæ* (with nine species of *Drimys*), *Lardizabala*, and the *Styraceæ;* upon the "vegetable ovule called anatropous;" additional observations on some Olacaceous genera; and a monograph of *Colletia* and its allies. The second volume begins with the monograph on the *Calyceraceæ*, admirably illustrated by ten plates, and largely extending our knowledge of this small family,—in which the genera are doubled and the species quadrupled in number; and contains papers on the *Bignoniaceæ*, the *Maté plant* and other species of *Ilex* employed in the preparation of *Paraguay Tea;* on various genera; on *Goupiaceæ;* on *Ephedra;* on the *Tricuspidarieæ;* and upon *Heliotropieæ* and *Cordiaceæ.* The third volume contains "a complete monograph of the *Menispermaceæ*," the result of a long and diligent investigation of this family, with sixty-seven plates, from a selection of the vast number of drawings made during studies extending over about thirty-five years. Nearly fifty-six years have passed since the publication by Mr. Miers of his travels in Chili and La Plata, in which a long and honorable career of botanical authorship commenced with a list of the plants he collected. A. G.

9. *S. Watson, Botany of a Geological Exploration of the Fortieth Parallel under Clarence King.* (Second Notice.)—Under the modest name of a catalogue of the known plants of Nevada and Utah, Mr. Watson has given us a treatise, not to say a flora, of a wide stretch of country between the Sierra Nevada and the Rocky Mountains, which is invaluable to the botanist studying the plants of that region in herbaria, and still more to explorers on the ground,—of which we hope there may be many. For not only are new or revised species described, but all species not contained in the common eastern manuals, &c., which every collector is supposed to possess; the characters of western genera are appended in foot-notes, and synopses of recently elaborated genera—some of them reprints or translations of scattered papers with corrections or additions, others original revisions by the editor himself—are added in an appendix, so as to afford every possible

help to the student or collector who has not access to a full botanical library, and indeed most acceptable facilities to those few who have.

After thus calling attention to a volume of so much importance, we propose to restrict our comments to sundry details of criticism, or points of information, where opportunity occurs.

Under *Thalictrum Fendleri* some synonyms are adduced which are not all certain; as there is another Oregon species which has been confounded with *T. dioicum*, but is distinct from both in the fruit, which was sparingly collected in the British Boundary expedition, and lately by Mr. Hall.

*Ranunculus alismæfolius* var. *montanus* is essentially equivalent to the var. *alismellus* Gray; although the specimens from the "head of Provo River in the Uintas" are a stouter and larger-flowered form, identical with Parry's No. 79, which we had wrongly named when distributed and which may be rightly characterized as merely a dwarf mountain state of Geyer's *R. alismæfolius.* We may now add that there is a much older name for this species, especially for this mountain form of it, viz., *R. Pseudo-Hirculus* of Schrank, 1842, a Songarian plant. It may also be noted that, while this species in Eastern America takes the place of the European *R. Flammula*, both occur on the western side of the continent (as also in Siberia), and in forms so much alike that only the character of the style and that of the petal and its scale (so well indicated by Mr. Watson) will serve to distinguish them. Of amply developed *R. Flammula*—as large as any European form—copious specimens have been collected in Oregon, last year, by Mr. Elihu Hall, and are soon to be distributed.

As to *R. fascicularis*, there is no clear evidence that this species extends to California, Nevada, or even to Oregon. The plant referred to and so named in Lyall's collection, though not in fruit, is apparently *R. orthorhynchus*, a plant most rare in collections, but now, thanks to E. Hall's collection of last summer, likely to be supplied to botanists. As to Mr. Watson's *R. orthorhynchus* var. *alpinus*, that is certainly not of this species, but a wholly new one, unless it be the rare and to us obscure *R. pedatifidus* of Smith, or at least of Hooker. For since Schlechtendal's plant of that name has been referred to *R. affinis*, the Siberian one of Smith may also be of that species.

A yellow-flowered *Aquilegia*, with flowers rather smaller and sometimes much smaller than those of *A. Canadensis*, and with spurs shorter than the widely spreading sepals, after the manner of *A. formosa*, and more or less curved (thus approaching the European type), which has been collected by Lyall, Bourgeau, and others, is now characterized as a new species, under the name of *A. flavescens* Watson. It should be noted that this has been cultivated in European gardens, from seeds collected by Rœzl, under the name of *A. aurea*, but it is doubtful if yet published under that name.

The *Cruciferæ* constitute an important order in the interior basin and its borders. One of Mr. Watson's most notable discoveries is that of Brown's *Parrya macrocarpa*, hitherto found only on the Arctic coast. It was detected on the highest peak of the Uintas, at an altitude of 12,000 feet. The next point of interest is found in our author's discoveries and views of plants of the *Streptanthus* and *Thelypodium* type. Two or three well-marked new species are introduced, and Nuttall's obscure *Streptanthus cordatus* is confidently identified. In the present view this is the only *Streptanthus* of the collection; Mr. Watson, having ascertained that several species, such as *S. procerus*, the curious *S. crassicaulis*, and two new species, have oblong seeds in a terete elongated pod, and cotyledons inclining to be incumbent in the manner of *Thelypodium*, combines them into his new genus, *Caulanthus*. And *Iodanthus*, with a few other species, some of which had already been excluded from *Streptanthus*, are referred, as had also been tentatively suggested, to *Thelypodium*. Which is all to be highly approved, except, perhaps, the expediency of the new genus, when all could be disposed in the two genera: *Streptanthus* for the species with flat or flattish pods, flat seeds, and truly accumbent cotyledons; *Thelypodium*, for those with more or less terete pods, narrow seeds, and more or less incumbent cotyledons.

We are bound, moreover, to take steps for the suppression of a nominal species which is here introduced in consequence of our own short-sightedness. In an evil moment we gave the name of *Smelowskia? Californica* to a plant of Prof. Brewer's collections, thought to be perennial, with exceedingly short few-seeded pods. This Mr. Watson identified with a common *Sisymbrium* of the region, distinguished from *S. canescens* by its seeds, strictly in a single series, and transferring the name, calls it *S. Californicum*. He had overlooked an article in this Journal (for Sept. 1866) upon this *Sophia* group of *Sisymbrium*, from which it would have been seen that the plant in question is *Sisymbrium incisum* of Engelmann, and the later *S. longipedicellatum* of Fournier, besides one or two other names of the same author more or less strictly referable to it.

A. G.

10. *Plants of Oregon.*—Mr. Elihu Hall, well-known as an excellent and enterprising collector, during the past season made an extensive collection of dried plants in Oregon, which are to be distributed in sets as soon as the materials can be put in order. The full sets will contain five or six hundred species, and Mr. Hall offers them to subscribers at eight dollars per hundred specimens. So far as the examination has gone, a good number of rare and interesting, and some wholly new species are brought to light. Plants of this region being far from common in herbaria generally, it is thought that these sets will at once be taken up. As Mr. Hall is likely to be very soon engaged in another exploration, intending subscribers may address Mr. Charles Wright, Harvard University Herbarium, Cambridge, Mass.

A. G.

11. *Saunders' Refugium Botanicum.*—This *Botanical Refuge*, disinterestedly established and maintained by W. Wilson Saunders, F.R.S., is not an asylum for decayed botanists, but a periodi-

cal or occasional publication, and its descriptive English title is, *Figures and Descriptions, from living Specimens, of little known or new Plants of Botanical Interest.* It is in royal octavo form; the plates are by W. H. Fitch; the descriptions by Prof. Reichenbach of Hamburgh as to the Orchids, and for other plants by Mr. Baker of Kew, whose name appears alone upon the title-page of the later parts. Each part contains about 24 plates and a variable amount of letter-press—commonly a single leaf or a single page accompanying the plate; sometimes a genus or a group is treated systematically and more at length. The first and second parts were issued in the year 1868; part three, completing the first volume, early in 1869. Of vol. II, devoted to Orchids, the first part appeared in the summer of the latter year; the other parts still lag. But vol. III was promptly issued in the autumn of 1869 and the early part of 1870; the first part of the fourth volume bears the date of Sept., 1870, the second of April, 1871. The plates are neatly lithographed by the artist himself, and are partly colored—all that is needful in this respect for botanical purposes. The editor, Mr. Saunders, supplies notes respecting the culture and the sources of the plants illustrated. The plants preferred for illustration are succulents generally, bulbous plants, *Araceæ*, Orchids, *Geraniaceæ*, &c., which the editor has cultivated for the sake of a better understanding of their structure and characters, these not being well to be made out in dried specimens, nor easily rendered in a description. Among these the species of *Cotyledon* (including *Echeveria*), now favorite succulents in cultivation, are fully illustrated; and an analytical table of the American species (*Echeveria*, 29 in number), drawn up by Mr. Baker, will be very useful to cultivators. So, also, in the third volume, Mr. Baker has given a monograph of *Ledebouria*, treated as a section of *Scilla*, with some revision of that genus and its nearest relatives. From *Scilla* Mr. Baker decidedly excludes *Camassia* (both eastern and western American species)—as Dr. Torrey had previously and Mr. Watson recently done—on the ground of geographical distribution, several-nerved perianth, and hypogynous stamens. The latter character, however, is not quite decided.

A. G.

12. *The Inflorescence or Flower in Euphorbia.*—Eugene Warming has published in the *Videnskabelige Meddelelser fra Naturhistorisk Forening i Kjobenhavn*, for the year 1871, an article of 108 pages upon the question whether the *Cyathium* of *Euphorbia* is a flower or an inflorescence. The development of the cup and its contents are studied and illustrated by numerous figures, filling three plates, and various diagrams are given in wood-cuts. The language is Danish; but, according to an excellent usage newly introduced, a recapitulation is appended in French. The current view, which appears to have originated with Lamarck, but was completed and fully developed, not to say established, by R. Brown, has been recently combated by Payen and by Baillon, who have revived the Linnæan idea that the cup is a perianth, and its contents the genitalia of a single hermaphrodite flower. This view

they sustain by a study of the organogeny of *Euphorbia.* Dr. Warming has now also investigated the organogeny in fourteen common species of the genus; by it and by a comparison with the plan of ramification, as well as by comparison with other genera of the family, he is led to re-affirm the Brunonian doctrine. The involucre, he maintains, is composed of five leaves, as Rœper had concluded, but on less exact grounds. Its glands, however important the part they play in fertilization, are not foliar organs, nor homologous with stipules, &c., but are to be likened to those on the margins of the leaves of various *Euphorbiaceæ*, and upon the bracts and bractlets of several species of *Euphorbia.* The male flowers (single pedicellate stamens) develop from five axillary buds, one in the axil of each leaf of the involucre, and so are in five fascicles, each fascicle representing a uniparous scorpioid cyme. The interfloral scales develop, as Payen and Baillon had shown, much later than the male flowers they accompany; but Dr. Warming is not disposed for all that to deny that they are true leaves, though it is an objection that they are not constant as respects position or number, being sometimes fewer, sometimes more numerous than the male flowers, and sometimes only one between two scorpioid cymes. In the development the involucre is formed, and the first flower of each of the five male fascicles sketched, before the female blossom originates. The three carpels, having a divergence of 120°, cannot be exactly opposite three of the five bracts of the involucre (Baillon describing the cells as superposed to the first three sepals); nor is the median carpel turned toward the main axis, but away from it, just as in Wydler's diagram, i. e. facing the space between the leaves two and five of the involucre, that toward which the *Cyathium* inclines in anthesis.

So *Euphorbia*, upon the conception now re-vindicated, is in harmony with all other *Euphorbiaceæ*, in having unisexual flowers, in themselves simple, but with inflorescence often very complicated.

A. G.

13. *Botanical Necrology*, 1870-1871.—Taking up anew the record which has been omitted for the last year or two:—

Franz Unger, of Gratz, was found dead on the morning of the 13th of February, 1870, under mysterious circumstances, which suggested violence, but the suspicion has not been verified. Unger was distinguished first in Physiological, afterwards in Fossil Botany.

Jean Léveillé died at Paris, Feb. 3, 1870, a well-known Mycologist.

G. S. Perottet, for many years director of the Botanic Garden at Pondicherry, died near the beginning of the same year.

Carl Müller of Berlin, the continuator of Walpers' Annales, June 21, 1870. The publication of the 7th volume of this work has been completed since his decease.

Franz Ruprecht, of the St. Petersburgh Academy, a botanist of distinction, August 4, 1870. His office as keeper of the Herbarium is filled by Dr. Maximowitz.

Baron Charles von Hugel, an Australian explorer and scientific cultivator, founder of the collection of live plants acquired by Prince Demidoff, and lately dispersed at the sale of the collections at the Villa Demidoff,—died in Belgium, where he was Austrian Minister, in the summer of 1870.

Thomas Anderson, late Superintendent of the Botanic Garden at Calcutta, an excellent botanist, who has done much good work and from whom much more was expected upon *Acanthaceæ*, died at Edinburgh, Oct. 26, 1870.

F. A. W. Miquel, the most distinguished botanist of the Netherlands and Director of the Leyden Herbarium, as well as Professor of Botany at Utrecht, died January 23, 1871, at the age of only 59 years.

B. S. G. Lantzius-Beninga, chiefly known for his researches upon the structure of the spore-case of Mosses, died at Göttingen, March 6, 1871.

Carl H. Schultz-Schultzenstein, Professor of Physiology at the University of Berlin, who wrote voluminously upon Cyclosis and Vessels of the Latex, died March 23, 1871.

William Wilson, of Warrington, England, the veteran Muscologist, former associate with Sir Wm. Hooker in the Muscologia Britannica, and sole author of the last edition of that work, or rather of the Bryologia Britannica, died April 3, 1871, at the age of 72.

Carl Theodor Hartweg, at one time botanical traveler and collector for the London Horticultural Society in Mexico, South America, and California (the dried plants enumerated by Bentham in Plantæ Hartwegianæ), and of late director of the Grand Ducal Gardens at Swetzingen, Baden, died February 3, 1871.

Paul Rohrbach, of Berlin, a most promising botanist, who has lately revised the *Sileneæ*, *Typhaceæ*, &c., with great credit, died June 3, 1871, before he had completed his 25th year.

Julius Milde, of Breslau, an investigator of *Equisetaceæ*, and later of Ferns, died July 3, 1871.

Ramon de la Sagra, a Spanish botanist long resident in Cuba, for whose work upon the civil and natural history of that island Montagne contributed the publication of the lower Cryptogamia, and Achille Richard commenced that of the Phanerogamia, died in June, 1871.

Henry Lecoq, of Clermont-Ferrand, France, author of a most elaborate work on the Geography of the Plants of Europe, and a distinguished French botanist, died August 4, 1871.

Siegfried Reissek, keeper of the Imperial Herbarium at Vienna, and author of some good botanical papers, died November 9, 1871.

James De Carle Sowerby, son of the artist of the original figures of the British Botany, and who himself drew most of the plates of the Supplement, died in London, August 26, 1871, at the age of 84.

Berthold Seemann, editor of the Journal of Botany, British and Foreign, author of the Botany of the Voyage of the Herald, of the

Flora Vitiensis (of which the last fasciculus has been unacountably delayed for the past three years), and of other botanical writings, —a very enterprising botanist, but of late years much occupied in business affairs in Central America,—died of fever in Nicaragua in November last, as we learn from a brief announcement of the sad event in the Gardeners' Chronicle of Dec. 16.

SEBASTIAN RENÉ LENORMAND, Vire, France. A wide circle of correspondents and friends will share our regret upon being informed of the death of this venerable botanist (specially an adept in Algology), and most charming man. This occurred on the 11th of December, 1871, in the 76th year of his age. A. G.

14. *Fish-nest in the sea-weed of the Sargasso Sea.* Extracts from a letter from Professor AGASSIZ to Prof. Peirce, Superintendent U. S. Coast Survey, dated Hassler Expedition, St. Thomas, Dec. 15, 1871.—* * * The most interesting discovery of the voyage thus far is the finding of a nest built by a fish, floating on the broad ocean with its live freight. On the 13th of the month, Mr. Mansfield, one of the officers of the Hassler, brought me a ball of Gulf weed which he had just picked up, and which excited my curiosity to the utmost. It was a round mass of sargassum about the size of two fists, rolled up together. The whole consisted, to all appearance, of nothing but Gulf weed, the branches and leaves of which were, however, evidently knit together, and not merely balled into a roundish mass; for, though some of the leaves and branches hung loose from the rest, it became at once visible that the bulk of the ball was held together by threads trending in every direction, among the sea-weed, as if a couple of handfuls of branches of sargassum had been rolled up together with elastic threads trending in every direction. Put back into a large bowl of water, it became apparent that this mass of sea-weed was a nest, the central part of which was more closely bound up together in the form of a ball, with several loose branches extending in various directions, by which the whole was kept floating.

A more careful examination very soon revealed the fact that the elastic threads which held the Gulf weed together were beaded at intervals, sometimes two or three beads being close together, or a bunch of them hanging from the same cluster of threads, or they were, more rarely, scattered at a greater distance one from the other. Nowhere was there much regularity observable in the distribution of the beads, and they were found scattered throughout the whole ball of sea-weeds pretty uniformly. The beads themselves were about the size of an ordinary pin's head. We had, no doubt, a nest before us, of the most curious kind: full of eggs too; the eggs scattered throughout the mass of the nest and not placed together in a cavity of the whole structure. What animal could have built this singular nest, was the next question. It did not take much time to ascertain the class of the animal kingdom to which it belongs. A common pocket lens at once revealed two large eyes upon the side of the head, and a tail bent over the back of the body, as the embryo uniformly appears in ordinary fishes shortly before the period of hatching. The many empty egg-cases observed in the nest gave promise of an early opportunity of seeing some embryos freeing themselves from their envelope. Meanwhile, a number of these eggs with live embryos were cut out of the nest and placed in separate glass jars to multiply the chances of preserving them, while the nest as a whole was secured in alcohol, as a memorial of our unexpected discovery. The next day I found two embryos in one of my glass jars; they occasionally moved in jerks, and then rested for a long while motionless upon the bottom of the jar. On the third day I had over a dozen of these young fishes in my rack, the oldest of which began to be more active, and promised to afford further opportunities for study.

* * * But what kind of fish was this? About the time of hatching, the fins of this class of animals differ too much from those of the adult, and the general form exhibits too few peculiarities, to afford any clue to this problem. I could suppose only that it would probably prove to be one of the pelagic species of the Atlantic, and of these the most common are Exocœtus, Naucrates, Scopelus, Chironectes, Syngnathus, Monacanthus, Tetraodon and Diodon. Was there a way to come nearer to a correct solution of my doubts?

As I had in former years made a somewhat extensive study of the pigment cells of the skin, in a variety of young fishes, I now resorted to this method to identify my embryos. Happily we had on board several pelagic fishes alive, which could afford means of comparison, but unfortunately the steamer was shaking too much and rolling too heavily, for microscopic observation of even moderately high powers. Nothing, however, should be left untried, and the very first comparison I made secured the desired result. The pigment cells of a young *Chironectes pictus* proved identical with those of our little embryos.

It thus stands as a well authenticated fact that the common pelagic Chironectes of the Atlantic (named *Chironectes pictus* by Cuvier), builds a nest for its eggs in which the progeny is wrapped up with the materials of which the nest itself is composed; and as these materials are living Gulf weed, the fish-cradle, rocking upon the deep ocean, is carried along as an undying arbor, affording at the same time protection and afterward food for its living freight.

This marvelous story acquires additional interest if we now take into consideration what are the characteristic peculiarities of the Chironectes. As its name indicates, it has fins like hands; that is to say, the pectoral fins are supported by a kind of prolonged, wristlike appendages, and the rays of the ventrals are not unlike rude fingers. With these limbs these fishes have long been known to attach themselves to sea-weed, and rather to walk than to swim in their natural element. But now that we have become acquainted with their mode of reproduction, it may fairly be asked if the most important use to which their peculiarly constructed fins are put is not probably in building their nest.

* * * All the officers of the Hassler are indefatigable in their efforts to help our investigations, and even the men show useful interest in our proceedings. We have just reached St. Thomas, so that I have nothing to add as to observations made here.

15. *On the Phosphorescence of Animals.*—Prof. PANCERI, of Naples, has been studying for some time past the phosphorescence of marine animals. He has examined *Noctiluca*, *Beroe*, *Pyrosoma*, *Pholas*, *Chætopterus*, and has lately published a paper on the phosphorescence of *Pennatula*. He finds in all cases that the phosphorescence is due to matter cast off by the animal—it is a property of dead separated matter, not of the living tissues. In all cases (excepting *Noctiluca*) he also finds that this matter is secreted by *glands*, possibly special for this purpose, but more probably the phosphorescence is a secondary property of the secretion. Further, the secretion contains epithelial cells in a state of fatty degeneration, and it is these fatty cells and the fat which they give rise to which are phosphorescent. Hence the phosphorescence of marine animals is brought under the same category as the phosphorescence of decaying fish and bones. It is due to the formation in decomposition of phospheric hydro-carbon, or possibly of phosphuretted hydrogen itself. In *Pennatula* Prof. Panceri has made phosphorescence the means of studying a more important physiological question—namely, the rate of transmission of an irritation. For when one extremity of a *Pennatula* is irritated, a stream of phosphorescent light runs along the whole length of the polyp-colony, indicating thus by its passage the rate of the transmission of the irritation. This admits of accurate measurement, and furnishes data for extending Helmholtz's and Donder's inquiries to animals so widely separated from their "Versuchs-thiere" as the *Cœlenterata*. It is also a proof of the thoroughness of Prof. Panceri's investigation that he has made use of the spectroscope for studying the light of phosphorescence.—*Nature*, Dec. 14.

16. *Application of Photography to Illustrations of Natural History. Bulletin of the Museum of Comparative Zoology*, iii, No. 2; by ALEXANDER AGASSIZ.—This paper is accompanied by two excellent samples of what can be done toward securing most accurate and permanent plates by some of the new photographic methods. The plates are some of those that have been prepared for the "Revision of the Echini," upon which Mr. Agassiz is now engaged. One of them, illustrating *Echinocidaris punctulata*, is by the "Albert" process, and the other, representing a section of *Laganum*, is printed by the "Woodbury" process. The latter retains the appearance and beauty of a fine photographic print most perfectly. There can be no doubt but that these and similar processes are destined to create an entire revolution in the illustration of works on Natural History, where absolute accuracy and fidelity to nature are of paramount importance. V.

17. *Microscopy and the American Naturalist.*—In entering upon their sixth volume, the editors of the American Naturalist announce that they have established a department of microscopy, with Dr. R. H. Ward, of Troy, N. Y. as special editor. This

judicious improvement in a journal already so ably and satisfactorily conducted, and so universally approved by naturalists, cannot fail to please the former subscribers, and secure new ones, and considering the small amount of microscopic literature published in this country, as compared with the amount of work actually done by our microscopists, and the very general interest in the subject, it is a change in every way desirable. V.

18. *Anatomisch-systematische Beschreibung der Alcyonarien, erste Abtheilung; die Pennatuliden, zweite Hälfte, erstes Heft, mit* vii *Tafeln;* by A. Kölliker, Frankfort, 1871.—In this part of Dr. Kölliker's excellent and almost exhaustive work upon the Pennatulians, he describes and illustrates the genera, *Halisceptrum*, *Virgularia* (15 species), *Stylatula* (8 species), *Acanthoptilum*, a new genus founded upon two species from the Gulf-stream explorations of Pourtales, *Scytalium*, *Pavonaria*, *Halipteris*, and *Funiculina*.

A large part of the work is devoted to descriptions of the anatomy and histology of the various genera and species. V.

19. *Illustrated Catalogue of the Museum of Comparative Zoology.* No. VI. *Supplement to the Ophiuridæ and Astrophytidæ*, with two plates; by Theod. Lyman, Cambridge, 1871.—We defer to the next number a notice of this work by Dr. Chr. Lütken.

## III. Astronomy.

1. *Stellar Photography.*—We are happy to learn that, through the liberality of members of his own and his wife's family, means have been obtained to enable Dr. B. A. Gould to avail himself of the inventions of Lewis M. Rutherfurd, Esq., and obtain photographs of the principal constellations in the southern heavens. The importance of this in a scientific point of view is thus clearly stated in a letter from Professor Peirce to Hon. Josiah Quincy. "This addition to astronomical research is unsurpassed by any step of the kind that has ever been taken. The photographs afford just as goodan opportunity for new and original investigation of the relative position of the near stars, as would be derived from the stars themselves as seen through the most powerful telescopes. They are indisputable facts, unbiased by personal defects of observation, and which convey to all future times the actual places of the stars when the photographs were taken." Dr. Sellack, Ph.D., a scientific photographer, after spending some weeks in the observatory of Mr. Rutherfurd, has sailed for Buenos Ayres with all the necessary apparatus for obtaining these photographs. Since his residence in Cordoba, Dr. Gould has been making an uranometry of the southern heavens—a catalogue and maps of all the stars visible to the naked eye on the clearest nights, together with a determination of their positions. Owing to the clearness of the sky, he has found many more than have previously been known. For instance, Argelander found from the North Pole to 30° S. 3256 stars visible to the naked eye; and Dr. Gould has already found from the South Pole to 10° N. 4600. To do this the sky has been divided into seventeen maps, and he and his four assistants have labored night and day in mapping and

estimating magnitudes, and making the calculations necessary for finding the position of each star from the position it held when previous catalogues were made. Argelander writes that "no work could be more important." When in addition to this an American astronomer, aided by an American inventor, can bring back exact photographs of the great southern constellations, a great addition will be made to astronomical science, of which as Americans we may justly be proud.

2. *Eclipse of the Sun of Dec.* 12.—A telegram from Mr. Davis, photographer to the English Eclipse expedition, says: "Mangadore, Baikul. Five totality negatives; extensive corona; persistent rifts; slight external changes." Another from Mr. Janssen, to the French Academy of Sciences, dated Octacamund: "Spectre de la couronne attestant matière loin qu' atmosphère du Soleil."—*Nature*, Dec. 21.

## IV. Miscellaneous Scientific Intelligence.

1. *Chicago Academy of Sciences.*—This active Academy, we are glad to learn, is likely to resume work under far more favorable conditions than was at first thought possible. While the loss of special collections cannot be repaired in all cases, and the losses of the results of years of labor by Dr. Stimpson in memoirs, then nearly complete when destroyed, are beyond repair, yet the property of the society in its real estates, owing to a change in the business centers consequent on rebuilding the city, is much enhanced in value. The academy hope to receive, through donations, an entire square whereon to rebuild, and they will have $60,000 or more for a building fund. The total destruction of the library makes all gifts of books, and even of separate copies of memoirs from authors, highly acceptable to the Academy. We know that some authors and publishers have already sent in offers of importance, and, no doubt, an organized effort, in response to the circular lately issued by the President, Col. Foster, and Dr. Stimpson the Curator, will be fruitful of good results.

Let us hope that this second total destruction of the Chicago Academy by fire will lead them, in rebuilding for the third time, to the exercise of every possible means of security against a similar disaster.

2. *The Natural Sciences in Public Schools.*—We learn, with great satisfaction, that a science-school for the teachers in the public schools of Boston has been established through the enlightened liberality of John Cummings, Esq., whose interest and zeal in promoting public education are well known. Professor A. Hyatt, and W. H. Niles, and many of the officers of the Boston Society of Natural History and Institute of Technology have coöperated in making the plan successful. The system of object-teaching is chiefly relied upon. The intention is to impart knowledge of such kinds, and in such modes, that the teachers can give it in their turn to their pupils. Thus even the youngest pupils may receive more or less of the sciences in the most suitable and practical manner.

It is certain that the attention of very young children can be directed to the study of Natural History, and habits of careful observation of natural objects and phenomena be thus established much more readily than later in life; and there can be no doubt but that such studies will ultimately become an essential part even of primary education. The first course of lessons, on Physical Geography by Mr. W. H. Niles, was attended by upward of five hundred teachers, and was very successful.

## V. MISCELLANEOUS BIBLIOGRAPHY.

1. *A Treatise on the Origin, Nature, and Varieties of Wine:* being a complete manual of Viticulture and Œnology; by J. L. W. THUDICHUM, M.D., and AUGUST DUPRÉ, Ph.D., Lecturer on Chemistry at Westminster Hospital. Large 8vo, pp. xxiv, 760. London and New York, 1872. (Macmillan & Co.) $9.00.—This book appears to us fully to justify its comprehensive title. The first four chapters, comprising 123 pages, are devoted to the vine and its culture, including vintage and vinification. The next five chapters—181 pages—treat of the chemical constituents of wine and the methods of estimating their amounts; and the succeeding eighteen chapters describe minutely the various wine-producing districts, the character of the cultivation in each and the peculiarities of the products. In the preface, the authors say that their statements are based, as far as possible, upon their own personal observation; and that for the purpose of supplementing these observations, they have consulted nearly two hundred out of the six hundred works which compose the world's œnological literature. The wide range which they have given to the discussion, they say, is for the purpose of making the book available to several classes of readers; to planters and wine-growers, to merchants, to consumers, to men of science, etc. Among the objects which they have had in view, is "the accomplishment of one of the most beneficial intentions of the Legislature; namely, to make accessible to the people at large, the wines of all countries which can be used as beverages, and which by the voice of science and the practice of entire nations are declared preferable by far to distilled spirit or to wines fortified by such." To favor the production in commerce, of pure wines, they condemn the practice of plastering either the must or the wine; and they also urge consumers to remember that the grape gives the individuality to the wine, and hence that "the most renowned wines are all made from distinct varieties." Consequently, the greater the number of varieties of grapes used to produce a wine, the less character the wine possesses, and therefore the more readily it may be artificially imitated. "The thoroughly fermented, unsugared, and unbrandied wines," say our authors, "cannot be imitated by the most expert wine-cooks." "Wines should be described in such a manner," they maintain, "that the grapes from which they are made constitute the first term of the description." The word "Sherry" cannot be distinctive, since when made from the Palomino grape

it differs greatly from that made from the Mantuo castellano, even when both are grown in the Xeres district. The same is true of the words "Claret" and "Hock," which lack significance and should be amended so as to designate the variety of the grape from which they have been prepared. At the close of the ninth chapter, very complete analyses of 133 leading wines are given in considerable detail.

This book must become at once the authority on wine and wine-making, and cannot fail to add to the already excellent reputation of its authors. The wood-cuts are superior, the letter-press is elegant, and the binding is superb. Mechanically the book is all that could be desired.

2. *Journal of the Anthropological Institute of New York.* Vol. I, No. 1. New York, 1871, 1872. (Westermann & Co.). The Anthropological Institute of New York is the American Ethnological Society reorganized—a change which was effected during the past year. Hon. E. George Squier is the President of the Institute, and J. C. Nott, M. D., and George Gibbs, Esq., Vice-Presidents. This first number of its publications contains several valuable original papers, besides a translation of the address of Dr. M. Paul Broca, before the Anthropological Society of Paris, on the progress of Anthropology. These papers are entitled —von Martius on some points of South American ethnology, by C. Rau; Antiquities from the Guano or Huanu Islands of Peru, with illustrations, representing silver fishes, wooden idols, etc., by E. G. Squier; Sculptured rocks, Belmont Co., Ohio, with figures of slabs with human and other footprints, by J. W. Ward; Canoe in Savannah river Swamp, by C. C. Jones, jr. Trepanning among the Incas, with a figure of the trepanned skull, by J. C. Nott; the Arch in America, by E. G. Squier; Indians of Oregon, etc., by George Gibbs; besides notes from other sources.

3. *Organic Philosophy.* Vol. III. *Outlines of Biology, Body, Soul, Mind, Spirit;* by HUGH DOHERTY, M.D., 556 pp. 8vo. London, 1871. (Trübner & Co.)—The previous volumes of Dr. Doherty's work, already noticed in this Journal, treated, the first, of Epicosmology, the second, of Ontology. This third volume takes up systematic Biology. A fourth is to follow, on Systematic Sociology, and a fifth on Dialegmatics or Biological Methods, in parallel with Mathematics as a Science of Method. Biology is discussed from a physical, a physiological, a psychological, an intellectual and a spiritual point of view.

4. *Map of the Geyser Region of the Yellowstone and Firehole Rivers, Wyoming Territory; Map of the Lower Geyser Basin, Firehole River; Map of the Yellowstone Lake.*—These handsome maps are issued by the Department of the Interior, as part of the Report on the U. S. Geological Survey of the Territories, under Dr. F. V. Hayden. They present the features of one of the most remarkable regions on the continent. The positions of all the numerous geysers are laid down, and also the temperature of the waters. A reduced copy of one of the maps of the geysers is issued in illustration of a paper by Dr. Hayden, and another will appear in the following number.

THE

AMERICAN

# JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

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## Art. XX.—*The Hot Springs and Geysers of the Yellowstone and Firehole Rivers;* by F. V. Hayden. With maps.*

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In an article, in the February number of this Journal, we closed with a brief description of the mud springs six miles below the Yellowstone Lake. The term Yellowstone Basin is sometimes applied to the entire valley; but the basin proper comprises only that portion enclosed within the remarkable ranges of mountains, which give origin to the waters of the Yellowstone, south of Mount Washburn and the Grand Cañon. The range, of which Mount Washburn is a conspicuous peak, seems to form the north wall or rim, extending nearly east and west across the Yellowstone, and it is through this portion of the rim that the river has cut its channel, forming the remarkable falls and the still more wonderful cañon. This basin is about forty miles in length from north to south, and on an average thirty miles in width from east to west. From the summit of Mount Washburn a bird's eye view of the entire basin may be obtained, with the mountains surrounding it on every side, without any apparent break in the rim.

This basin has been called, by some travelers, the vast crater of an ancient volcano. It is probable that during the Pliocene period, the entire country drained by the sources of the Yellowstone and the Columbia was the scene of as extensive volcanic activity as that of any portion of the globe.

* The charts accompanying these articles were prepared by Mr. E. Hergesheimer, a most accomplished topographer connected with the U. S. Coast Survey.

It might be called one vast crater made up of thousands of smaller rents and fissures, out of which the fluid interior of the earth fragments of rocks and volcanic dust have been erupted in unlimited quantities. Hundreds of the nuclei or cones of these volcanic vents are now remaining, some of them rising to a height of ten thousand to eleven thousand feet above the sea. Mounts Doane, Langford, Stevenson, and more than a hundred other peaks, may be seen from any high point on either side of the basin, each of which was once a center of eruption. Indeed the hot springs and geysers of this region are only the closing stages of that wonderful period of volcanic action, which began in Tertiary times. In other words, they are the escape-pipes or vents for those internal fires which were once so active, but are now gradually dying out. The evidence is clear that, ever since the cessation of the more powerful volcanic action, these springs have been the escape pipes, and have been declining to the present time, and will continue to do so until they entirely cease. The charts accompanying these articles will enable the reader to form a clear conception of the position and number of the most important springs in this basin; but an equal number of the dead and dying springs have been omitted.

Even at the present time there are connected with these manifestations of internal heat, earthquake phenomena, which are well worthy of attention. While we were encamped on the northeast side of the lake, near Steamboat Point, on the night of the 20th of July, we experienced several severe shocks of an earthquake, and these were felt by two other parties, fifteen to twenty-five miles distant, on different sides of the lake. We were informed by mountain men, that earthquake shocks are not uncommon, and are, at some seasons of the year, very severe; and this fact is given by the Indians as the reason why they seldom or never visit this portion of the country. I have no doubt that if this region should ever be settled and careful observations made, it would be found that earthquake shocks are of very common occurrence.

The lake itself is about twenty-two miles long and averages ten or fifteen miles in width. Our soundings show it to have an unusual average depth, though the greatest depth which we were able to find, after a careful series of observations, was about three hundred feet. It is fed by the snows that fall upon the lofty ranges of mountains that surround it on every side. It is the most beautiful sheet of water I have ever seen in the West. The clear green shading, with the deep ultramarine hue of the waters, adds not a little to the effect of the scene. The lake has, at all seasons, nearly the temperature of cold spring water. Its height above the sea level is about 7,427 feet. We were able to discover but one species of fish, a trout weighing from one to three pounds each. They are very abundant; but five out of six of them were infested with a singular parasitic worm, which is found in the abdominal cavity, or interwoven in the muscular portions in sacs or cysts, or sometimes in the gills. Dr. Leidy has described these worms under the name of *Dibothrium cordiceps.* It is possible that this diseased condition of the fish is caused by the proximity of the hot springs, which are abundant all around the shore of the lake and sometimes extend far out into the waters.

We cannot at this time present a full description of a lake which would of itself furnish the material for an extended article. We may remark, in passing, that we regard the lake basin as due in part to erosion. All along its margin are high banks and terraces composed of a modern stratified deposit, passing up into an aggregation of sand, pebbles, &c., which is not unfrequently cemented into a tolerably firm conglomerate. These deposits, which are made up of eroded volcanic rocks, have in some instances the white appearance, and somewhat the composition, of the Pliocene clays, marls and sands of the other lake-basins along the Missouri and the lower Yellowstone. In the northern portion of the basin, these deposits reach a thickness of three hundred to six hundred feet, and must be of the later Pliocene age, and perhaps extended down to the present time. The two lakes were then connected, although probably never completely united. The belt of mountains that separated them was about four miles in width. I have estimated that, since the period of volcanic activity, the depth of the lake has been about five hundred feet greater than at present, the shore line being then high up on the sides of the surrounding mountains. During the time of the greatest volcanic action, the waters must have covered the loftiest peaks; for many of them are composed of the breccia or conglomerate in a regularly stratified condition. This breccia surrounds the highest volcanic cones or nuclei, as Mounts Doane, Stevenson, &c. The area occupied by the lake is now gradually but very slowly diminishing.

On the shore of the southwest arm of the lake is an interesting group of hot springs, which extend along the margin, covering a belt about three miles long and nearly a mile in width. These springs have built up a series of beds, or strata, about 25 feet thick, in the aggregate, composed of laminæ of silica, which have been worn into a bluff wall by the waves. The shores are covered with the decomposed siliceous crust, so that it looks as if it were covered with the fragments of washed sea-shells.

Many of the springs, which might be called pulsating springs, are in a constant state of quite violent ebullition, but rise and fall every second or two, and, with each pulsation, throw out a small quantity of water. Quite a pretty symmetrical funnel-shaped crater is formed with a circular rim varying from a few inches to several feet in diameter. Some of these funnel-shaped

1.

HOT SPRING.

chimneys extend out into the lake several feet, and the hot spring deposits may be seen through the clear depths for fifty yards. Bubbles may be seen on the surface of the water some distance from the shore in many spots and show the presence of a spring beneath.

The same variety of colors, quiet springs, mud springs, old ruins, &c., that we have before described, occur here. No geysers were observed, but the group of mud springs keep up a constant thud-like noise, which can be heard with great distinctness for half a mile.

On the east and northeast sides of the lake are a number of groups of living or dead springs. High up on the sides of the mountains are two quite extensive patches of the siliceous deposit, which look in the far distance like an immense bank of snow. They are called by the mountaineers, brimstone basins. The large double basin on the southeast arm was once covered with hot springs, though at the present time, there is no water there with temperature above ordinary spring water. Great quantities of sulphur are mingled with the silica, and hence the name.

At Steamboat Point there are two vents which keep up a constant pulsating noise like a high-pressure engine on a river steamboat. Columns of steam are thrown out at each pulsation to the height of 100 feet or more. Hundreds of small simmering vents are scattered all around; dead and dying springs in great numbers can be seen along the shores of the lake, and high up among the foot hills of the mountains, a mile or two from the lake. One of the most conspicuous of these great white hills, seen from all sides of the lake, is called Sulphur Mountain: it is located on the side of the mountains at the north end of the lake. The summit of this deposit rises about 600 feet above the lake; it is the remains of one of the most interesting group of springs in the vicinity; there are now many steam vents lined with a brilliant coating of sulphur. The deposit is from 50 to 150 feet in thickness, and when not mingled with sulphur, is as white as snow. Silica predominates over all other materials; but it is much variegated by oxide of iron, sulphur, &c. At the foot of the mountain, near the margin of Pelican Creek, a few springs issue from beneath the crust with a temperature from 150° to 180°, but this great group may now be regarded as extinct.

We will now leave the Yellowstone Basin, and, pursuing a westerly course, make our way over the high range, or divide, into the great Geyser Basin of the Firehole river, a branch of the Madison Fork. The mountains that surround the Yellowstone Basin are of the same character as those which extend down the branches of the Madison and Gallatin Forks for thirty miles; and not until then do the sedimentary or granitic rocks appear to any extent. Immense quantities of obsidian also are found on both sides of the range. Little lakes, varying in size from the diameter of a few hundred yards to four or five miles, are scattered all about the sources of the Missouri, Yellowstone and Columbia. Some of them are situated on the very summits of the mountains, ten thousand and eleven thousand feet above the sea.

Traveling in this region is attended with great difficulties, on account of the fallen timber. The uplands, as well as the lowlands, are covered with a dense growth of pines, the majority of which have a trunk not over six to twelve inches in diameter, but run up to a height of 100 to 150 feet, as straight as an arrow. These pines often grow so thickly together, that, for miles, it is very difficult to find space between them for the passage of our pack animals. Almost every year the autumnal fires rage among these dense forests, destroying the trees; and then come the strong winds that lay them down in every direction. We have traveled for thirty to fifty miles over a perfect network of these fallen pines, from three to six feet high, requiring great ingenuity and labor to make our tortuous way among them.

In crossing the main divide between the drainage of the Yellowstone and the Madison, we first strike the sources of the branch named, on the chart of the Lower Geyser Basin (accompanying this paper), the East Fork. Every few miles we meet a group of dead or dying springs. Very few of these contain much water at the present time, but steam was issuing from hundreds of vents. There was one locality, covering several acres, that presented one of the most beautiful of scenes. The entire area was covered thickly with conical mounds of various sizes, ranging in diameter from a few inches to a hundred feet or more, and these cones or hillocks were full of orifices, from which streams were issuing. All these little chimneys or orifices were lined with the most brilliant crystals of sulphur, and when the heated crust was removed, we found the under-side adorned in the same manner. The basis of the deposit was silica, as white as snow; but it was variegated with every shade of yellow from sulphur, and with scarlet or rose color from oxide of iron. In the distant view the appearance of the whole country may be not unaptly compared to a vast limekiln in full operation. The east branch of the Madison is almost entirely fed by water from the hot springs, and its temperature is 60° or 80° all the time. The vegetation that grows along its branches and in the stream itself is a marvel of luxuriance.

The mountains that enclose the valley on either side are composed of basalt and obsidian. The valley itself, which varies from half a mile to a mile in width, is underlaid with hot-spring deposits. The surface waters pour in abundantly from numerous springs, at the base of the hills on either side, and cover the valley, so that it is one great marsh or bog. Among the foot hills are a number of old ruins, or groups of dead and dying springs, with a few steaming sulphur vents remaining to mark the dying stages.

As we proceed down the valley, toward the junction of the East Fork with the main Madison, the springs grow more abundant, and we soon come to the great basin of the Firehole, in which the most powerful geysers are found.

First, before reaching the valley of the Firehole, there is a large group of springs, on both sides of the East Fork (see chart). Here there are no true geysers, but great numbers of boiling and quiet springs, having basins varying in diameter from a few inches to fifty feet, and temperatures ranging from 100°, to 197° F. The elevation here is such that the boiling point is from 192° to 196° F. Only the more important springs are located on the chart, a large number of dead or dying ones being not considered worthy of attention.

A broken range of hills, forming a kind of ridge, extends down between the valleys of the Firehole and East Fork. Near its terminus it is broken into several isolated butes, which are largely made up of old hot spring material, as well as basalt. Indeed, the igneous rocks on either side of both the valleys show plainly that during the time that the volcanic forces were dying out, the hot-springs were in their most active condition, forming very thick deposits, which made up a large portion of the mountain.

From the large group of springs on the East Fork, we passed, between the isolated butes, to the valley of the Firehole, where the principal springs and geysers are located. The entire valley, averaging about three miles in width, is covered with the sili-

HOT SPRING BASIN.

ceous crust as white as snow. Among the dense pines in the foot hills, and even quite high on the mountain side, a column of steam, rising above the tops of the trees, reveals the location of a spring or a steam vent. As we came out into the level open plain of the Firehole valley, the elevated mounds and numerous columns of steam revealed to us where the most important groups were located. It will be seen on the chart that all these groups, and nearly all the springs, occur along the valleys of the streams, and for the most part very near their banks. On the east side of the valley are scattered groups of springs, the aggregated waters of which form quite large streams. By the side of the largest stream we encamped for two days, making use of the water for drinking and cooking purposes. Some of these springs have the most beautifully scalloped rims, with the inner and outer surfaces covered over with delicate bead-like elevations. The basins vary in diameter from a few inches to one hundred feet. Some of them have nearly circular rims, with funnel-shaped orifices, and are filled with water up to the very margin, which is so transparent that we could look down into the clear depths for five to forty feet and see the smallest tubercle upon the surface. The funnel-shaped orifice or basin usually extends down until it closes up to a very narrow fissure, and then extends on below to an unknown depth.

In the Lower Geyser Basin, although there are many groups of most interesting springs, none of them can rank as geysers of the first class. Over an area of about three miles in width and five in length, the surface seems to be literally riddled with the orifices of active, quiet, dying and dead springs. There must be, at least a thousand of them; only the most important are noted on the chart. Some of them may be called true geysers having rather regular periods of activity, and throwing up columns of water from two to six feet in diameter to the height of 15 to 30 feet. One geyser, with quite a small orifice, played every fifteen minutes or so, sending up a column of water 20 to 30 feet high. A large number of the springs were in a constant state of violent ebullition, throwing the water up two to four feet. Occasionally an unusual impulse was given to the column, sending it up 10 or 12 feet. One of the most remarkable of the springs in this lower basin had built up for itself a cistern, which for beauty and elaborateness would compare well with those of the springs on Gardiner's river. We called it the *architectural fountain.* The whole basin is about 150 feet in diameter. Near the center is the rim of the spring, which is about 25 feet in diameter; the water is in constant agitation, occasionally spouting up a column of water, like an artificial fountain, and filling up the reservoirs and the sides for a radius of 50 feet or more. The siliceous accumulation made by this spring descends for several hundred feet in innumerable semi-circular steps varying from one-fourth of an inch to two inches in height, and is exquisitely beautiful in all its details. When in active operation a column of water is thrown 30 to 60 feet high, when the waters spread over a radius

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ARCHITECTURAL FOUNTAIN.

of fifty feet, filling the numerous reservoirs that surround the immense rim of the basin. There were other funnel-shaped basins with elegantly scalloped rims, which were covered all over the inner side, to the depth of 10 to 20 feet, with bead-like tubercles of silica. Sometimes these siliceous beads were arranged in large numbers like Fungia corals, or like the heads of cauliflowers.

In the Firehole Basin, silica predominates in the deposit, and so far as we could determine there was very little, if any, lime. Sulphur occurs in very small quantities in the lower basin, although there were two or three springs the orifices of which were lined with it.

A short distance from this beautiful geyser is a remarkable group of *mud springs*. One of them has a basin fifty feet in

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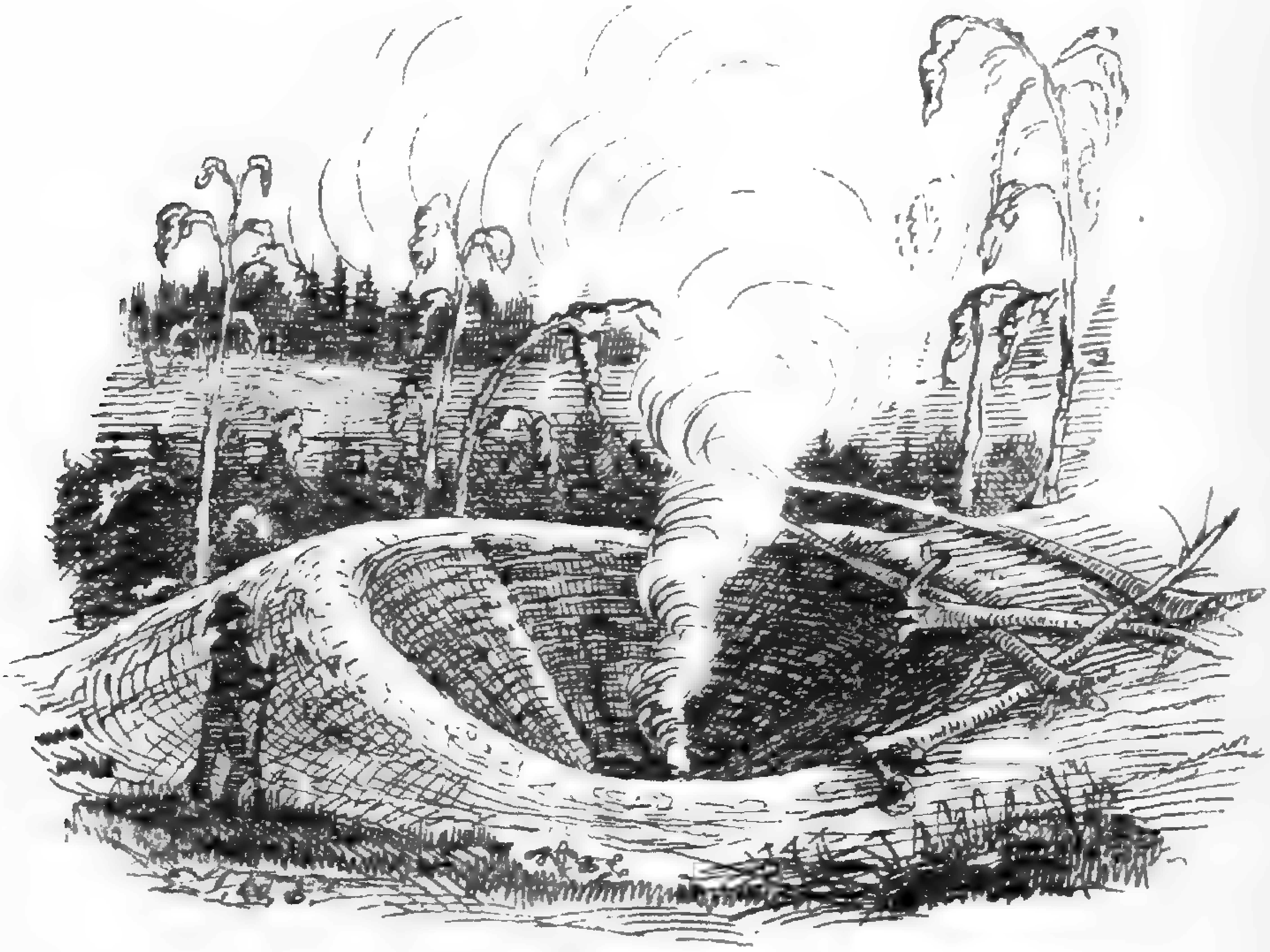

MUD GEYSERS.

diameter, which is covered over thickly with puffs, like an immense cauldron of thick hasty-pudding. The exact symmetry of these puffs, their uniformity of size and the fineness of the material render them exceedingly beautiful; and there is among them every shade of color, from a bright scarlet to the most delicate pink or rose, with a base as white as snow. The white siliceous clay, when dried, has the appearance of the finest meerschaum. The most fastidious manufacturer of porcelain ware, would go into ecstacies over this magnificent bed of mortar, that has perhaps been worked and re-worked for many thousands of years.

MUD PUFFS.

These springs occur in small groups all over the basin, and are often in close proximity to geysers or to perfectly clear quiet springs. They are found in every stage, from simply turbid water, through all grades of consistency, to thick stiff mud, through which the gases force themselves with a suppressed thud-like sound. Each of these mud springs probably commenced as a geyser or at least as a boiling spring. The water is at first clear, then becomes turbid, and grows gradually thicker until the heat dies out.

About half of the springs are in the last stage of action. They have been either geysers, or very active boiling springs, as is shown by the character of their basins; but now their temperature is diminished to 150° and all the way to 80°. When the temperature diminishes to 160°, oxide of iron is thrown down, and they become what are marked on the charts as iron springs. A thick coating of a dull iron-rust color is deposited all over the inner side of the basin, and over the surface where the water flows. This coating in the old springs becomes broken up, so that it is suspended all over the sides of the springs like rotten mouldy fragments of leather. The iron is undoubtedly held together by vegetable matter. When these springs entirely dry up, these leathery fragments are blown about the surface in every direction by the winds.

In the vicinity of the active geysers, the surface over which the surplus water from an eruption flows is sometimes covered, to the thickness of two to four inches, with a substance which appears to the touch like jelly or pulp. All over the surface there are irregular depressions with sharp raised edges, like the inner surface of a cow's stomach. The colors are varied, being usually a white base with every variety of scarlet, pink or rose color, with brilliant shades of green.

Another interesting feature was the quantity of incrusted and silicified wood found scattered about the springs. Very frequently the pine trees, which are abundant in the vicinity, have fallen across the basin of a geyser, or an active boiling spring. The wood becomes permeated with the hot water holding silica in solution, and soon becomes like paper pulp. When the spring dries up, the wood remains in the basin thoroughly silicified and incrusted with a coating of silica. The entire cellular structure is permeated with the silica, and the process of petrifaction is most clearly shown. Into one of the large hot springs, about fifty feet in diameter and twenty feet deep, a living pine tree had been blown by the wind, and all the branches, leaves and cones were completely incrusted over and partially permeated by the silica.

Up the Firehole river about ten miles, there is the Upper Geyser Basin, where the great geysers are found.

In the Lower Geyser Basin on both sides of the Firehole, even up among the foot hills of the mountains on either side, are springs in a state of greater or less activity, and upon the very summits of the mountains is here and there a steam vent. But none of the Grand Geysers are found here. For four or five hours in the early morning, this valley presents one of the most interesting pictures that can well be imagined: columns of steam are rising from a thousand vents, completely shrouding the valley as with a dense fog. A view of the city of Pittsburg from a high point would convey some idea of the appearance of this valley, except that in the former case the dense black smoke arises in hundreds of columns, instead of the pure white feathery clouds of steam.

The Upper Geyser Basin is located very near the source of Firehole river, and between it and the Lower Geyser Basin there is an interval of about five miles in which the hills come close to the river on both sides, and the springs occur only in small groups. Although possessing some interest, yet there were so many others in the region that they did not attract much attention. The valley, as well as the bed of the creek, is covered with old deposits, showing clearly that these springs have been successively breaking out, reaching their culminating period of activity, and then dying out, ever since the Pliocene era. Above this woody and rocky interval, the valley again expands, and a branch comes in from the southwest,

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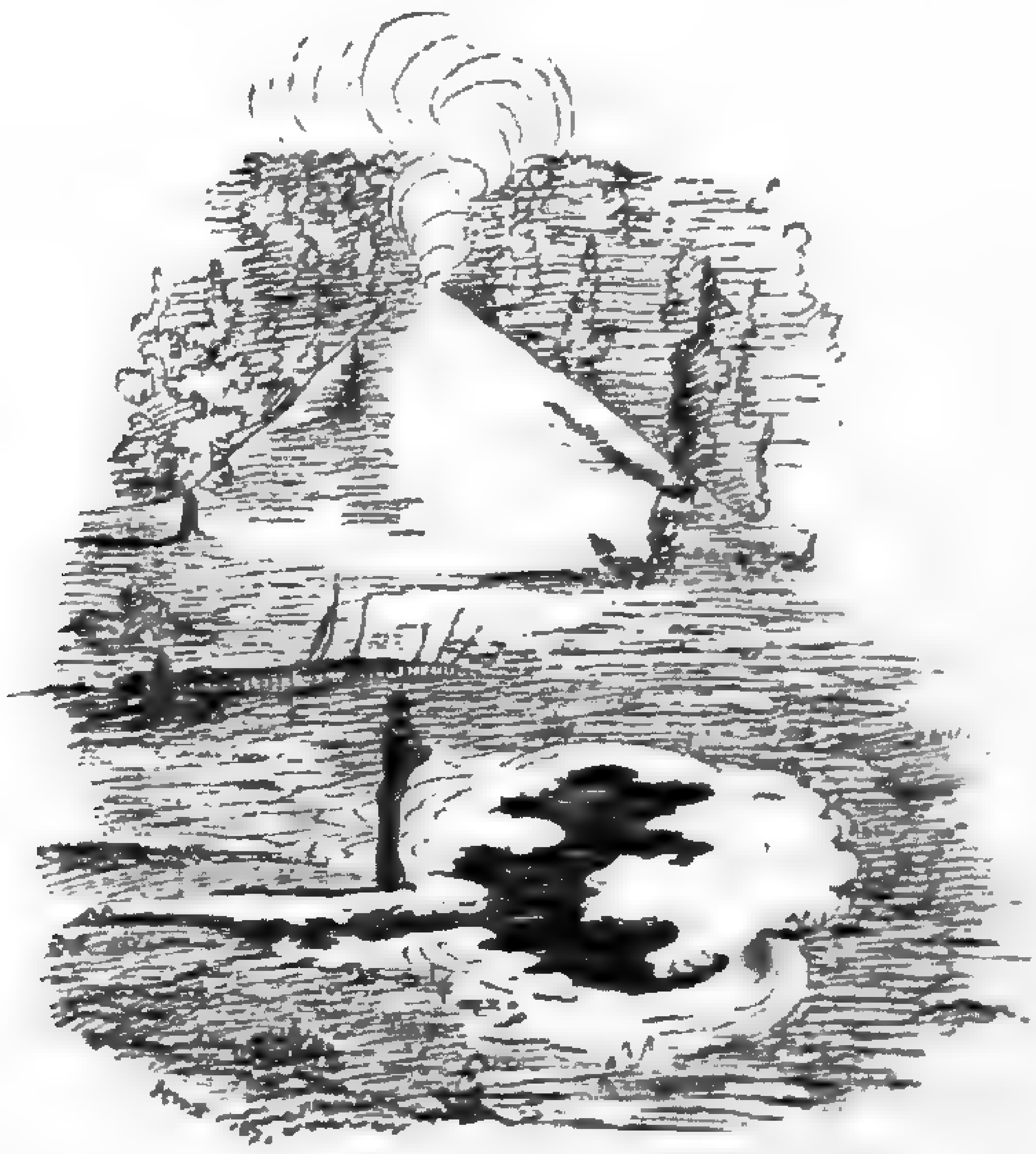

STEAM SPRING AND CONE.

which we call Iron Spring Creek, on which are located many more springs, as the chart indicates. This stream receives its name from the vivid yellow and pink clays, on both sides, from mouth to source. Ascending the Firehole, we find the surface, on both sides of the river, covered with a thick siliceous crust, and completely riddled with springs of every variety. Quiet springs, with basins varying from a few inches to a hundred feet in diameter, are distributed everywhere. Some high pyramidal cones, with steam issuing from the summits, indicate the last stages of what were once important geysers.

Near the center of the basin, which is about two miles long and half a mile in width, there is one of the most powerful geysers of the basin. During our short visit of two days it operated twice. Our camp was pitched within a few yards of it. The preliminary warning was indicated by a tremendous rumbling, which shook the ground all around us with a sound like distant thunder. Then an immense mass of steam burst out of the crater as from an escape pipe, followed by a column of water eight feet in diameter, and rising by steady impulses to the height of two hundred feet; I can compare the noise and excitement which it produced only to that of a charge in battle. This wonderful fountain continued to play for the space of fifteen minutes, when the water gradually subsided and settled down in the crater, about two feet, and the temperature slowly diminished to 150°. There are here two separate basins, one of which is in a constant state of violent agitation, while the other plays only at intervals of about thirty-two hours; and although, so far as the eye could detect, there was a partition of not more than two feet in thickness between them, neither of them seemed to be affected by the operation of the other. The decorations about these springs were beautiful beyond anything I had ever seen in nature. The most delicate embroidery could not rival them in their wonderful variety and complexity. The surface within and without was covered over with little tubercles of silica, which had a smooth enameled appearance like the most delicate pearls; down on the sides of the basin were large rounded masses like corals, formed entirely of silica. There was one spring with a small elevated crater about two feet high, which threw up a small column of water, about twelve feet high, by continued impulses, like the movements of a saw, and thus it received the name of the Sawmill Geyser. There were probably from twenty to fifty geysers of greater or less importance in this valley; and it is quite possible that some of the springs placed in the quiet class operated at times as first class geysers. There were also the Grotto Geyser and Castle Geyser. The crater of the latter is about 40 feet in height, and one hundred and fifty to two hundred feet in diameter at its base; it was built up of thin layers of the silica, which rise, much like steps, to the chimney on the summit, which is about ten feet high. Clouds of steam issue constantly from this chimney, and every few moments a column of heated water is thrown up fifteen to twenty-five feet.

But the most accommodating, and, in some respects, the most instructive geyser in this basin was called by Messrs. Langford

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GIANT GEYSER.

and Doane "Old Faithful." During our stay it operated every hour, throwing up a column of water six feet in diameter from one hundred to one hundred and fifty feet. When it is about to make a display, very little preliminary warning is given. There is simply a rush of steam for a moment, and then a column of water shoots up vertically into the air, and by a succession of impulses is apparently held steadily up for the space of fifteen minutes, the water falling directly back into the crater and overflowing in large quantities. It then ceases, and with a rush of steam for a few seconds closes the display for the time. Words can convey but an inadequate conception of the intense excitement which the scene produces upon the mind.

Night and day some of the geysers are in operation continually, and, at certain periods, several of them perform at the same time.

The two kinds of deposits in these regions, the calcareous and siliceous, have been mentioned in the preceding descriptions. According to analyses by Dr. Peale, Chemist of the U. S. Geological Survey, the springs on Gardiner's river which we call the White Mountain Springs deposit carbonate of lime mostly. There is present also sulphate of magnesia, chloride of lime, sulphate of soda and a little silica. In the deposits of the Firehole Basin not a trace of lime could be detected, but about 85 per cent of silica, 11 per cent of water and the remainder mostly chloride of magnesia; and only a slight trace of lime was found in the water. In but one locality west of the lake, Col. J. W. Barlow found a calcareous deposit. There are, scattered over the great area, about forty by fifty miles in extent, a few patches of the sedimentary rocks, and it is most probable that underneath the deposit of this small group of springs, there are portions of the Carboniferous limestone.

So far as we could ascertain, in all the deposits of the Yellowstone Basin proper, and in the Firehole Basin, silica is the dominant constituent. The springs are, with very few exceptions, and those not important, near the borders of the streams below any beds of limestone. It is quite possible that underneath the vast masses of volcanic material, which compose the mountains on every side, the sedimentary rocks exist, but I am disposed to believe that they occur only in isolated and much restricted patches, if at all.

We may therefore state, in general terms, that the great hot spring region of the sources of the Yellowstone and Missouri rivers is covered with rocks of volcanic origin, of comparatively modern date.

In this article I have been able to present only a few of the wonderful and most attractive features of this unique region. A bill has been introduced into Congress which has for its purpose the setting apart of this wonderland as a great National Park for all time. We have, as a precedent, a similar action with regard to the Yosemite valley, and this noble act has met with the hearty approval of the people. The speedy passage of this bill, which will prevent squatters from taking possession of the springs and destroying the beautiful decorations, will also meet with the cordial approval of all classes. We hope that before this article is published to the world the act will have become a law.

ART. XXI.—*On the Electrolysis of the Substituted Derivatives of Acetic Acid. Preliminary Notice;* by Dr. G. E. MOORE.*

MORE than a year ago the writer undertook, at the suggestion of Prof. Hermann Kolbe, the study of the phenomena attending the electrolysis of monocyanacetic acid. The question for whose solution the work was undertaken is the following:

It is well known that Kolbe obtained by the electrolysis of acetic acid a gaseous product, which he held to be identical with the univalent radical *methyl.* According to the generally received opinion the products of the action of chlorine, iodine, and bromine, etc., on acetic acid, stand in the very simple relation to the parent substance, that one or more atoms of hydrogen in the *methyl* group are replaced by a corresponding number of atoms of chlorine, iodine or bromine. According to analogy, therefore, the electrolysis of these substituted acids should result in the formation of substances which represent such substituted radicals. Prof. Kolbe formulated this reaction as follows:

$$2\left.\begin{matrix}H_2\\CN\end{matrix}\right\}C\left[\mathbf{CO}\right]OH+H_2O=2\left(\left.\begin{matrix}H_2\\CN\end{matrix}\right\}C\right)'+2CO_2+H_2O+H_2,$$

in other words, the univalent radical *monocyan methyl* $\left(\left.\begin{matrix}H_2\\CN\end{matrix}\right\}C\right)'$ was to be expected, a substance which would probably be either a gas or a readily volatile fluid.

For the purpose of answering this question, a quantity of rather more than 200 grm. of pure monocyanacetic acid was prepared, and purified from every trace of chlorine by a very tedious fractional crystallization of the lead salts of the mixture of monochlor- and monocyan-acetic acids first obtained.

With this material the electrolysis was performed in the month of December, 1870. The result obtained was decidedly *negative;* the expected substance could not be detected among the products of decomposition, and the question for whose solution the investigation was originally undertaken was therefore to be considered as settled.

It appeared desirable, nevertheless, to subject the products of the electrolysis to a more thorough examination. They are of very diverse nature, and their examination is by no means completed; as, however, temporary postponement of the work has become necessary, it may not be without interest to communicate a few of the more interesting results already obtained; all analytical data are reserved for a future detailed communication.

* Communicated, in substance, to the Chemical Society of Berlin, at the sitting of May 22d, 1871.

If a concentrated neutral solution of pure potassium monocyanacetate, free from chlorine, be subjected to the action of the current from six Bunsen's elements, a voluminous evolution of gas ensues at the positive pole, which is, with the exception of a slight residue, soluble in potash solution. The unabsorbed portion appears to be, after the removal of a trace of gases absorbable by bromine, an entirely indifferent gas, probably nitrogen. The strongly acid solution in the positive cell, was, after the completion of the reaction, repeatedly shaken with ether and the latter distilled from the water-bath. The residue of the distillation, a deliquescent acid substance, was dissolved in a large volume of ether, the solution rendered neutral by agitation with the least possible quantity of potash solution, filtered and the ether distilled off from the water-bath. There remained a brownish residue, solid at ordinary temperatures, which agreed in its crystalline texture and other external properties, as well as in its fusing point (37°·8 C.), with ethylene cyanide $C_2H_4(CN)_2$. When boiled with a concentrated potash solution it evolves ammonia, and leaves a residue in which, by means of its suffocating vapor and reaction with ferric chloride, ethylene succinic acid may easily be detected.

The course of this phase of the decomposition may therefore be represented by the following equation:

$$2\begin{matrix}CH_2CN\\|\\CO.OH\end{matrix}+H_2O=\begin{matrix}CH_2CN\\|\\CH_2CN\end{matrix}+2CO_2+H_2O+H_2,$$

precisely analogous to the reaction by which, during the electrolysis of potassium acetate *dimethyl* $\begin{matrix}CH_3\\|\\CH_3\end{matrix}$ is obtained.

The study of the associated products of the electrolysis being still incomplete, I abstain from a further development of the theoretical bearings of the facts already communicated until the missing data can be obtained.

As far as studied the reaction affords a very clear and positive evidence regarding the constitution of ethylene; it proves by a simple synthesis that this body is formed by the direct union of two methylene groups, and, that its formula should be written, in accordance with what is now the general usage $\begin{matrix}CH_2\\\|\\CH_2\end{matrix}$ and not, as it is still occasionally written, $\left(\begin{matrix}CH_3\\H\end{matrix}\right\}C\Big)''$, or, what is the same thing, $\left(\begin{matrix}CH_3\\|\\CH\end{matrix}\right)''$.

It is my intention to extend this investigation to the doubly and triply substituted acetic acids, and, as the corresponding cyanogen derivatives are still unknown, I shall try if it be possible to obtain a similar series of reactions among the chlorine derivatives. Monochloracetic acid should give ethylene dichloride $\begin{matrix} CH_2Cl \\ | \\ CH_2Cl \end{matrix}$, and, by a precisely analogous reaction, we might expect from the electrolysis of dichloracetic acid acetylene tetrachloride $\begin{matrix} CHCl_2 \\ | \\ CHCl_2 \end{matrix}$. In the same manner the electrolysis of trichloracetic acid would probably yield dicarbon hexachloride $\begin{matrix} CCl_3 \\ | \\ CCl_3 \end{matrix}$.

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## Art. XXII.—*Green Mountain Geology. On the Quartzite;* by James D. Dana.

The quartzite of the Green Mountain region is the most remarkable of its rock formations. It has a wide distribution along the range, occurring in Connecticut, Massachusetts and Vermont, and some parts of New York adjoining. It is peculiar in the isolation and bold obtrusiveness of its outcrops; for its hills and ridges often rise out from among the other rocks with the look of independence that belongs to an eruptive intruder. While some patches barely show themselves above the general surface, others make mountain ridges or peaks, the summits two thousand feet and more above the sea.

The outcrops are smallest to the south, in Connecticut, and largest in the southern half of Vermont. In the latter region, the quartzite departs somewhat from its habit of isolation, and forms, according to the geological map of Vermont in the Report of 1861, a ridge, with but small interruptions, over one hundred miles in length, rising near Bennington, in Bald Mountain, to a height of 3100 feet.

The quartzite has still another peculiarity in usually cropping out in the vicinity of the great metamorphic limestone of the Green Mountain range, called the Stockbridge limestone; and in largest amount, but not exclusively, near the eastern border of the limestone region. When the conclusion was reached, or assumed, that this limestone was of Lower Silurian age, it was, obviously, a natural inference that the quartzite, in many places manifestly an underlying rock, was the Potsdam sandstone, the great quartz formation of the early Silurian. These views were brought out as parts of one scheme by Professors W. B. and H. D. Rogers in 1841,* the slates between

* Proc. Amer. Phil. Soc., Jan. 1, 1841; also, Trans. Assoc. Amer. Geol. and Nat., 1842, p. 482; and Address before the Assoc. in 1844, Am. Jour. Sci., xlvii, 150, 1844

the Hudson river and the Stockbridge limestone being regarded as in part the Hudson river shales folded and partially metamorphic.

Professor Emmons in his Geological Report (1842), treating of his Taconic system, reversed the order, putting the Stockbridge limestone over the quartzite; but the Taconic slates, lying to the west, with some limestone strata associated with these slates, conformably below both, and making all older than the Potsdam, or the basal rock of the New York series. The fact that, in the New York series below the great Lower Silurian limestones, there were no beds corresponding to the extensive range of Taconic slates, was the prominent reason urged in his Geological Report of 1842 for the pre-Silurian age of these rocks; and the occurrence of fossils (trilobites, proved since to be Primordial) in the Black slate of Bald Mountain (near Chatham Four-corners), unlike any known in the American Lower Silurian, was an additional argument in his Agricultural Report published in 1843.

In the Report of 1842, the Taconic region is made to extend to the western base of the Taconic mountain, and the slates west are called, in the sections (plate xv), Hudson River slates. In that of 1843 the slates all the way to the Hudson river are referred to the Taconic system. Besides this change of view, the order of the strata of the Taconic series is reversed in the latter Report, the quartzite being placed at the bottom; over this, conformably (in some localities), the Stockbridge limestone; next, the schists and slates, to the west; and last, the Black slate of Bald Mountain, the newest of the series; and this order is made consistent with the easterly dip throughout, by supposing, in order, "to assist us in maintaining these views," that the "superior members," or newer rocks, were removed by abrasion to the eastward before they were upturned, and were "thus limited in an easterly direction;" and, besides, the upper strata were probably "scantily extended east and west," "the whole system having been formed in a trough." The quartzite is still made conformable to the limestone, while the black slate is at the other end of the series conformable also. In his American Geology, published in 1855, this order is in the main sustained, the quartzite and associated slates being overlaid conformably by the Stockbridge limestone, this by the "talcose" slate of Graylock, and the Taconic slates to the west; and, finally, the Black slate of Bald Mountain being made Upper Taconic, and the Georgia slates of Northern Vermont being brought into parallelism with it.

Had Professor Emmons made out rightly the relations of the quartzite to the Stockbridge limestone, the argument presented in 1842, and since, for the pre-Silurian age of the Taconic would have been without any foundation worthy of note.

Later geologists have accepted the conclusion that the Stockbridge limestone and the Taconic slates, to the Hudson, make one series of rocks; but they have made all of Lower Silurian age, and the slates older than the Trenton. Logan has referred the beds to the Quebec group on his geological map of Canada. The quartzite, however, is still of undetermined relations, some regarding it as at the base of the Lower Silurian, and Logan placing it at the top.

I propose to state the more important facts which I have observed in connection with the Green Mountain quartzite at a few of its localities, and some of the conclusions which they appear to sustain.

Several sources of uncertainty attend the investigation of the quartzite formation.

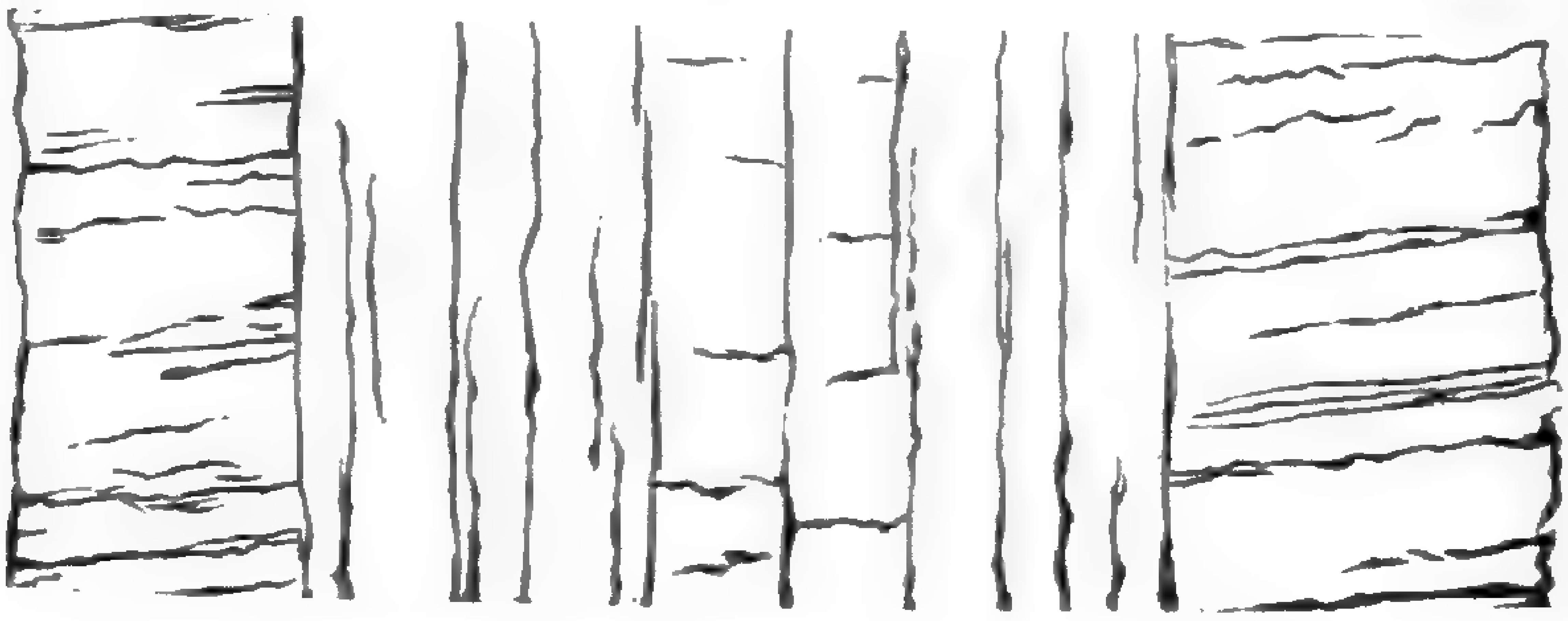
In the first place, there are quartzites of more than one age in New England, west of the Connecticut river. A Helderberg quartzite exists at Bernardston, Massachusetts, in the Connecticut river valley; and it does not differ in characters from much of the Green Mountain quartzite. Another quartzite, of different age, is interstratified with gneiss, about three miles west of Plymouth, Vermont, on the road to Cuttingsville; and the gneiss of the region is apparently the ordinary Green Mountain gneiss. Then there is the great quartzite of the Green Mountain range, whose relation to the quartzite in the gneiss is unascertained. We cannot assume, therefore, that this last is all of one geological age.

Another difficulty in the way of investigation arises from the fact that the quartzite is very generally jointed, and the joints are often so numerous and regular that they are easily mistaken for planes of bedding. The only safe course in all cases was found to be, to doubt as to the bedding unless there were alternate layers differing distinctly in structure or fineness of texture, especially when the divisional planes dip at a high angle. So far as my observation goes, its joints are commonly nearly or quite vertical; while the beds seldom have a greater dip than 45°, and often are nearly horizontal.

The obliteration of the bedding by impulses of lateral pressure is well illustrated in the quartzite near Poughquag,* Dutchess Co., N. Y., where the bedding is beautifully distinct and nearly horizontal. In two or three places, in the course of a long section of the well stratified beds, there are narrow vertical portions, of the whole height of the section exposed, which have lost entirely the bedding, or division into layers, and are divided only by vertical joints. The accompanying sketch illustrates one of them. The jointed vertical strip is only 8 feet wide, and looks a little way off like a dike of igneous rock. Yet it is only a narrow vertical section of the strati-

* Pronounced as if spelt *Poquaig*.

fied quartzite, in which, under the lateral pressure, fractures were produced, and where, consequently, the successive movements shook down and re-arranged the sands adjoining, so as to obliterate the planes of bedding and substitute vertical planes.



JOINTS IN THE POUGHQUAG QUARTZITE.

In a case of this kind only a force that was comparatively light could have acted, since nearly all the rest of the rock has its stratification perfect, although much jointed. But the same process, if continued, might result in a universal obliteration of the bedding.

It should be noted that after a quartzite had been consolidated this obliteration of the bedding would be an impossibility, however powerful the forces at work. The sand beds must be feebly compacted, or the sands could not be shaken down and re-arranged into a series of vertical or nearly vertical beds. Hence the jointed structure, when connected with absence of planes of bedding, is proof that the forces producing the structure acted *before, or at the time of, the final solidification—certainly not after it.*

Again, the quartzites of different periods are almost identical in structure and mineral characters, so as to afford nothing by which they may safely be distinguished. In the same region all kinds often occur, from the finest and hardest granular quartz to pebbly layers, and to conglomerates made of stones as large as cobble-stones, on one side, and to thin friable layers on the other. The presence or absence of a pearly micaceous or talcoid mineral in the layers is not a distinction of value; for the same stratum may be a pure quartz rock in one place, and even look gneissoid in another.

The conclusion of the whole matter is, that the age of each quartzite outcrop must be determined by an examination of its special stratigraphical relations to the adjoining rocks.

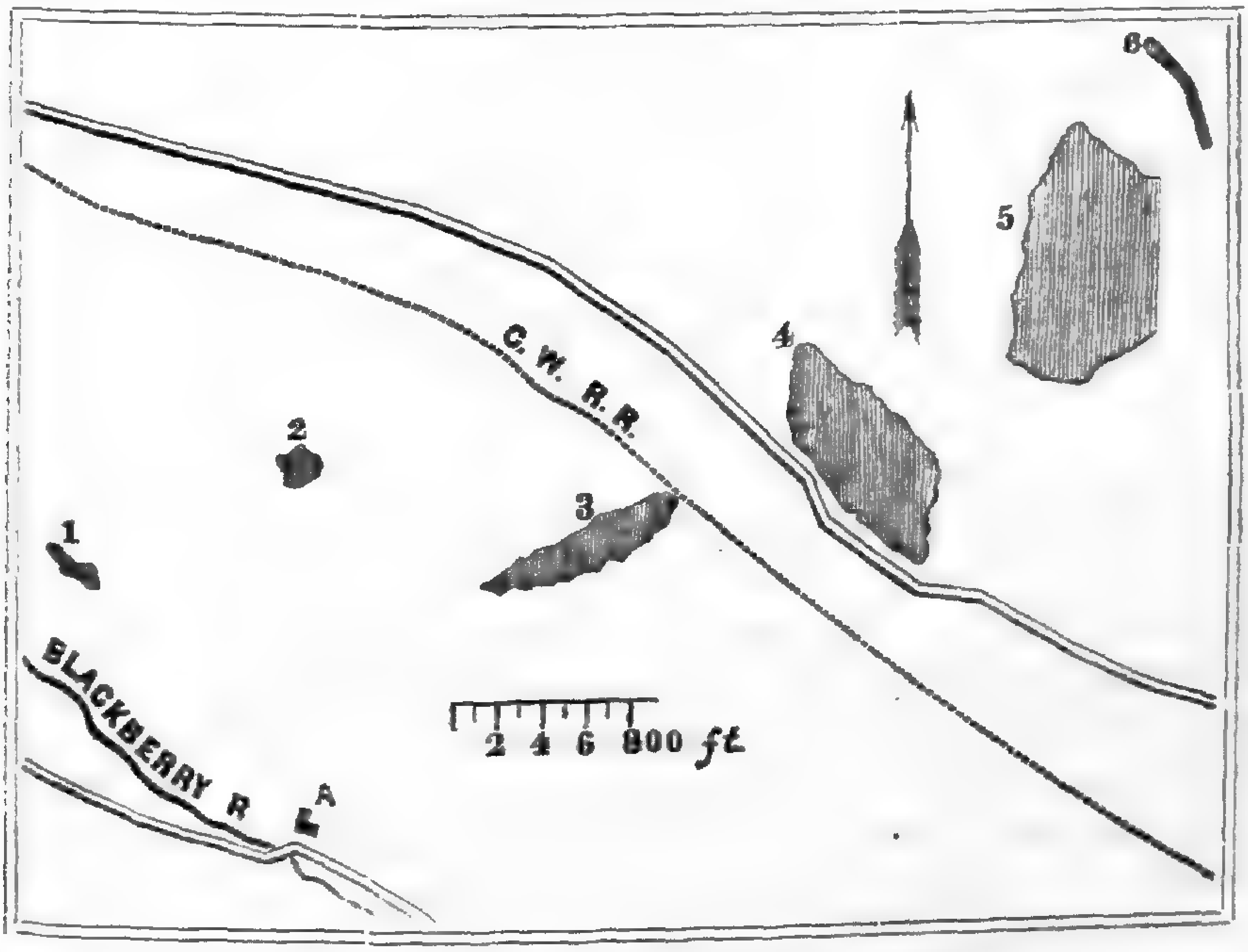
I proceed now to an account of the quartzite of a few Green Mountain localities. The observations at the first two of the following localities, Canaan and Poughquag, were made in conjunction with Mr. James T. Gardner, an excellent stratigraphical observer, and one of the corps of the Clarence King Surveying Expedition along the 40th parallel, west of the Rocky Mountains.

## 1. Quartzite of Canaan, Connecticut.

The village of Canaan is situated in Northwestern Connecticut, in the town of North Canaan, the northern town of the State on the east bank of the Housatonic River. Canaan Mountain, an east-by-south and west-by-north ridge, stands along the southern border of the town. The quartzite outcrops occur to the north of this mountain, and within a mile of it, not far from the residence of Dr. Adam, on Blackberry River.

The Green Mountain series of outcrops of quartzite, consisting in Massachusetts of prominent ridges and ridgelets, here has one of its southern terminations, none existing in Connecticut, as far as known, south of Canaan Mountain. This is not, however, the most southern extension of the rock, for other outcrops occur at distant intervals twenty miles farther west, in Dutchess Co., New York, and to the southwestward.

The quartzite of Canaan constitutes low ledges in a region of crystalline limestone and metamorphic schist. There are six of




Map of the Canaan quartzite region.

these ledges over an area exceeding but little a mile from east to west, and half a mile from north to south, as represented in the annexed map,* the scale of which is 1,600 feet to the inch.

Ledge No. 1 is 250 feet long, 80 wide and 20 high above the plain; 2 is 180 feet wide and long, and 24 feet high; 3 is 960

* I am indebted for this map and the measurements of the ledges to Mr. Joseph S. Adam of Canaan. It is reduced from a large map furnished me by Mr. Adam. 1 to 6 are quartzite ledges; A, Dr. Adam's house; C. W. R. R., the Connecticut Western Railroad.

feet long, and 120 feet wide, and 45 high; 4 is 1,080 feet long and 450 wide and 70 feet above the road on the southeast; 5 is 1,400 feet long, and 30 feet above the plain; 6 is 400 feet long.

The surface between the quartzite ledges is covered with limestone; and this limestone is part of the great crystalline limestone of the Housatonic valley, which has in Canaan a breadth, as laid down by Percival, of nearly ten miles. It is a continuation of the Stockbridge limestone of Massachusetts and the Eolian of Vermont; and the same wide band stretches southward, and somewhat westward, through Salisbury, Conn., and Dover and Pawling in Dutchess Co., N. Y.

This limestone is generally admitted to be of Lower Silurian age, and to represent more or less of the time from the Calciferous to the Trenton periods. The fossils from the Eolian limestone of Whiting and Sudbury, Vermont,* identified by Prof. James Hall, included species of the genera *Euomphalus*, *Zaphrentis*, *Stromatopora*, *Chœtetes*, and *Stictopora*, with large encrinal stems, and have been regarded as indicating that the rock is not older than the Trenton. Mr. Billings has presented evidence tending to prove that limestones of the Quebec group are included in the formation; and if so, the Chazy is probably present also.†

The dip of the limestone about Canaan varies from nearly vertical to nearly horizontal, the latter prevailing; and there is a like diversity in the strike. Such an irregularity of position is common in this rock elsewhere in the Green Mountain region, whenever it is not tilted throughout at a high angle; and it is evidently owing to the inflexible character of a limestone stratum when subjected to lateral pressure.

The metamorphic schist associated with the limestone is an arenaceous mica schist, which is in part an arenaceous gneiss. It alternates with, or overlies, the limestone, as may be seen in several localities in the vicinity of the quartzite. Rattlesnake mountain, a hill 300 feet high above the plain around it, and situated about a mile and a half north of Dr. Adam's house, has a base of limestone, while made up mainly of the overlying schist, a fine-grained, fragile arenaceous rock, in part gneiss-like. The layers of both rocks are nearly horizontal. The peculiar want of firmness in this superincumbent arenaceous gneiss and mica schist may be owing to the fact that the heat

* Geol. of Vermont, 2 vols. 4to, 1861, i, 418.

† In a paper on a Primordial limestone in Northern Vermont—the Winooski limestone—at page 145 of this volume, Mr. E. Billings suggests that the Stockbridge limestone may not merely include this Primordial limestone, but may be made up of it. His conclusion is based on sections by Professor Emmons, which I shall show, before the close of this paper, are not of a kind to sustain it. Moreover it will appear, on what I think is good evidence, that the Primordial does not enter at all into the proper Stockbridge limestone, although it may constitute other areas not far distant from it.

of metamorphism had to reach it through the thick horizontal limestone formation; for the gneiss where much tilted is a firmer rock. In some places about Canaan it is decomposed to a depth of thirty or forty feet or more, and then resembles a fine-grained soft sandstone.

The quartzite is for the most part the ordinary fine or coarse-grained hard quartz rock. The ledges indicated on the above map are more or less completely surrounded by limestone, so that you cannot get from one ledge to another without crossing a limestone interval, although the distance between is in no case over 400 yards, and in one but little over 100. The quartzite evidently underlies the limestone.

The rock is very strongly and evenly jointed, and nearly vertically so, and the joints are generally the only divisional planes, or are far more distinct than any planes of bedding. The direction of the joints in the several ledges is N. 30° E. to N. 37° E.

There is an exception in ledge No. 5 to this remark with regard to the absence of planes of stratification. This ledge has a bluff front facing the northeast, thirty feet high, in which the bedding is displayed in great perfection. It is made distinct by the alternation of very fine crumbling layers with others of the hard rock. The crumbling layers look as if they might be a calcareous quartzite, but on examination with a lens they proved to be an aggregation of the finest of quartz sand. The strike of the beds was N. 35° W. (compass course), and the dip 50° to the southwestward. The rock was also jointed, and the direction of the joints N. 32° E., conforming to the principal joints in other localities.

In the ledge No. 6, also, the stratification is distinct, but in an opposite direction to that of No. 5, the dip being 25° to the *northeastward*; as if the two, which are but 400 feet distant, were parts of a small fold in the stratification.

The quartzite and the associated limestone are *unconformable.* While in so close association, an interval of but a dozen yards of soil sometimes separating the outcrops, they are no where seen in conformable layers. The schist and limestone outcrop together among the quartzite outcrops, and manifest plainly their intimate relations; but nowhere is this true of the quartzite and limestone. Along the rail-road there is a section of ledge No. 3; and then, but a few rods to the southeast, one of gneiss and limestone together. This isolation of the quartzite is calculated to excite a strong impression that the two are wholly distinct in stratification. As the quartzite is so hard a rock, its outcrops ought to be continued through the limestone areas in long lines if they are conformably interstratified; but, instead, it is in short, low, island-like outcrops.

Again, the jointing is essentially uniform in all the quartzite ledges from 1 to 6, varying little from N. 35° E. In the limestone, on the contrary, there are all kinds of dip and strike, as above stated. Such a hammering as the quartzite formation (sand-beds at the time) must have undergone, before its stratification became so completely obliterated as in most of the ledges, should have left an ineffaceable impression on the limestone, if the limestone were then in existence and overlying it. In ledge No. 1, the jointing is nearly vertical and very decided, while the limestone near by is almost horizontal. This uniformity of structure in the quartzite demonstrates that its origin antedates the deposition of the limestone.

The ledges 5 and 6 (see map, p. 183) are stated to have the opposite dip that indicates a fold. But No. 6 is altogether too narrow to be the counterpart of No. 5, or the other half of the arch. Put the limestone out of the way, and then the difficulty would disappear. If therefore the uplifts of the quartzite, and its uniform system of joints, were produced before the deposition of the limestone and its associated schists, the condition of the rocks would be intelligible.

But the unconformability is directly demonstrated about ledges No. 5 and 6, in which the stratification of the quartzite is distinct. The dip of the quartzite in No. 5 is, as has been stated, to the southwest and that in No. 6 to the northeastward. Between the two, as it were in a basin made in a decapitated fold, limestone lies having a dip nearly that of No. 6. To the northward-and-eastward of No. 6, the strike of the limestone is N. 50° E., with the dip to the northwestward (N. 40° W.) 40°. This dip is persistent around the north and east sides of the quartzite ledge No. 6, and shows a total independence in the positions and relations of the two rocks.

The limestone between the ledges 5 and 6 corresponds more nearly in dip to the quartzite in No. 6, than to the limestone on the north and east; showing that the tilting it underwent was somewhat dependent on the ledges between which it lay; and it thereby indicates that the ledges had a previous existence. The facts favor the idea that the great irregularity in the tiltings of the Canaan limestone and schist, sometimes conforming to the jointings of the quartzite but oftener not, may have been in part due to the resisting ledges of quartzite beneath.

The conclusions to which the facts lead are, therefore :—

(1) That the quartzite is the inferior rock.

(2) That it is everywhere unconformable to the overlying limestone.

(3) That the jointing, uplifting and consolidation of the quartzite took place before the limestone was deposited.

ART. XXIII.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XVIII.—*On the Affinities of Paleozoic Tabulate Corals with Existing Species;* by A. E. VERRILL.

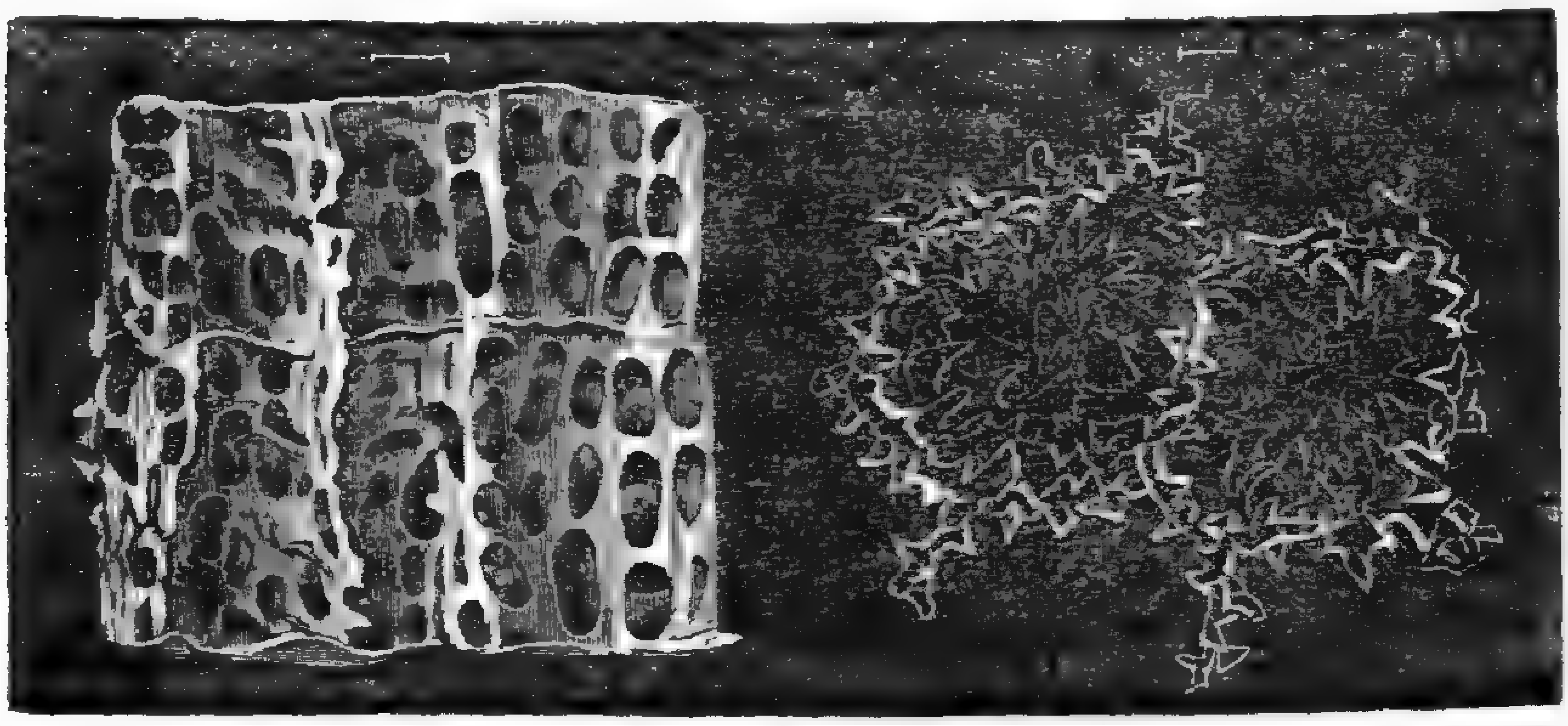
THE works of Milne Edwards and Haime upon corals are so extensive and important, and their classification is so well understood and generally adopted, especially by geologists, that it is of great importance that their errors of classification should be pointed out and fully understood.

A very unfortunate mistake was made when they instituted the exceedingly heterogeneous and artificial group known as "*Madreporaria Tabulata.*" This division was based wholly upon a single character of uncertain value, found in certain corals differing very widely among themselves in all other respects. This character, regarded by them as of such fundamental importance, was merely the existence of complete transverse septa or plates across the coral tubes, or cells, occupied by the lower parts of the bodies of the coral-polyps, thus dividing the lower, unoccupied portion of these coral-cells into a series of closed chambers, each plate in turn marking a former position of the base of the polyp, which occupied the cell, as it grew upward. In most of the other corals, on the contrary, there are either no transverse plates, or else they exist between the radiating lamellæ or septa, thus dividing each of the *radiating chambers* into a series of transverse cavities, which are *usually* not exactly on the same level in the different chambers. At the time when this classification was proposed the polyps of but few of the "tabulate corals" had been examined, and no characters were drawn from the soft parts. The explanation of the transverse septa seems to be, judging from my own dissections and also from analogy with other animals, that they are formed after each discharge of ova; the vacuity thus produced, being useless, is cut off from the visceral cavity above it by the formation of a septum. Therefore, if the eggs be discharged from all the radiating chambers simultaneously, or if from any other cause the polyp abandons all the chambers simultaneously, it is obvious that a complete septum or transverse plate will be formed across the entire tube; but if the eggs be discharged at different times from the ovaries occupying the various radiating chambers, the septa formed below them in the different chambers will not be coincident, or exactly at the same level in all. It would seem, therefore, that the existence, or non-existence, of complete transverse plates is simply a matter of periodicity in the discharge of ova.

We should, naturally, expect to find such variations in periodicity among the species and genera of many diverse groups,

—and this, I think, can easily be shown to be the case. Thus, for example, the genus *Cœlastræa* V., an undoubted Astræan coral, has the septa in all the chambers on the same level, thus forming true tabulæ; the genus *Alveopora* (figure 1, *a*), and others allied to *Porites* and *Madrepora*, have true tabulæ; also the genus *Astræopsammia* V., of the Eupsammidæ; the species of *Pocillipora*, a genus closely allied in its animals, and otherwise, to *Oculina* and *Stylophora*, have very numerous and per-

*a* Fig. 1.* *b*



fect transverse septa; even among the Alcyonaria, the genus *Tubipora* occasionally has transverse internal septa; and the same is true of *Millepora*, belonging to the class of *Acalephs*.

Notwithstanding the very slight basis upon which the group of "Tabulata" was established, and disregarding the very great and important differences which exist among the corals thus unnaturally brought together, most writers upon corals, whether recent or fossil, during the past twenty years have adopted this classification without hesitation.

And yet this is but another instance forcibly illustrating the general rule that classifications based on single characters are very likely to be artificial and erroneous. It also illustrates the manner in which such an error often leads to others of still greater importance.

In 1857 Professor Agassiz made the very important discovery, that the animals of *Millepora* are not true *polyps*, but genuine *hydroids*, belonging to the class of Acalephs or Medusæ.† But since *Millepora* is a genus belonging to the "Tabulata," he immediately concluded that all the "Tabulata" are, therefore, hydroid Acalephs! And not content with this sufficiently bold

* Figure 1 *a*, a longitudinal section of *Alveopora spongiosa* Dana; 1 *b*, a vertical view of some of the cells; both much enlarged, copied from Dana's atlas of the Zoöphytes of the U. S. Expl. Exp. For the use of this cut I am indebted to Messrs. Dodd & Mead, the publishers of Professor Dana's new work on Corals and Coral Islands.

† Proceedings of the Boston Society of Natural History, vol. vi, p. 373, 1859. See also Pourtales, in Illustrated Catal. of the Mus. of Comp. Zoölogy, No. iv, p. 56, 1871.

generalization, he extended it likewise to the extinct "Rugosa" or Cyathophylloid corals,* at first apparently with some hesitation, but more recently without qualification.†

From this conclusion, if admitted, it followed that in the Paleozoic ages there were few, if any, true polyp-corals, but, on the other hand, the class of Acalephs was abundantly represented by a great variety of coral-making forms, some of them of great size, and capable of building extensive coral-reefs, similar to those made by true polyp-corals in modern times! Thus the geological importance of these two classes of animals would be completely reversed, as well as our ideas of the nature of corals and coral-reefs.

These views have been held and advanced by Professor Agassiz for many years, and have been urged quite recently, notwithstanding the great amount of evidence that has been published to show that the "Tabulata" include corals very diverse in structure and affinities. The proposition of Professor Agassiz to consider all "Tabulate" and "Rugose" corals as Acalephs, has not been very generally adopted, but has been received with more or less hesitation and doubt, by many zoölogists and geologists. In fact, it is not easy to see how Professor Agassiz could reconcile, in his own mind, the structure of many of the Tabulata and Rugosa with his own definitions of the two classes, Polyps and Acalephs. The distinction upon which he and others have chiefly insisted is the existence in the former of radiating fleshy lamellæ, dividing the interior of the body into a number of radiating chambers, in the center of which, in coral-making species, the radiating plates are formed; while in Acalephs no such radiating lamellæ and chambers exist. Therefore it would not be possible for an Acaleph to form a coral having distinct radiating plates or septa, unless we alter our definition of an Acaleph. In that case I do not know what distinction would remain. And yet we find many Tabulate corals, both recent and ancient, with twelve or even twenty-four well-developed radiating septa; and among the Rugosa there are very many genera in which numerous radiating septa are as highly developed as in the ordinary modern corals of undoubted polyp-origin, while in some there are not even traces of *transverse* septa. If we regard the relations of the soft parts to the corals, it will, therefore, be necessary to consider all corals in which *distinct radiating plates* are formed as true polyp-corals, but the absence of such plates is not of itself proof that the coral was not made by a polyp, for many corals now living, and formed by genuine polyps, have no radiating septa (e. g., *Tubipora*, some species of *Pocillipora*).

* Contributions to the Natural History of the United States, vol. iii, pp. 61–3, and vol. iv, pp. 292–6, and p. 338.

† Bulletin of the Museum of Comparative Zoölogy, vol. i, No. 13, p. 384, 1870.

In the present state of science, the only stony corals which are *known* to be formed by hydroids are the several species of *Millepora.* We can reasonably infer that a few other genera having essentially the same structure, or belonging properly to the same family, are also the corals of hydroids. But as to the great majority of the "Tabulata" and "Rugosa," there can no longer be any reasonable doubt that they were made by true polyps, essentially similar to those of the existing corals.*

But among the Tabulate corals, after excluding the *Milleporidæ*, great diversities of structure still remain, and no doubt representatives of several families that ought to be widely separated in a natural system, are thus combined together on account of a single unimportant character. Many of these genera are extinct and apparently have no very closely allied representatives among living corals. The affinities of such genera may long remain doubtful. But in other cases there are living corals having very close relations with certain Paleozoic genera, and these we are even now able to classify with as much certainty as we can the ordinary forms of existing corals.

Among the best known of the tabulate corals are the numerous species of *Pocillipora* and allied genera, which evidently constitute a distinct family (*Pocilliporidæ*), largely represented in the tropical waters of the Pacific and Indian oceans. These corals are characterized by rather small, tubular cells, usually with 6, 12 or 24 radiating septa, which even in the same specimen may be obsolete in some of the cells; by *imperforate*, compact walls; and by a more or less abundant, compact cœnenchyma between the lateral cells, which may, however, be absent

* The following quotation from the Bulletin of the Mus. of Comp. Zoölogy, i, No. 13, p. 384, Nov., 1869, will serve to illustrate the views of Professor Agassiz:

"If we now remember that the Acalephian affinities of the *Tabulata* are unquestionable, and that, with them, the *Rugosa* must be removed from the class of Polyps and referred to that of the Acalephs; and if we further take into consideration the fact that *Palæodiscus* belongs to the type of Rugosa, and not to the family of Fungians, it becomes evident that in their order of succession from the Mesozoic era, in which they first make their appearance, the great types of the class of Polyps have succeeded one another in the following order: first Turbinolians, next Fungians, next Astræans, and last Madrepores; in exactly the sequence in which these types stand to one another, as far as their structural gradation is concerned, and in exactly the same order in which, during their growth, these corals pass from one stage to another."

But on the other hand, since we now find that the Acalephian affinities of the Rugosa and most of the Tabulata are wholly imaginary and without the slightest foundation in nature, all this beautiful theory of geological sequence falls to the ground, and we find the *Madrepores* represented even in the Lower Silurian rocks by *Favosites* and other *Alveopora*-like forms, which are certainly neither *low* nor *embryonic* types! And even in Mesozoic times the Astræans appear in force quite as early as the Fungians or the Turbinolians. If there has ever been such a definite geological sequence of the groups of corals as Agassiz imagines, it must have taken place in the ante-Silurian ages, concerning the life of which we know nothing. In the Lower Silurian seas the order was already well developed and highly diversified.

where the cells are crowded, as at the ends of the branches. The writer has shown in several previous papers* that the *Pocilliporidæ* are the corals of *true polyps.* The animals of *Pocillipora* are exsert in expansion, with a regular circle of 12, nearly equal, stout, tapering tentacles, surrounding the circular disk ;† and 12 internal, radiating, fleshy lamellæ show through the disk. Thus they closely resemble the polyps of *Stylophora, Porites,* and *Madrepora,* which are among the most typical of true polyps. The existence of stellate cells, with 6, and even 12, well-developed, radiating septa in several species of *Pocillipora* (e. g., *P. elongata* Dana, *P. plicata* D., *P. stellata* V.) should be sufficient evidence that such corals have no Acalephian affinities whatever, even without the conclusive evidence derived from a study of the living polyps.

The Silurian genus, *Columnaria,* appears to belong to a different family, and if not actually a member of the Astræidæ, it should at least be referred to a family very near that group. It has 24 to 36 well-developed, imperforate, radiating septa, those of the first cycles wider, and in *C. stellata* (Hall, sp.) reaching the center, while those of the last cycle are quite narrow. The larger septa have the upper edge finely serrate. The walls of the adjacent cells are united together as in *Cœlastræa* and *Goniastræa*; they are solid, and apparently imperforate. The genus closely resembles *Cœlastræa,* but the budding is marginal or interstitial, while in the latter the cells divide across the middle.

Another well-known and important group of tabulate corals was abundantly represented in the Paleozoic seas by the genus *Favosites,* with its numerous species, and by several other allied genera, constituting the sub-family Favositinæ of Edwards and Haime. In these corals the walls are thin and perforated by more or less numerous pores or foramina, which are small in *Favosites,* but large and numerous in *Koninckia.* The cells are usually crowded and polygonal, and there is no cœnenchyma. The radiating septa are sometimes obsolete, but usually 12 or 24, which may be continuous, or represented only by vertical rows of spine-like points, as in *Favosites* and the existing genus, *Alveopora* (figure 1, *b*). The transverse septa are variously developed, being often nearly flat, but with the intervening spaces variable, as in *Favosites;* sometimes partly vescicular and incomplete, as in *Emmonsia;* not unfrequently convex and vescicular, as in *Michelinia;* rarely infundibuliform, as in *Rœmeria.* It is obvious that this group has no relationship

* On the Affinities of the Tabulate Corals, in Proceedings of the American Association for Adv. of Science, 1867, p. 148. Proceedings of the Essex Institute, vol. vi, p. 90, 1869. Transactions of the Connecticut Academy, i, p. 518, 1870. This Journal, vol. i, p. 389, May, 1871.

† Trans. Conn. Academy, i, p. 523, (*Pocillipora lacera* V.). The polyps of *P. damicornis,* as figured by Quoy and Gaimard in the Voyage of the Astrolabe, are quite similar.

with the *Milleporidæ*, and at best only a distant one with the *Pocilliporidæ*, although Edwards and Haime placed it in the same family with the latter.

In the Report on the Zoöphytes of the U. S. Exploring Expedition, 1846, p. 509, Professor Dana instituted the family, Favositidæ, in which he included three sub-families: 1st, Alveoporinæ, including the genus *Alveopora*; 2nd, Favositinæ, embracing *Stylophora*, *Pocillipora*, *Seriatipora*, with *Favosites* and other extinct genera; 3rd, *Helioporinæ*, for *Heliopora*, *Millepora*, *Heliolites*. This family was placed next to the *Poritidæ*. Although more recent discoveries have shown that this arrangement is incorrect in several points, it is, nevertheless, much nearer correct than the classifications of Edwards and Haime, and Agassiz. In thus bringing *Alveopora* and *Favosites* near together, Professor Dana made a very important step in advance, and one that has unfortunately been lost sight of, or overlooked, by recent writers, and most unfortunately by Edwards and Haime, by whom these genera are very widely separated. In describing the genus *Alveopora*, Professor Dana gives, as one of its characters, "transverse septa remote," and on Plate 48, fig. 3, *d*, of his Atlas, from which the accompanying cut has been copied, he figured a vertical section of *Alveopora spongiosa*, in which the transverse septa are well shown (figure 1, *a*). In this species the walls of the cells are exceedingly thin and pierced by numerous large openings, often leaving a mere skeleton of a wall. The transverse septa, although thin, are perfectly developed and imperforate, completely closing the cells at intervals of about ·05 to ·20 of an inch, varying even more than this in some parts of the coral, but not more than do many species of *Favosites*. Moreover the septa in many adjacent cells are situated at the same level, giving the coral the appearance of being divided into successive layers by broad thin transverse plates. This appearance is due merely to the thinness and porosity of the walls and coincidence of the plates. The same arrangement of plates is found in the Silurian genus, *Dania*, which is said, however, to have imperforate walls.

The structure of the walls in the tabulated genus, *Koninckia*, from the Cretaceous, is very similar to that of *Alveopora*. Moreover the latter, like *Alveopora* (figure 1, *b*) has vertical rows of spine-like points, representing the twelve radiating septa. In some, if not all, species of *Favosites* the septa were likewise represented by just such rows of slender points. And the same is true of other extinct genera belonging to the same group. Whether all the species of *Alveopora* have complete transverse septa is uncertain, for they appear to have been generally overlooked by the describers. Edwards and Haime make no allusion whatever to such septa in their descriptions of the genus and its species. In all the species which I have examined, however, these septa are to be found, but they are usually more remote and less evident than in *A. spongiosa*, while the walls in most of the other species are thicker and perforated by fewer and smaller openings, thus producing firmer corals. In *A. dædalea* Dana * the walls are much thicker and perforated by smaller, rounded orifices, of which there are two or three vertical series on each side of a cell. The cells are very deep and the transverse septa are complete though distant, and coincident in adjacent cells. The radiating septa are represented by twelve vertical rows of stouter spines, which often meet at the center. Mr. W. S. Kent † has described and figured a recent coral, under the name of *Favositipora Deshayesii*, which has well developed transverse septa, and agrees in all other respects, according to Mr. Kent, with *Alveopora*. But as the presence of such septa appears to be characteristic of *Alveopora*, the *Deshaysii* should be regarded as a species of *Alveopora*, in which the transverse septa are, perhaps, unusually numerous. Mr. Kent also mentions a Paleozoic fossil coral, supposed to be from North America, which he refers to the same genus (*F. palæozoica*). This may prove to be an ancient species of the genus *Alveopora*, and in any case cannot be more than generically separated, either from *Alveopora* or *Favosites*, as remarked by Mr. Kent. The genus *Koninckia* of the Cretaceous is, perhaps, not generically distinct from *Alveopora*, approaching *A. dædalea* very closely, and differing from *A. Verrilliana* D. chiefly in having but six vertical rows of septal spines, instead of twelve. The genus *Goniopora* is closely related to *Alveopora*, differing chiefly in having about 24 radiating septa, which are more fully developed, but perforated by large irregular openings; and a distinct columella. The walls are usually rather firm and rough, as if composed of coarse irregular granules, so united together as to leave many openings through the wall. The lateral and younger cells are often very shallow, with a large rough columella, and with six small paliform lobes arising from the inner part of the septa, while in some cases the walls are much thickened and roughly granulous at the surface, in these characters closely resembling *Porites*, to which it is also allied in the internal structure of the coral. In fact, *Goniopora* combines many of the characters of *Alveopora* and *Porites*, and has some additional special characters. The transverse septa are usually quite numerous and thin, usually irregular, but with an evident tendency to coincide in height in all the chambers of the same polyp-cell, though much broken up and forced out of the transverse plane by the presence of the large irregular columella.

* This species, which proves to be distinct from the *dædalea* of Forskal, etc., has been named *A. Verrilliana* by Prof. Dana in his recent work on Corals and Coral Islands.

† Annals and Magazine of Natural History, vol. vi, p. 384, Nov., 1870.

In one species of Goniopora I have occasionally seen cells with a deeply infundibuliform septum completely closing its cavity below, thus recalling the septa of *Rœmeria*.

The three genera, *Goniopora*, *Alveopora*, and *Porites*, agree closely in the characters of their polyps; the first has, however, 24 tentacles, while the others usually have but 12, although there are often a few larger polyps with 24 tentacles, scattered among the smaller ones, in both genera. It seems necessary, therefore, to place these genera and the others that are evidently closely allied to each of them in one family, *Poritidæ*. It will also be understood, from what has already been said, that it is impossible to assign any characters sufficient for separating the *Favositinæ*, even as a family, from the *Poritidæ*. It is very doubtful whether the group can be maintained even as a sub-family, for *Alveopora* and *Goniopora* combine the characters of both groups. The family, PORITIDÆ,* thus extended, might perhaps, be provisionally divided into three sub-families; PORITINÆ, for *Porites* and the closely allied genera; ALVEOPORINÆ, to include *Alveopora*, *Goniopora*, *Litharæa*, and, if considered distinct, *Koninckia* and *Favositipora*; FAVOSITINÆ, to embrace *Favosites*, *Emmonsia*, *Michelina*, and the other closely allied genera. It is probable, however, that even such a slight separation of *Alveopora* and *Favosites* is greater than the differences actually observed will warrant.

Admitting these necessary changes in the classification,† it follows that the *Madreporaria perforata*, or *Madreporacea*, which is generally regarded as the highest division, or sub-order, of the true corals, was abundantly represented even in the Silurian seas. Moreover, the family *Poritidæ*, which now includes many of the most important of reef-building corals, was also, even in Paleozoic ages, a family rich in reef-forming species, for some of the species of *Favosites* grew into hemispherical masses eight or ten feet in diameter. It also seems probable that the genus *Alveopora* has existed through all periods from the Paleozoic to the present time, which would seem the more remarkable, considering the extreme delicacy and fragility of these corals, and also the fact that, so far as known, they are all shallow water and reef species.

* The genus *Montipora*, for which Edwards and Haime constituted their second sub-family of Poritidæ (*Montiporinæ*), belongs properly to the Madreporidæ, as explained elsewhere by the writer (Trans. Conn. Acad., vol. i, p. 501), and where it was also placed by Prof. Dana.

† The opinion that the Favositinæ belong to the Madreporacea was advanced by the writer in 1870 (Trans. Conn. Acad., i, p. 518). Mr. Kent, in the article referred to, published simultaneously with mine, expressed the same opinion and used independently nearly the same arguments. He also uses the argument with reference to the impossibility that a coral with radiating septa could be formed by hydroid polyps, as I had also done both in the paper referred to and in that of 1867. This coincidence of opinion, arrived at through studies pursued in different ways and approached from different directions, could not fail to be gratifying both to the writer and to Mr. Kent.

ART. XXIV.—*Geological and Mineralogical Notes on some of the Mining Districts of Utah Territory, and especially those of the Wahsatch and Oquirrh Ranges of Mountains;* by B. SILLIMAN.

WITHIN the last two or three years, important developments have been made in the mineralogical and metallurgical resources of the eastern ranges of the North American Cordilleras of the Great Basin, and especially in the Wahsatch and Oquirrh Mountains of Utah, in the valley between which flows the Jordan river, pouring the fresh waters of Utah Lake into the Great Salt Lake. It is in these two ranges of mountains that the most important and best known of the "mining districts" of Utah Territory are established.

Commencing on the western slopes of the Wahsatch, near Salt Lake City, we find in order, going southward, the districts known as "New Eldorado," "Big Cottonwood," "Little Cottonwood," and "American Fork"; on the eastern flanks of the same range are the "Uintah" and "Snake Creek" districts; while on the southern extension of the Wahsatch, are the "Spanish Fork," "Mount Nebo" and "Tintic" districts.

On the Oquirrh range, looking to the east, are "the West Mountain" and "Lower Districts:"—"Bingham Cañon" being the most important locality of the first named district. On the western side of the Oquirrh range, looking, in part, over Rush valley, are the "Tooele," the "Stockton," the "Ophir," the "Camp Floyd" and the "Osceola" districts: "East Cañon" in the Ophir district being one of the most important of the new mining regions.

There are other mining districts in the lower extension of the above ranges and also in other ranges of Utah, but we need not dwell on them at present.*

The characteristic metallurgical feature of all the mining districts of the Wahsatch and Oquirrh is the occurrence of ores of lead, rich in silver. The two ranges mentioned fall within the zone of argentiferous galena lodes which extend through New Mexico, Utah and Western Montana.

The writer had occasion, in 1864, while studying the structure of the parallel ranges of Nevada, to note the fact, that these ranges were characterized by the existence in each of parallel zones of metallic veins; sometimes of the precious metals, almost without admixture of base metals, as in the Plutonic rocks of Western

* Two hundred miles farther south, and chiefly in the counties of Beaver and Piute, upon the so-called "Beaver River range" and "Mineral range," are Washington, Star, Lincoln, Granite and Beaver districts in Beaver county, and the Ohio and Warsaw districts in Piute county: some of these are probably important, but are as yet only imperfectly explored districts, yielding copper, iron, gold, silver, antimony, bismuth, &c.

Nevada, full of evidence of hot springs, solfatara and volcanic action, and yielding such mines as those of the Comstock lode and of Aurora, Bodie, and the White Mountains; or again, those like the Toyabe range, yielding silver with base metals, as antimony, lead, arsenic, copper, zinc, &c., as is also true in a more marked degree of the Humboldt range. So, in the present case, we find in the Wahsatch and Oquirrh ranges ores of silver, either argentiferous galenite, or largely epigene species secondary to galenite, with some ores of copper, antimony, zinc, &c., from which silver is rarely entirely absent. Prof. W. P. Blake, in his catalogue of Californian minerals sent to the Paris Exposition (1867), distinctly points out this parallelism in the metallic contents of the ranges of the American Cordilleras, and the same feature is fully recognized by Mr. King in his chapter on Mining Districts introductory to "Mining Industry," vol. iii of the Geological Exploration of the Fortieth Parallel, p. 5.

The structure of the Wahsatch and Oquirrh ranges is fortunately exposed to view by the cañons, which cut profoundly into them from the valleys. It is in these cañons that most of the mining districts are located, and through them the summits of the ranges are conveniently reached.

The Big Cottonwood and Little Cottonwood cañons, for example, expose profound sections of the Wahsatch range, cutting eastwardly across the structure of these mountains, forming a V-shaped chasm with very precipitous sides and obliquely transverse to the axis of the main range. Thus the average direction of the Little Cottonwood cañon is about N. 62° E., cutting the main range at an angle of about thirty degrees. Entering this cañon, above the mesa over the Jordan valley (Salt Lake Valley), the observer finds himself at once within very precipitous cliffs of gray granite, and surrounded with massive fallen blocks of the same rock of remarkable uniformity of texture and with broad cleavages. The bedded structure of this granite is conspicuous, the beds dipping easterly into the mountain at a high angle, recalling the fan-like structure of the western slopes of the Sierra Nevada as seen in California. This rock extends up the cañon for several miles, the lines of original bedding being distinctly visible. These granites are probably metamorphic of conglomerates, an opinion first suggested to me by Prof. W. P. Blake. Besides the conspicuous patches of darker colored material pasted into the light gray matrix, with the aid of a glass one can detect a certain pebble-like roundness in the quartz of this granite, and an absence of crystalline structure suggestive of a mechanical origin. It is in the lower part of this cañon that the granite has been quarried for building the Mormon Temple at Salt Lake City. These quarrying operations have been confined to splitting the great fallen masses of granite on the surface, and we may here see fresh faces thus split, measuring, at least, twenty feet vertical by more than this laterally.

At a cabin known as "Garrard's house," some six or eight miles up this cañon, is a fine terminal moraine of the ancient glacier system, forming a complete dam across the cañon, over which the road now winds and through which the mountain torrent finds its way after giving motion to Garrard's mill. The surface of this old moraine I found to be approximately 2140 feet above the Townsend House in Salt Lake City. The Townsend House is about 60 feet above Great Salt Lake, so that the lower end of the ancient glacier system of the Wahsatch at this point was, in round numbers, 2200 feet above the present level of Salt Lake, or 6400 feet above sea level, assuming 4200 feet to be the proper elevation of this inland sea, as commonly stated.

The following heights were determined by one of Green's aneroid barometers, and may be considered as approximate.

| | Above Salt Lake. |
|---|---|
| Townsend House, in Salt Lake City, ---------- | 60 feet. |
| Mesa over Salt Lake Valley, ---------------- | 510 " |
| Emmaville, half-way house, ---------------- | 655 " |
| Garrard's House, top of old moraine, --------- | 2200 " |
| Central City, six miles above Garrard's, ------- | 4460 " |
| Emma Silver Mine, ---------------- ------- | 5560 " |

The loftiest point yet measured in the Wahsatch is the Twin Peaks, which Clarence King has determined. I have not seen his figures, but they are said to make this point over 12,000 feet above tide.

The granite in the Little Cottonwood cañon is followed by heavy bedded quartzites, and these are succeeded by slates, upon which rest conformably thick beds of crystalline white limestones. Obscure forms, probably organic, are occasionally seen on the weathered surfaces of the white limestones, but all I was able to collect of these are so much altered by the metamorphism of the matrix and by exposure as to be mostly unintelligible. A well characterized *Archimedes*, in the possession of Prof. Blake, renders it highly probable that the limestones are, in part at least, Carboniferous, though the geological position of the beds indicates for a large part of the mass a lower horizon. I find by chemical analysis that the white limestones, containing the obscure fossils, are not magnesian. They contain a little silica, with minute scales of white mica, and a little combined alumina and sesquioxide of iron. But the limestones in which the silver ores are found are saccharoidal, and without crystalline structure. They are moreover dolomite in chemical constitution, almost completely free from silica and iron, but containing a little alumina. This latter rock breaks up into small rhombic masses, and is easily reduced to a fine granular non-crystalline powder, while the non-magnesian beds beneath resemble dolomite in fracture, though quite free from magnesia. They are non-fossiliferous so far as observed by me. Whether they are strictly conformable to the crystalline white limestones is doubtful, and further explorations are needful to decide this point, which is one of considerable interest in view of their metallurgical contents.

The ores of the mines thus far opened in the Wahsatch Mountains are largely composed of species resulting from the oxidation of sulphides, especially galenite and antimonial galena, with some salts of zinc and copper, all containing silver and rarely a little gold. Iron and manganese ochres occur in considerable quantity, mingled with the other products of decomposition. Masses of unchanged sulphides occur, and especially galenite in considerable quantity in some of them; but the process of oxidation has prevailed very extensively, so that the ochraceous character of the ores is the striking feature of most of the mines in this range.

The great chamber of the Emma Mine, which is an ovoidal cavity measuring, so far as explored, about 110 feet vertical by about 80 by 110 feet transverse, was found to be filled almost exclusively with epigene species, the product of oxidation of sulphides, and capable of removal without the aid of gunpowder, for the most part. The study of this mass reveals the interesting fact that it is very largely composed of metallic oxides, with but comparatively small proportions of carbonates and sulphates. Fortunately I am able to present an analysis of an average sample of 82 tons (=183,080 pounds) of first class ore from the Emma Mine, made by James P. Merry of Swansea, April, 1871, which is as follows, viz:

| | | | |
|---|---|---|---|
| Silica, | 40·90 | Silver, | 0·48 |
| Lead, | 34·14 | Alumina, | 0·35 |
| Sulphur, | 2·37 | Magnesia, | 0.25 |
| Antimony, | 2·27 | Lime, | 0·72 |
| Copper, | 0·83 | Carbonic acid, | 1·50 |
| Zinc, | 2·92 | | 90·42 |
| Manganese, | 0·15 | Oxygen and water by diff., | 9·58 |
| Iron, | 3·54 | | 100·00 |

The quantity of silver obtained from this lot of ore was 156 troy ounces to the gross ton of 2240 pounds.

This analysis sheds important light on the chemical history of this remarkable metallic deposit, and will aid us in the study of the paragenesis of the derived species. It is pretty certain that all the heavy metals have existed originally as sulphides, and we may, therefore, state the analysis thus, allowing 8·52 sulphur to convert the heavy metals to this state.

| | |
|---|---|
| Silica, | 40·90 |
| Metallic sulphides, | 52·60 |
| Al ·35, $\dot{M}g$ ·25, $\dot{C}a$ ·72, $\dot{M}n^2\dddot{M}n$ ·20, | 1·52 |
| | 95·02 |
| Water, carbonic acid and loss, | 4·95 |

This calculation assumes that the sulphides are as follows, viz:

| | |
|---|---|
| Galenite, | 38·69 |
| Stibnite, | 3·30 |
| Bornite, | 1·03 |
| Sphalerite (blende), | 3·62 |
| Pyrite, | 5·42 |
| Argentite, | 0·54=52·60 |

This statement excludes the presence of any other gangue than silica, and considering that the ores exist in limestone, the almost total absence of lime in the composition of the average mass is certainly remarkable. The amount of silica found is noticeable, since quartz is not seen as such in this great ore chamber, nor so far as I could find, in other parts of the mine. The silica can have existed in chemical combination only in the most inconsiderable quantity, since the bases with which it could have combined are present to the extent of less than 1½ per cent, nor do we find in the mine any noticeable quantity of kaolin or lithomarge, resulting from the decomposition of silicates, nor are there any feldspathic minerals. It is most probable that the silica existed in a state of minute subdivision diffused in the sulphides as I have seen it in some of the unchanged silver ores of Lion Hill in the Oquirrh range.

The absence of chlorine and of phosphoric acid in the analysis corresponds well with absence of the species *cerargyrite* and *pyromorphite*, of which no trace could be found by the most careful search among the contents of the mine The miners speak of the "chlorides," and unscientific observers have repeated the statement that silver chloride is found in the Emma Mine, but the ores indicated to me as such are chiefly antimonic ochres.* The general (perhaps total) absence of the phosphates of lead in the mines of the Wahsatch and Oquirrh Mountains, so far as explored, is a striking peculiarity of the mineralogy of these ranges. On the other hand, the absence of chlorine in the mines of the two Cottonwoods and the American Fork is in striking contrast with the constant occurrence of cerargyrite (horn silver) in the Oquirrh and also in the southern extension of the Wahsatch. I have sought in vain for a trace of this species in the

* There exists generally among the mining population of the central territories of the United States a distinction between *horn silver* and *chloride of silver*, an error arising, as I am persuaded, from supposing the ochreous ores to be chlorides not so perfectly developed as to be sectile.

districts of the Wahsatch just named, and the occurrence of pyromorphite is extremely doubtful.

*Molybdic acid*, however, exists pretty uniformly disseminated in the mines of the Wahsatch, in the form of *wulfenite*. Although it occurs in minute quantity, it is rarely absent, and may be regarded as a mineralogical characteristic of the districts of the two Cottonwoods and of the American Fork. For this reason a few particulars will be in place here.

Wulfenite is found associated with calamine, cerussite, malachite, azurite and more rarely alone in little cavities in the ochraceous ores. In the "Emma Mine," vugs, or geodes, are occasionally found lined with botryoidal, apple-green calamine, rarely crystallized, often brownish and sometimes colorless, but invariably associated with wulfenite. The calamine encloses and covers the crystals of wulfenite, which form the backing of the calamine and extend into and among crystals of cerussite, which form a lining of considerable thickness. The wulfenite is in thin tabular crystals of a yellow color, resembling the Carinthian variety of this species. The crystals are very brilliant and perfect, but quite minute, rarely two or three millimeters in width, and not over 1mm. in thickness, often less. They are quite abundant in this association, no piece of the calamine which I have seen being without them. They sometimes, but rarely, penetrate through the globules of the calamine so as to show themselves on the upper surface of that species. But the calamine has obviously formed in botryoidal masses around the wulfenite, a crystal of this species being often seen forming the nucleus of the calamine globules.

These facts are of interest in the paragenesis of these epigene species. The order of production has obviously been, first, the cerussite resting on ochraceous iron, manganese, and other metallic oxides; next, the wulfenite crystals were deposited upon and among the crystals of cerussite, and lastly came the calamine, crystalline at first, and as it accumulated becoming fibrous and amorphous, completely enclosing and capping the other species.

Wulfenite occurs also in this mine, as likewise in the "Flagstaff," the "Savage," and "Robert Emmet," without the calamine, but never, as far as observed, without cerussite and other carbonates. In the "Savage," masses of cerussite with various oxides are interpenetrated by the tabular crystals of wulfenite.

Although wulfenite forms a very minute factor of the entire ore mass in these mines, by the law of mineral association it may be considered as the characteristic species of the ores of these districts, occurring in the magnesian limestones. So far as I am informed, or have observed, wulfenite has not been hitherto found in any of the other mining districts of Utah; but by the same law, it may be reasonably looked for wherever deposits of epigene minerals are explored in the same geological and mineralogical relations in the Wahsatch range of mountains.

The oxidizing and desulphurizing agency which has acted upon the great ore mass of the Emma Mine, whatever it was, has performed its work with remarkable thoroughness. A careful study of its action discloses some other facts of interest in the paragenesis of species. From the appearance of numerous large blocks of ore forming solid boulders in the general mass, a concentric arrangement is easily recognized. On breaking these masses across, the fresh fractures disclose a dark center which consists almost entirely of decomposed sulphides, composed chiefly of cerussite blackened by argentite and metallic silver in a pulverulent form. This dark center, chiefly of cerussite, is often pseudomorph of galenite in its fracture. Next is usually a zone of yellowish and orange yellow antimonial ochre, cervantite, often quite pulverulent, at times only staining the cerussite; then follows a narrower zone of green and blue copper salts, malachite, azurite, cupreous anglesite, with, rarely, wulfenite; then follows cerussite, sometimes stained with antimony ochre, and not unfrequently associated with wulfenite; outside of all are the iron and manganese ochres. This concentric arrangement I have observed in a great number of cases; and the above order of species, while not invariable, is believed to reflect accurately the general arrangement. Well crystallized species, as mineralogical specimens, are rare in this great mass, but the following may be recognized as its chief components:

*Galenite*, sphalerite, pyrite, jamesonite (?), argentite, stephanite, boulangerite (?), *antimonial galenite*, *cervantite*, mimetite (?) limonite, wad, kaolin, lithomarge, *cerusite*, anglesite, linarite, *wulfenite*, *azurite*, *malachite*, *calamine*. The names of those most abundant or best crystallized are in italics. This list can no doubt be extended as opportunity occurs for the more careful study of the ores, the great mass of which, amounting to many thousands of tons, have gone into commerce without passing under any mineralogical eye.

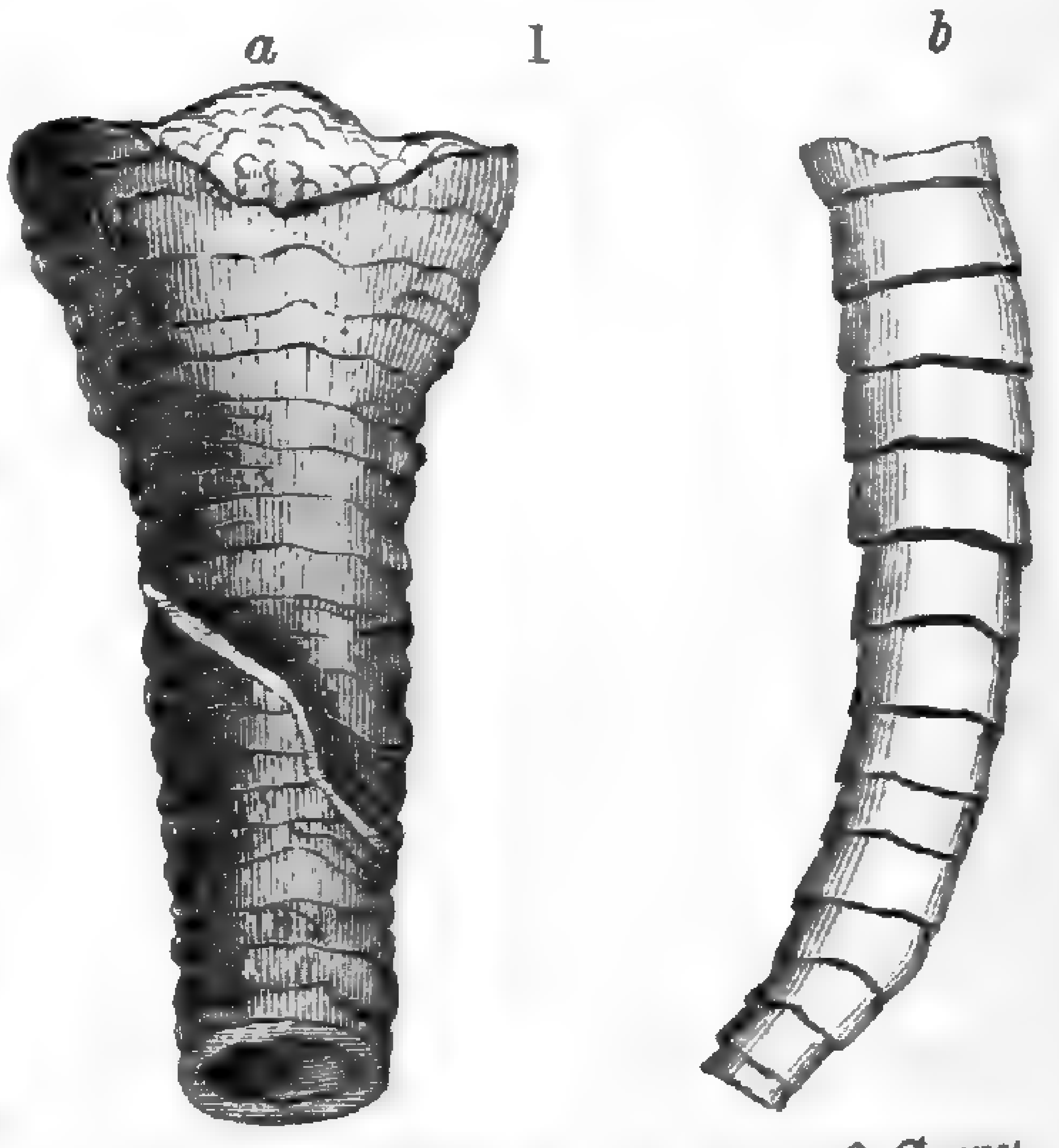
In a subsequent paper will be presented some remarks upon the Oquirrh range and some of its ores, and notices of minerals from other districts of Utah.

New Haven, January, 1872.

ART. XXV.—*On the genera Cornulites and Tentaculites, and on a new genus Conchicolites;* by HENRY ALLEYNE NICHOLSON, M.D., D.Sc., Professor of Natural History and Botany in University College, Toronto.

## I. CORNULITES AND CONCHICOLITES.

THE genus *Cornulites* was founded by Schlotheim (*Petrefacten*) to include certain Silurian fossils, of somewhat doubtful affinities, but apparently most nearly allied to the tubicolar annelides. The remains included under this head consist of calcareous tubes, with tolerably thick walls, often attaining a considerable size, and tapering towards one extremity, so as to form an extremely elongated cone. The entire tube is somewhat flexuous, and is ringed with irregular annulations; and the smaller end of the tube is not only attached by its sides to some foreign object (McCoy, Salter, &c.), but is usually more or less bent. It is obvious that these characters approximate very closely to those of the recent *Serpulae;* and if this were all, there would be little hesitation in regarding *Cornulites* as a tubicolar annelide secreting a calcareous tube. The tube of *Cornulites*, however, has an extremely complex structure, wholly unlike that of the *Serpulae.* The walls are of very considerable thickness, and are composed of a number of large rounded or oval cellular spaces or cavities, bounded by thin walls; which are especially conspicuous in the transverse ridges or annulations, which surround the tube (fig. 1 *a*). When a cast of the tube is obtained (fig. 1 *b*), we are presented with a solid tapering rod-like body, composed of a longitudinal series of imbricated rings.



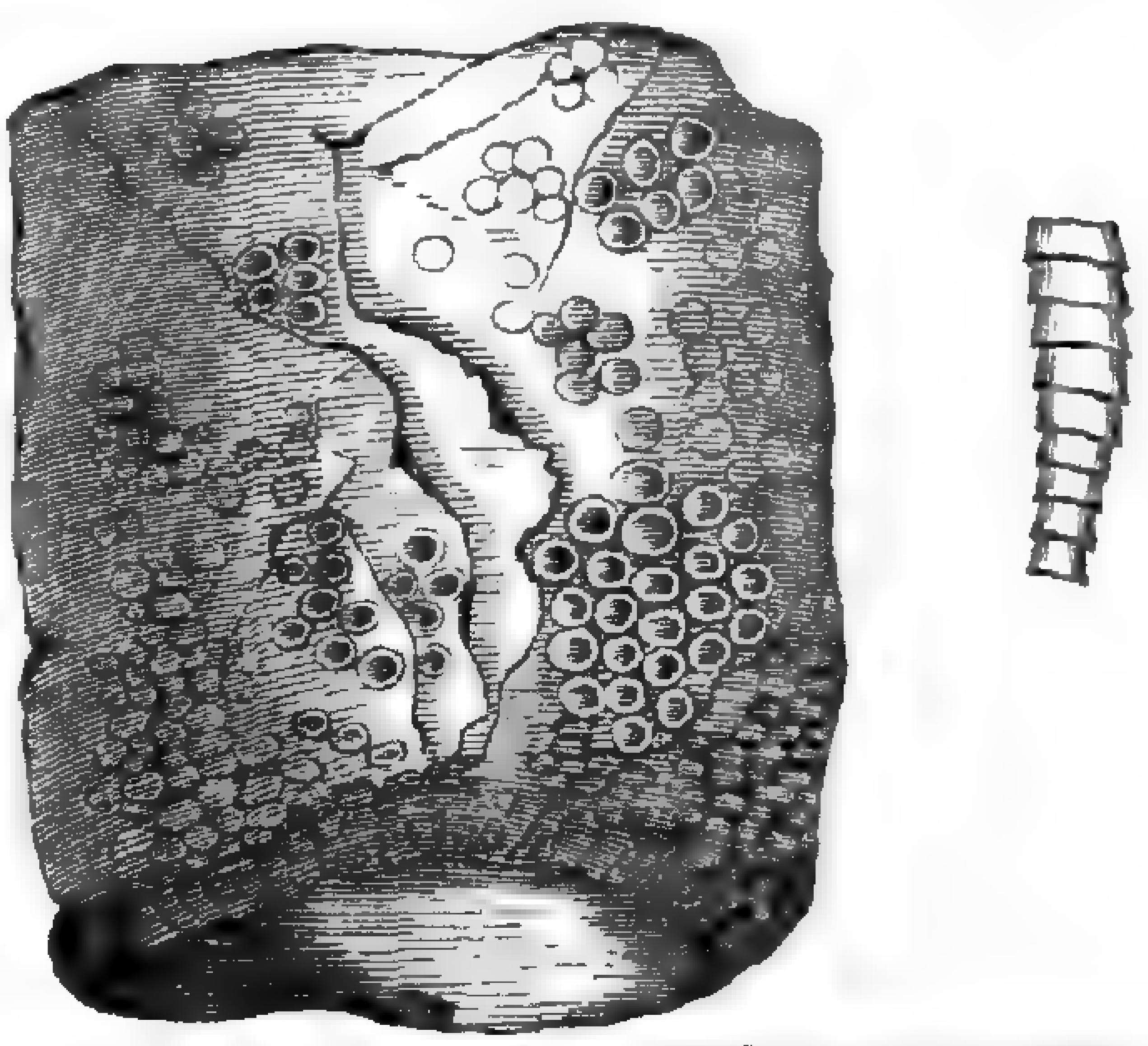

*a.* Upper portion of the tube of *Cornulites serpularius* Schlot., nat. size. From the Wenlock Limestone of Dudley, *b.* Cast of the tube of the same, nat. size.

Each ring is in the form of a truncated cone, having its smaller end directed toward the mouth of the tube, and fitting into the larger aperture of the ring next it in the series. The rings are generally narrower and more crowded together toward the fixed end of the tube, and the entire surface of the cast is quite smooth. The best known species is the *Cornulites serpularius* of Schlotheim, in which the tube attains a length of several inches, and a circumference of about two inches at its aperture. This species may be recognized, not only by its great size and by the thickness of the investing tube, but by the fact that the external surface of the tube is covered with very numerous and fine longitudinal striæ, communicating to the fossil something of the aspect of a coral.

Recently, several specimens of a new fossil have come under my notice, which I at first referred to *Cornulites*, but which I am now disposed to place, provisionally at any rate, in a new genus, under the name of *Conchicolites*, under the specific title of *C. gregarius*. From their peculiar mode of occurrence, these fossils are of considerable interest, and no doubt can be entertained as to their being truly the remains of tubicolar annelides.

*Conchicolites gregarius* occurs in the form of small clustered tubes (fig. 2), generally slightly curved, tapering towards one end, and attached by their smaller extremities to some foreign body. Most of the specimens in my possession occur attached in great numbers to the dead shells of *Orthocerata* (fig. 2), generally along with crusts of *Stenopora fibrosa* Goldf. It is clear, therefore, that *Conchicolites gregarius* very closely resembled in its habits the modern *Serpulae*, and its zoological affinities are altogether beyond doubt.

a 2 b



*a.* Fragment of an *Orthoceras* covered with the tubes of *Conchicolites gregarius*. Natural size. Only the mouths of the tubes are visible in this specimen. *b.* Cast of the tube of another specimen of the same.

All of my specimens, which show more than the *mouths* of the tubes, are in the state of casts; and I am unable to speak positively as to the characters of the tube itself, except from one or two fragmentary examples. The disappearance, in some cases, of the walls, leaving merely the internal casts, renders it tolerably certain that the tubes were calcareous. It is also to be regretted that the materials at present in my hands do not render it possible to determine the presence or absence of the cellular structure which is so conspicuous in *Cornulites serpularius*. In the specimens growing on *Orthocerata*, as in fig. 2, the tubes themselves are in part preserved; but it is almost impossible to determine their characters. Over all parts of the surface of the shell, where the view is not obscured by the adherent matrix, the tubes are so accurately and closely compacted together that no portion of their lateral surface is exhibited, and nothing can be seen but the *mouths* of the tubes. Where the *Orthoceras* is broken across, one would have expected to get a view of the surfaces of the tubes. Owing, however, to their growing obliquely and not exactly at right angles to the shell, this is only partially the case, and they appear on this surface in a very fragmentary and obscure condition. A careful examination, however, of this portion of the fossil has convinced me that the exterior of the tube presents the same appearance as the cast, consisting, namely, of a series of imbricated rings. There are, therefore, no traces of the longitudinal striæ which distinguish the outer surface of the tube of *Cornulites serpularius.*

The *casts* of the tubes of *Conchicolites gregarius* (fig. 2 *b*) have exactly the characters of those of *Cornulites serpularius*, but on a greatly reduced scale. Each consists of a succession of short, imbricated, conical rings, the wider ends of which are directed towards the smaller end of the tube, whilst their surface is smooth. From their small size, the casts, on a cursory examination, are not at all unlike specimens of *Tentaculites;* and it seems extremely probable that some of the uncertainty which has prevailed as to the true nature of the latter has arisen from its having been confounded with specimens of the present fossil.

The following are the characters of the genera *Cornulites* and *Conchicolites*, and of the species already alluded to :—

Cornulites Schlot.—Animal solitary, inhabiting a long shelly tube of carbonate of lime. Tube tapering, flexuous, attached by its smaller extremity to some foreign body. Tube annulated externally, with numerous fine longitudinal striæ. Walls of the tube very thick, composed of numerous cellular cavities. Cast of the tube composed of short conical rings fitting into one another in an imbricated manner. Surface of the cast smooth and polished, with one or two longitudinal furrows.

*Cornulites serpularius* Schlot.—Tube when fully grown attaining a length of three or more inches, with a diameter at its aperture of half an inch or more. Cast of the tube exhibiting about twelve rings to the inch in the fully developed portion. This well known species is distinguished by its large size, its solitary habit, its thick cellular investing tube, and the fine longitudinal striæ of the external surface.

Locality and formation.—Wenlock limestone of Dudley, and Ludlow rocks of Westmoreland, England.

Conchicolites Nich.—Animal social, inhabiting a calcareous (?) tube, attached in clustered masses to some solid body. The tube is conical, slightly curved, attached by its smaller extremity. The wall of the tube is thin, its external surface devoid of longitudinal striæ. The tube thin, composed of short imbricated rings, but apparently destitute of any cellular structure. Cast of the tube composed of short conical rings, its surface completely smooth, and destitute of striæ or furrows.

*Conchicolites gregarius* Nich.—Tubes closely in contact, attached by their smaller ends to dead shells. Tube varying in length from ¼ to ½ an inch, and having a diameter at its mouth of about half a line. Conical rings which compose the tube about four in the space of a line.

From the great similarity presented by casts of the tubes of this species to those of *Cornulites*, I was at first disposed to regard this as a small example of the latter genus. A more careful examination, however, of my specimens has led me to think that they may well be placed in a separate genus. *Conchicolites* is distinguished from *Cornulites* by its social habit, its small size, the thinness of the wall of the investing tube, and the absence, so far as can be made out, of any cellular structure of its tube. In the face of these differences, it is somewhat singular to find that the internal casts of the two should be so absolutely undistinguishable except in point of size. *Conchicolites* presents some resemblances to the genus *Salterella* of Mr. Billings, defined as consisting of "small, slender, elongate-conical tubes, consisting of several hollow cones placed one within another, the last one forming the chamber of habitation of the animal." In *Salterella*, however, the tubes appear to be solitary, and no evidence has been adduced to show that they were attached to foreign bodies, though Mr. Billings regards them as allied to *Serpulites.*

Locality and formation.—*Conchicolites gregarius* occurs not uncommonly attached to the shells of *Orthoceras Brongniarti*, in dark flaggy shales of Caradoc age, Dufton, Westmoreland, England.

## II. Tentaculites.

It may not be out of place to add here a few remarks on the genus *Tentaculites* of Schlotheim, though most palæontologists are now agreed as to its zoölogical affinities and systematic position. The genus *Tentaculites* was originally founded by Schlotheim in 1820 (Petrefact, I, p. 377), for certain minute tubular fossils at that time believed to be the terminations of the jointed arms of Crinoids. In more modern times, there have been two leading opinions as to the nature of the fossils in question, some regarding them as tubicolar annelides, whilst others, following Austin, refer them to the *Pteropoda.* Amongst those who held the former view may be mentioned the late Mr. Salter, who retained this opinion up to the time of his death. A good deal of this difference of opinion may doubtless be explained upon the supposition that casts of *Cornulites, Conchicolites*, and *Salterella* have been in some cases confounded with the shells of *Tentaculites;* and it is curious to note in thus connection that whilst *Tentaculites* has been referred to the tubicolar annelides, there have not been wanting observers who would place *Cornulites* amongst the *Pteropoda.*

The shell of *Tentaculites,* as in well known, has the form of a straight conical tube, tapering towards one extremity to a pointed closed apex, and expanding toward the other to a rounded aperture. The walls of the shell are thin, and are surrounded with numerous thickened rings or annulations, sometimes with intermediate striæ, over the whole or part of the length of the tube.

No specimen of *Tentaculites* has ever been found attached to any foreign body; and though this of itself would not be fatal to the view that the genus belongs to the *Tubicola,* the mode of occurrence of the fossil completely negatives this supposition. Thus, Tentaculites are usually found in great numbers together, often over large areas, confusedly scattered over the surfaces of the laminae of deposition. If we had to deal with a tubicolar annelide, it seems certain that specimens would be found imbedded vertically in the rock, with the closed apex downwards, and the aperture directed upwards; or else we should find them attached by their smaller extremities to shells and other foreign objects. On the contrary, the aspect presented by a slab covered with *Tentaculites* is precisely that which would be the result of the fortuitous aggregation on the sea-bottom of a number of small shells, sinking from the upper strata of the ocean. All the evidence, then, at present in our possession goes to show that *Tentaculites* was an oceanic genus, comprising minute pelagic creatures which swarmed at the surface of the Silurian seas, and the shells of which were scattered in myriads on the floor of the ocean when their tenants died. If this be admitted, there can be little hesitation in adopting the view, now almost universally held, that *Tentaculites* is a genus of the *Pteropoda.*

There are, however, two points of resemblance to be noticed by the practical palæontologist between *Tentaculites* on the one hand, and *Cornulites* and *Conchicolites* on the other hand. In the first place, the internal cast of *Cornulites* is not unlike *Tentaculites;* and when we have a small form like *Conchicolites,* the resemblance, if superficial, is very decided. In the second place, Hall asserts that the cast of the shell of *Tentaculites elongatus* is smooth, and "presents the appearance of a series of reversed truncated cones, or short cups, placed one within the other, having all the characters of *Cornulites.*" It might, therefore, in some cases, be impossible to decide whether a given specimen were the cast of a *Tentaculites* or the mould of a *Cornulites* or *Conchicolites,* which had been accidentally broken off from its point of attachment.

ART. XXVI.—*On the Meteorites of the Hacienda " La Concepcion" and San Gregorio;* by JUAN URGINDI. (Extract from a letter to Prof. Henry, Secretary of the Smithsonian Institution, to whom we are indebted for the communication.)

THE meteorite that is now at the south corner of the main house of this Hacienda, as seen from the front and in profile resembles the enclosed drawings [drawings not sent].

Nothing is known, with certainty, regarding the fall of this meteorite, nor is it mentioned in the deed of this Hacienda. There is an inscription engraved on the upper part of it which reads thus: " A 1600" ; and the antiquated form of these characters has created the general belief that they refer to the year in which the meteorite fell, or rather to that of its discovery, since historical tradition (not to speak of the absurd fable to the effect that Malinche let it fall, while transporting it hidden through the air, on account of a cock having crowed) only tells us that, during the last century, it was discovered buried in the sand, on a piece of bushy land which had been drained, situated eight hundred yards south of this house, whence, unburied, it was taken about a hundred yards off, where it remained a long time; and that in the year 1810, Don Manuel Concha, then Administrator of this Hacienda, removed it and placed it as a sign at the door of a blacksmith's shop, situated about 15 yards from the said corner. There it was when I first knew it, in 1823, and from there my brothers and I managed to roll it to its present place. Lately it has been necessary to straighten it, as it was leaning, in consequence of the sinking of the ground, or of the effects of a stroke of lightning in 1859, which probably damaged also the walls of the corner in question.

With much difficulty, and after spoiling chisels of good steel, several pieces have been cut at different times, resembling the two which I now send you, leaving a brilliant surface where separated. Even a bridle-bit, knives, and some other small objects have been made of it, the first of which articles, it is said, was presented to the late Spanish Commander General of Chihuahua. The blacksmiths assert that the metal is very ductile and malleable. Regarding its chemical composition, it is said to consist almost entirely of iron, with a little nickel. The peculiar appearance of the many little holes seen in its surface show that at some time it was in a state of fusion, since such holes are identical with the cavities left by bursting bubbles.

In regard to its weight and dimensions, I copy what I find in some notes in my possession, which read thus: * * * From the above reckoning, it will be seen that the meteorite measures

39,299 cubic inches. Considering the metal as cast iron, the weight of which is to the weight of distilled water, frozen, as 72,070 is to 1000, and that the cubic centimeter of such water weighs 20·031 grains, we may infer that the meteorite weighs $154\frac{132}{1000}$ "arrobas."*

This is all the information I can give regarding the meteorite of this Hacienda, and I fear it is too scanty, and perhaps too little exact, to satisfy the learned professor for whom it is intended. The pieces that I send will enable him to ascertain the substances of which it is composed; and if some photographer should come in this direction, I will have it photographed, and will take much pleasure in sending you a copy.

I am still less informed in regard to the meteorite of San Gregorio, since I have seen it only twice, in 1856.† It is larger than the one at this place, and seems to consist of the same material, has very much the shape of a sofa, and bears an inscription, which reads thus (translated):

> "Only God with his power
> This iron will destroy,
> For the world will have
> No one able to divide it in pieces."

In my opinion, this meteorite and the one we have here are fragments of another much larger one, that probably burst at a sufficient height from the earth to cast one piece on this Hacienda, another one on that of San Gregorio, 10 leagues to the northwest, and other larger ones on Chupaderos, 20 leagues to the northwest of this place. I have not seen the latter ones, which are said to be the most curious; but I have already taken some steps to have them carefully examined, and I promise to myself the satisfaction of transmitting the result to you.

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## ART. XXVII.—*On the Mean Motions of Jupiter, Saturn, Uranus, and Neptune*; by Professor DANIEL KIRKWOOD.

THE recent note of Professor Peirce,‡ announcing his discovery of some interesting relations between the mean motions of the four outer planets, has recalled my attention to a number of similar coincidences detected by myself several years since, while engaged in a somewhat laborious examination of the

* One arroba is equivalent to 25 lbs.

† For an article on this meteorite by Dr. J. Lawrence Smith, see this Journal, III, i, 335.

‡ This Journal for January, 1872. It will be observed that Professor Peirce's third equation is identical with that discovered by Professor Newcomb in 1857. See Gould's Astr. Journ., vol. v, p. 101.

planetary elements. Of these, the following may be worth putting on record for future discussion:

$$2n^{v} - 3n^{vi} - 11n^{viii} = 0 \quad - \quad - \quad - \quad - \quad (1)$$
$$2n^{vi} - 21n^{vii} + 30n^{viii} = 0 \quad - \quad - \quad - \quad - \quad (2)$$
$$3n^{v} - 8n^{vi} - 2n^{vii} + 7n^{viii} = 0 \quad - \quad - \quad - \quad - \quad (3)$$

With the values of $n^{v}$, $n^{vi}$, and $n^{vii}$ adopted in the American Ephemeris, the value of $n^{viii}$ obtained from either of the above equations differs by less than one second from the latest determination.* The second equation was submitted some two years since to Professor Newcomb, of the U. S. Coast Survey. That distinguished astronomer was inclined, however, to regard the coincidence as merely accidental. Be this as it may, I have strong confidence in the accuracy of the third. The re-examination of this last has recently led to the discovery of two others, viz:

$$68n^{vi} - 325n^{vii} + 257n^{viii} = 0 \quad - \quad - \quad - \quad - \quad - \quad (4)$$
$$257n^{v} - 844n^{vi} + 587n^{vii} = 0 \quad - \quad - \quad - \quad - \quad - \quad (5)$$

both of which, I believe, are accurately true. The fifth, however, is not an independent equation, but is derived from the third and fourth. By means of these equations I have found the remarkable cycle of 11657·24 Julian years, which separates the epochs at which the planets Jupiter, Saturn, Uranus, and Neptune, return to the same relative positions. It is obvious, moreover, from the same equations, that *no three of the four outer planets can ever be in conjunction at the same time.*

Bloomington, Indiana, January, 1872.

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## Art. XXVIII.—*Brief Contributions to Zoölogy, from the Museum of Yale College.* No. XIX.—*Recent Additions to the Molluscan Fauna of New England and the adjacent waters, with notes on other species;* by A. E. Verrill.

The new edition of Gould's Invertebrata of Massachusetts, edited by Mr. W. S. Binney, and published in 1870, was intended to include all the Mollusca, exclusive of the Bryozoa, hitherto observed on the coast of Massachusetts, as well as those from the adjacent waters farther north. Practically, therefore, it included all, or nearly all, the species known from New England and the adjoining British Provinces. A few New England species, previously described or recorded, were, however, omitted or accidentally overlooked. In the present communication it is my intention to enumerate the marine species from New England and closely adjacent waters, not included in Binney's Gould,

* Newcomb's Orbit of Neptune, p. 76.

whether previously known or more recently discovered, so far as known to me from personal observation or from the statements, believed to be reliable, of others;* to describe several new species recently discovered; and to record a few observations on the distribution, structure, and affinities of species previously known.

As more detailed descriptions and fuller synonymy will be given in a work on the Mollusca of the coast of southern New England, now in preparation for the Transactions of the Connecticut Academy of Science, the species will be treated here as briefly as possible. It is believed, however, that the figures will prove sufficient, even with short descriptions, for the easy identification of the new species.

*List of species not included in Binney's Gould.*

*Rossia palpebrosa* Owen (?); Hyatt in third Annual Report of the Trustees of the Peabody Academy of Science, p. 79, 1871. Manchester, Mass., in stomach of Hake,—A. Hyatt.

*Mangelia cerinum* = *Pleurotoma cerinum* Stimp. and Kurtz; Shells of New England, p. 49, pl. 2, fig. 2, 1850. New Bedford, Mass.—Dr. Stimpson; Vineyard Sound, 8 to 10 fath.,—A. E. V. and S. I. Smith.

*Scalaria Humphreysii* Kiener. Greenport, L. I.,—Sanderson Smith; near Great Egg Harbor, N. J.,—J. E. Todd; Stonington, Ct.,—Linsley ("*S. clathrus*"). The occurrence of this species at Stonington needs confirmation. Linsley's species may have been *S. Grœnlandica.*

*Acirsa borealis* Morch. = *Scalaria borealis* Beck, 1841, = *S. Eschrichtii* Möll., 1845. Eastport, Maine, 10 to 40 fath., shelly bottom,—A. E. Verrill and S. I. Smith; Greenland,—Möller.

*Aclis polita* V., sp. nov. Plate vi, figure 5, ×5 diameters. Eastport, Maine, 20 fathoms,—A. E. Verrill.

*Turbonilla elegans* V., sp. nov. Pl. vi, fig. 4, ×5 diameters. Vineyard Sound, 8 to 10 fath., shelly,—A. E. V., S. I. Smith.

*Stylifer Stimpsonii* V., sp. nov. On *Euryechinus Dröbachiensis* V., in 32 fathoms, off Long Island,—Capt. Gedney.

*Cæcum costatum* = *Cæcum Cooperi* Smith (non *C. Cooperi* Carp.), 1863. Pl. vi, fig. 6, ×24 diameters. Vineyard Sound, 6 to 8 fath.,—A. E. Verrill; Long Island,—Sanderson Smith.

*Doris bifida* V., this Journal, II, vol. 1, p. 406, 1871. Eastport, Me., and Savin Rock near New Haven, under stones at low water, laying eggs Oct., 1871,—A. E. Verrill.

*Doridella obscura* V., this Journal, II, vol. 1, p. 408, 1872. Near New Haven at Savin Rock and off South-end, 4–6 fath-

* The following species need confirmation: *Lepton fabagella* Con., Newport; *Yoldia Gouldii* (Dekay); *Tellina versicolor* Dekay (Stratford, Conn.,—Linsley); *Solen viridis* Say (Stonington,—Linsley; N. Jersey,—A. E. V.); *Fusus imbricatus* Dekay; *Littorinella levis* (Dek.) = *Rissoa Stimpsoni* Smith (Stratford, Dekay).

oms,—A. E. V. and E. T. Nelson; Great Egg Harbor, N. J., 2 fathoms, shelly,—A. E. V., S. I. Smith, and J. E. Todd.

*Dendronotus robustus* V., op. cit., p. 405, fig. 1.
Eastport, Me., and Grand Menan,—A. E. V. and O. Harger.

*Cavolina tridentata.* Fresh shells dredged in 20 to 25 fathoms off Martha's Vineyard,—A. E. V., Dr. A. S. Packard.

*Styliola vitrea* V., sp. nov. Plate vi, figure 7, ×3 diameters, off Gay Head, among *Salpæ*,—A. E. V. and Dr. A. S. Packard.

*Martesia cuneiformis* Adams, =*Pholas cuneiformis* Say.
New Haven, in shells,—G. H. Perkins, perhaps imported.

*Angulus modesta* V. Plate vi, figure 2, ×5 diam.; 2[a], nat. size. Vineyard Sound, 6 to 8 fath., and off New Haven,—A. E. V.

*Gastranella tumida* V., sp. nov. Pl. vi, fig. 3, ×16 diam., 3[a], ×6 diam. Off South-end, near New Haven, 4 to 6 fath.—A. E. V.

*Semele equalis*, =*Amphidesma equalis* Say.
Stonington, Conn.,—Linsley. This has not been found by recent collectors on this coast, and therefore needs confirmation.

*Cryptodon obesus* V., sp. nov. Plate vii, figure 2, ×3 diam. Off Martha's Vineyard, 20 to 25 fathoms, mud,—A. E. V., Dr. A. S. Packard.

*Cyclocardia Novangliæ* = *Actinobolus* (*Cyclocardia*) *Novangliæ* Morse, first Annual Report of the Trustees of the Peabody Academy of Science, p. 76 (figure), 1869.

*Astarte lutea* Perkins, Proc. Bost. Soc. Nat. Hist., xiii, p. 151, figure, 1869. Near New Haven,—Perkins. The relations of this form are not yet fully ascertained.

*Modiola hamatus.* Pl. vii, fig. 3, ×2 diam.,=*Mytilus hamatus* Say.
New Haven harbor and vicinity, usually attached to oysters, —G. H. Perkins, A. E. Verrill; Gulf of Mexico,—Say.

*Cynthia pulchella* V., this Journal, III, vol. i, p. 98, 1871.
Eastport,—A. E. V.; Newfoundland Banks,—T. M. Coffin.

*Glandula arenicola* V., sp. nov.
Murray Bay, Gulf of St. Lawrence,—Dr. J. W. Dawson.

*Molgula retortiformis* V., this Journal, vol. i, p. 56, fig. 3, 1871.
Bay of Fundy,—A. E. V., S. I. Smith, O. Harger.

*Molgula papillosa* V. Pl. viii, fig. 4, ×2 diam.; op. cit., p. 57, fig. 4 b, 1871.
Eastport, Me.,—A. E. V.; off Martha's Vineyard,—A. Hyatt.

*Molgula littoralis* V., op. cit., p. 56, fig. 4[a], 1871.
Eastport, Me.,—A. E. V., S. I. Smith, O. Harger.

*Molgula pannosa* V., op. cit., p. 55, fig. 2.
Bay of Fundy,—A. E. V.; Murray Bay,—J. W. Dawson.

*Molgula pellucida* V. =*Molgula producta* Binney, pl. 22, figs. 315, 316, but not the description (non Stimpson).

*Eugyra pilularis* V. =*Molgula pilularis* V.; l. c., p. 56, fig. 4 c. Eastport, Me. and Grand Menan,—A. E. V. and S. I. Smith; off Martha's Vineyard, 20 fathoms, mud,—A. E. V.

*Perophora viridis* V., this Journal, vol. ii, p. 359, 1871.
Wood's Hole and Vineyard Sound, low water to 10 fath.,—A. E. V. and S. I. Smith.

*Amouroucium glabrum* V., this Journ., vol. i, p. 288, figs. 20–22, 1871. Eastport, Me. and Bay of Fundy,—A. E. V.; Murray Bay,—J. W. Dawson.

*Amouroucium pallidum* V., op. cit., p. 289.
Eastport, Me. and Bay of Fundy,—A. E. V.; off Martha's Vineyard,—A. Hyatt.

*Amouroucium pellucidum* V.. op. cit., p. 290.
Point Judith, R. I.,—J. Leidy; Vineyard Sound, etc.,—A. E. V., S. I. Smith, J. E. Todd.

*Amouroucium stellatum* V., op. cit., p. 291.
Vineyard Sound, Mass., 1 to 10 fathoms,—A. E. V., S. I. Smith, J. E. Todd, H. E. Webster.

*Amouroucium constellatum* V., this Jour., ii, p. 359, 1871. With the preceding.

*Macroclinum crater* V.; op. cit., i, p. 292, figs. 23–25, 1871.
Banks of Newfoundland,—T. M. Coffin.

*Lissoclinum aureum* V., op. cit., p. 444, fig. 26, 1871.
Eastport, Me.,—A. E. Verrill.

*Lissoclinum tenerum* V., op. cit., p. 445, 1871.
Eastport,—A. E. V.; Newfoundland Banks,—T. M. Coffin.

*Leptoclinum albidum* V., op. cit., p. 446.
Long I. Sound to Labrador; common in Vineyard Sound, 8–10 fathoms, on shells and stones.

*Leptoclinum luteolum* V.; op. cit., p. 446.
Vineyard Sound, 8–10 fath.,—A. E. V., S. I. Smith; Bay of Fundy,—A. E. V.

## BRYOZOA.

*Alcyonidium ramosum* V., sp. nov. Pl. viii, fig. 10, ×2 diam.
Long I. Sound, near New Haven, in 1 to 5 fath., common, forming large, much branched, arborescent clumps, a foot or more high,—A. E. V.; Vineyard Sound, Mass., and Great Egg Harbor, N. J.,—A. E. V., S. I. Smith and J. E. Todd.

The following species have been found on the shores of Long Island, but probably not in New England waters:

*Donax fossor* Say; *Arca ponderosa* Say; *Sigaretus perspectivus* Say; *Diplothyra Smithii* Tryon (Staten I.); *Margarita ornata* Dekay.

### *Changes in the Nomenclature of Species previously recorded.*

It is not intended to revise, at this time, the entire list of New England species; but merely to enumerate a few of the more important and necessary changes. Mr. Dall* has already

* Proceedings of the Bost. Soc. of Nat. Hist., xiii, p. 240, March, 1870.

given a revised list of the species described in Binney's Gould, and has referred the species to the recently proposed genera of the Messrs Adams and others, but not always correctly, even if we admit the validity of the genera recognized by him. Corrections have also been made by others, which are here omitted.

*Nassa vibex*, var. *fretensis* = *N. vibex* (pars) Say; Binney = *N. fretensis* Perkins.

*Astyris lunata* = *Columbella lunata* (Say) + *B. Wheatleyi* Dekay (var.) = *C. Gouldiana* Ag.

*Lunatia heros* = *Natica heros* Say + *N. triseriata* Say (var).

*Elysiella catulus* (gen. nov.) Plate vii, figs. 5, ×3 diam., and 5ª, = *Placobranchus catulus* Ag.

*Onchidoris tenella* V., this Jour., vol. l, p. 407, = *Doris tenella* Ag.

*Onchidoris grisea* V., l. c. = *Doris grisea* Stimp. (MSS.) in Gould.

*Onchidoris pallida* V., l. c. = *Doris pallida* Ag., in Gould.

*Ensatella Americana* (Gould, nom. prov.) = *Solen ensis* Gould (non Linn.)

*Periploma papyracea.* Plate vii, figs. 1, 1ª, ×4 diam., 1ᵇ, ×30 diam.; pl. viii, fig. 1 (anatomy) = *Anatina papyracea* Say.

*Turtonia nitida* V. (sp. nov.) Plate vii, fig. 4, ×40 diam., and fig. 4ª, = *T. minuta* Gould (not of European authors).

*Astarte undata* Gould (nom. prov.) = *A. sulcata* Gould, pars (not of European writers).

*Astarte lens* Stimp. (MSS.) = *A. crebricostata* Gould, fig. 440 (not of Forbes).

*Astarte quadrans* Gould = *A. quadrans*, + *A. Portlandica* Migh.

*Pecten tenuicostatus* = *P. tenuicostatus*, + *P. fuscus* Linsl. (young).

*Anomia glabra* V. = *A. ephippium* (pars) Linn.; Gould, + *A. electrica* Binney (non Linn.), + *A. squamula* Gould (non Linn.), young.

*Ostræa Virginiana* Gm. = *O. Virginica* Lam. + *O. borealis* Lam. + *O. Canadensis* Lam.

*Leptoclinum luteolum* V. = *Didemnium roseum* Binney (non Sars).

*Botryllus Gouldii* V., l. c. = *B. Schlosseri* Gould (non Pallas).

*Molgula Manhattensis* V., l. c. = *Ascidia Manhattensis* Dekay + *A. amphora* Ag.

*Molgula psammophora* V. = *A. psammophora* Ag.; Binney.

*Eugyra glutinans* V. (Möll. sp.) = *Glandula fibrosa* B., pars (species figured), not of Stimpson.

*Glandula mollis* Stimp. = *G. mollis* B., pars (not the figures).

*Pera crystallina* V. (Möll. sp., 1845) = *Pera pellucida* Stimp. 1852.

*Cynthia partita* Stimp. Pl. viii, fig. 7, = *C. partita*, +? *C. rugosa* Ag. (MSS.) + *C. stellifera* V. (var.)

*Cynthia carnea* V. = *Ascidia carnea* Ag. + *C. gutta* Stimp. + *C. placenta* (pars) Pack. (species figured by Binney).

*Cynthia monoceros* (Möll. sp.) = *C. condylomata* Pack.
*C. echinata* (Linn. sp.) = *C. echinata*, + *C. hirsuta* Ag. (young).
*Ciona tenella* V., l. c. = *Ascidia tenella* Stimp. + *A. ocellata* Ag.
*Ascidiopsis complanatus*, gen. nov. (Fab. sp.) Plate viii, fig. 8, part of gill, = *Ascidia callosa* Stimp.

[To be continued.]

# SCIENTIFIC INTELLIGENCE.

## I. Chemistry and Physics.

1. *On an essential improvement in the method of fractional distillation.*—Linnemann has successfully applied to laboratory purposes the principles of a method largely used in the arts, in the construction of the so-called dephlegmators. This principle consists in partially condensing locally the vapor which rises from a boiling liquid, in such a manner that the vapors which subsequently rise shall pass through the condensed liquid, and thus be in a measure washed. The apparatus employed consists simply of a vertical tube attached to the flask, in which the liquid boils, and containing six or eight little caps of platinum wire gauze, separated from each other by small intervals. The tube may also have two or three bulbs blown on it, each bulb being placed first above a wire gauze cap. From the upper part of this tube a lateral tube passes to the condenser, while a thermometer is inserted in the upper end of the tube. The proportions are so selected that more liquid condenses in the bulbs and caps than can flow back through the meshes of the wire-gauze. It is, therefore, necessary occasionally to interrupt the boiling, by removing the lamp. The meshes of the gauze are about 0·75 of a square millimeter, and the caps are easily formed by stamping in a press or mould of hard wood. The tubes and wire caps are easily cleaned by alcohol or ether, without removing the caps. The author gives a number of new determinations of the boiling points of familiar organic liquids in a state of purity. These abundantly illustrate the great value of the method.—*Ann. der Chemie und Pharmacie*, clx, 195. W. G.

2. *On the preparation of Absolute Alcohol.*—Elenmeyer has modified Mendelejeff's method of preparing absolute alcohol by means of quicklime, so as to obtain the same result in much less time. Alcohol of 0·792 is to be boiled with quicklime, in pieces projecting above the surface of the liquid, for from half an hour to an hour, with an inverted condenser, so that the liquid may flow back into the flask. The condenser is then to be reversed, and the alcohol distilled over. If the alcohol contains more than 5 per cent of water, the process must be repeated two or more times. If the alcohol contains much water, the lime should not, on the first boiling, be allowed to project above the liquid. It is best to fill the vessel containing the alcohol only half full of pieces of lime, as

otherwise it may be broken by the rapid formation of the hydrate. In any case, the process enables the chemist to prepare, in a few hours, several liters of absolute alcohol.—*Ann. der Chemie und Pharmacie*, clx, 249. W. G.

3. *On the action of Light upon Chlorine and Bromine.*—BUDDE has communicated the results of a series of experiments which appear to show conclusively that chlorine and bromine expand when exposed to the so-called chemical rays of light. The apparatus employed by the author consisted of a differential thermometer, like that of Leslie, the bulbs being filled with chlorine, and exposed to the different rays of the spectrum. The bulbs were 5–6 centimeters in diameter, the connecting tube $1^{mm}$ in diameter and 30 centimeters in length. The liquid used was sulphuric acid, previously saturated with chlorine. The bulbs were so placed that each could be illuminated, by a definite portion of the spectrum. Their distance from the prism varied from 1 to 2 meters. The index was illuminated with gas and observed by a telescope with cross lines. When the temperature had become stationary, the zero point was noted, and the illumination then varied. Calling the two bulbs A and B, it was found that whenever A was placed in the red of the spectrum and B was dark, a change of from ½ to 1 millimeter, indicating a trifling expansion of the gas in A, was observed. When A was placed in the blue, violet, or ultra-violet, and B was dark, the expansion amounted, as a maximum, to $7^{mm}$. Corresponding results were obtained by reversing the relative positions of the two bulbs in the spectrum. Budde considers it proved that substances exist which increase in volume when exposed to the chemical rays, as all bodies do when exposed to heat. He suggests the following possible explanation of the phenomenon:

(1.) Light may decompose the chlorine molecules into atoms.

(2.) The refrangible rays of light may produce in chlorine some other unknown species of work, which may, in its turn, be converted into heat, and thus cause expansion.

(3.) We may assume that there are bodies which are warmed by violet more than by red light. The usual division of the spectrum into a heating and a non-heating portion, depends on the relation of the incident rays to the lamp-black surface of the thermopile, and if this were not warmed by the red rays, we might consider them as exerting no heating effect.

The author considers the first of these views as most probable, and promises a further investigation of the subject.—*Pogg. Ann.*, cxlix, p. 213. W. G.

4. *On the Ammonia-platinum Bases.*—CLEVE has communicated, to the Chemical Society of Paris, a resumé of his elaborate and most successful study of the ammonia-platinum bases. Although some of his results have already been given in this Journal, an abstract of the whole subject, from a single point of view, will, doubtless, prove of interest. The author adopts Blomstrand's theory of the constitution of these bodies, and gives the following as the formulas of the 12 known bases:

1. Platosamine (Reiset's second base), $\overset{\text{ii}}{\mathrm{Pt}}\left\{\begin{matrix}NH_3\\NH_3\end{matrix}\right.$

2. Platoso-semi-diamine, $\overset{\text{ii}}{\mathrm{Pt}}\left\{NH_3 \,.\, NH_3\right.$

3. Platoso-mono-diamine, $\overset{\text{ii}}{\mathrm{Pt}}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3\end{matrix}\right.$

4. Platoso-diamine (Reiset's first base), $\overset{\text{ii}}{\mathrm{Pt}}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\end{matrix}\right.$

5. Platinamine (Gerhardt's base), $\overset{\text{iv}}{\mathrm{Pt}}\left\{\begin{matrix}NH_3\\NH_3\end{matrix}\right.$

6. Platino-semi-diamine, $\overset{\text{iv}}{\mathrm{Pt}}\left\{NH_3 \,.\, NH_3\right.$

7. Platino-mono-diamine, $\overset{\text{iv}}{\mathrm{Pt}}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3\end{matrix}\right.$

8. Platino-diamine (base of Gros & Rāwsky), $\overset{\text{iv}}{\mathrm{Pt}}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\end{matrix}\right.$

9. Diplatinamine, $\overset{\text{vi}}{\mathrm{Pt}_2}\left\{\begin{matrix}NH_3\\NH_3\\NH_3\\NH_3\end{matrix}\right.$

10. Diplatoso-semi-diamine, $\overset{\text{ii}}{\mathrm{Pt}_2}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\end{matrix}\right.$

11. Diplatino-semi-diamine, $\overset{\text{vi}}{\mathrm{Pt}_2}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\end{matrix}\right.$

12. Diplatino-diamine, $\overset{\text{vi}}{\mathrm{Pt}_2}\left\{\begin{matrix}NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\\NH_3 \,.\, NH_3\end{matrix}\right.$

In the present paper the author describes the salts of several very complex radicals, understanding simply by this term a complex of atoms which may be transferred without change from one compound to another.

If we denote by R the molecule, $\mathrm{Pt}\left\{\begin{matrix}\left.\begin{matrix}\Theta\\2NH_3 \,.\, \Theta\end{matrix}\right\}S\Theta_2\\2NH_3\\\Theta H\end{matrix}\right.$,

we have the following compounds as crystalline salts:

$RCl+2H_2\Theta$, $PtCl_4 \,.\, 2RCl+2H_2\Theta$, $RB_2+2H_2\Theta$, $RN\Theta_3$, $R_2S\Theta_4+3H_2\Theta$, $R_2\bar{C}_2\Theta_4+2H_2\Theta$, $R_2\bar{C}r\Theta_4+xH_2\Theta$, $R_2\bar{C}_2\Theta_7$.

If we denote by R the molecule, $\overset{\text{iv}}{\mathrm{Pt}}\left\{\begin{matrix}\Theta H\\2NH_3\\2NH_3\\C\Theta_2 \,.\, \bar{C}H_3\end{matrix}\right.$,

we have the following crystalline salts:

$2RCl_2+H_2\Theta$, $\left.\begin{matrix}R\left\{\begin{matrix}Cl\\Cl\end{matrix}\right.\\R\left\{\begin{matrix}Cl\\Cl\end{matrix}\right.\end{matrix}\right\}\begin{matrix}Cl\\Cl\end{matrix}PtCl_2+2H_2\Theta$, $R \,.\, 2N\Theta_3$, $2(R.S\Theta_4)+3H_2\Theta$, $RCr_2\Theta_7+H_2\Theta$.

The iodide and iodo-nitrate of platino-diamine give with ammonia two compounds having respectively the formulas:

$$(1.)\ \overset{\text{vi}}{Pt}_2\left\{\begin{array}{l} I \\ 2NH_3\,.\,I \\ NH_3\,.\,NH_2 \\ NH_3\,.\,NH_2 \\ 2NH_3\,.\,I \\ I \end{array}\right. + H_2\Theta \ \text{ and } (2.)\ \overset{\text{vi}}{Pt}_2\left\{\begin{array}{l} I \\ 2NH_3\,.\,N\Theta_3 \\ NH_3\,.\,NH_2 \\ NH_3\,.\,NH_2 \\ 2NH_3\,.\,N\Theta_3 \\ I \end{array}\right. .$$

The first of these bodies gives with nitric acid a nitrous-iodo-nitrate of platino-diamine, $\overset{\text{iv}}{Pt}\left\{\begin{array}{l} N\Theta_2 \\ 2NH_3\,.\,N\Theta_3 \\ 2NH_3\,.\,N\Theta_3 \\ I \end{array}\right.$; the second gives with nitric acid the iodo-nitrate of diplatino-diamine,

$$\overset{\text{vi}}{Pt}_2\left\{\begin{array}{l} I \\ 2NH_3\,.\,N\Theta_3 \\ 2NH_3\,.\,N\Theta_3 \\ 2NH_3\,.\,N\Theta_3 \\ 2NH_3\,.\,N\Theta_3 \\ I \end{array}\right. .$$

This salt is decomposed by chlorhydric acid, and gives small octrahedrons having the formula, $Pt\left\{\begin{array}{l} I \\ 2NH_3\,.\,Cl \\ 2NH_3\,.\,Cl \\ Cl \end{array}\right.$ By double decomposition it gives the salts:

$\overset{\text{vi}}{Pt}_2\,.\,8NH_3\,.\,I_6$, $\overset{\text{vi}}{Pt}_2\,.\,8NH_3\,.\,(S\Theta_4)_2I_2$, $Pt_2\,.\,8NH_3\,.\,(P\Theta_4H)_2I_2$, $Pt_2\,.\,8NH_3\,.\,(C_2\Theta_4)_2I_2$, $Pt_2\,.\,8NH_3\,.\,(N\Theta_3)_4(H\Theta)_2$, $Pt_2\,.\,8NH_3\,.\,6N\Theta_3+4H_2\Theta$, $Pt_2\,.\,8NH_3\,.\,Cl_4(\Theta H)_2+H_2\Theta$, $Pt_2\,.\,8NH_3\,.\,(S\Theta_4)_2(\Theta H)_2+2H_2\Theta$, $Pt_2\,.\,8NH_3\,.\,(P\Theta_4)_2+2H_2\Theta$, $Pt_2\,.\,8NH_3\,.\,(Cr_2\Theta_7)_2(\Theta H)_2$ and $Pt_2\,.\,8NH_3\,.\,(C_2\Theta_4)_2+2H_2\Theta$.

By the action of bromine on the basic nitrate

$$Pt_2\,.\,8NH_3\,.\,(N\Theta_3)_4(H\Theta)_2,$$

Cleve obtained the bromo-nitrate $Pt_2\,.\,8NH_3\,.\,(N\Theta_3)_4Br_2$, from which by double decomposition the following salts were formed:

$Pt_2\,.\,8NH_3\,.\,Cl_4\,.\,Br_2$, $Pt_2\,.\,8NH_3\,.\,(S\Theta_4)_2Br_2+2H_2\Theta$, $Pt_2\,.\,8NH_3\,.\,Br_2\,.\,(C_2H\Theta_4)_2\,.\,C_2\Theta_4$. —*Bulletin Mensuel de la Société Chimique de Paris, April, May and June*, 1871, p. 181. W. G.

5. *Capillary attraction.*—Mr. VALSON has shown that in capillary attraction the product of the density of a saline solution and the height to which it rises is a constant. Thus a solution of nitrate of lithium, the density of which is 1·036, rises in a capillary tube to 59 millimeters; and the product of these numbers is 61·9. A solution of nitrate of silver, of a density 1·133, rises to 54·2 millimeters; and the product is 61·7, differing but slightly from that with nitrate of lithia.—*Acad. Sci. Paris, Jan.* 8; *L'Institut, Jan.* 10.

## II. Geology and Natural History.

1. *Geological Survey of Ohio. Report of Progress in* 1870.—The notice of this Report, commenced on page 143, is here continued.

Prof. Edward Orton reports on the geology of Highland Co. The rocks of this county range from the upper beds of the Cincinnati group, through the Clinton, Niagara and Helderberg limestones, the Huron Shales (Black Slate) to the Waverley Sandstone. The maximum thickness in the county is 875 feet, 100 of this being the Cincinnati group (Lower Silurian), 50 the Clinton, 275 the Niagara, 100 the Helderberg, 250 the Huron shale (Devonian), 100 the Waverley (Lower Carboniferous); but this maximum thickness does not occur at any one place. The highest elevations of the county are Stults's Mountain and Fisher's Knob, the former 1,325 feet above the sea, and the latter about 20 less; Long Lick Mountain, east of Carmel, is 1,254 feet above the sea.

Prof. Orton reports the occurrence of the red lenticular iron ore of the Clinton group (an important ore in Central New York), near Sinking Spring, just south of the Highland county line. The following paragraphs relate to an important point connected with the Clinton beds and the earlier condition of Southern Ohio:—

"A very interesting fact in the Clinton limestone of Highland county remains to be mentioned. A bed of limestone conglomerate, several feet in thickness, occurs near the base of the series in the southern part of the county. But a single exposure of the conglomerate has yet been noted. This is found one mile due west of Belfast, on the Belfast and Fairfax road, on the land of Charles Dalyrymple. The pebbles that compose the conglomerate appear to have been derived from the blue limestone or Cincinnati rocks. The conglomerate is also fossiliferous, well-worn forms of ancient life being incorporated with it. The fossils can be referred either to the Cincinnati or Clinton group, as they consist of forms that are common to both formations, viz: cyathophylloid corals of the genus Streptelasma and the remarkable fossil—Orthis lynx—a bivalve shell of immense vertical range, as is shown by its occurrence in the Trenton, Hudson (Cincinnati), Clinton and Niagara limestones of the Lower and Upper Silurian ages, successively. It seems more probable, however, that the fossils in question were derived from Clinton seas rather than from the waste of rocks of a previous age.

"The occurrence of this conglomerate attests the existence of land near by—the shores of which were wasted by the sea, and the water-worn and rounded fragments of which were re-deposited on the floor of the sea. Since the first systematic study of the geology of the Mississippi valley, proofs have been accumulating that a Silurian island stretched northeastward from Nashville, toward and beyond Cincinnati. Highland county furnishes its full quota of facts as to the existence and as to certain of the boundaries of this ancient land. Other facts will be adduced that bear upon this point in the description of the remaining formations of the county. The date of the uplift of this island is approximately determined by the fact already quoted—as land at the westward is found in existence early in the history of Clinton time. This folding of the crust, then, that transformed a portion of the ancient sea-bottom into dry land, probably occurred about the close of Lower Silurian time, and it seems also safe to say that it not only marks the date, but furnishes the producing cause of the great change in the formation that then took place.

Next follows a full Agricultural Report by John H. Kleppart, embracing observations on the meteorology of the State, and various matters of general interest.

The Chemical Report by T. G. Wormley contains numerous analyses of the coals, iron-ores, fire-clays, limestones and soils of the State, a discussion of the yield of the coal in gas and coke, and of the character of these products; and all his results show the skillful chemist. We cite a few facts.

The amount of *moisture* in the coals of the State varies from 1·10 to 9·10 p. c., those of the southern part of the State containing the most. The coal loses less in weight at a temperature of 240° F. than at 212° F.; if, after heating at 212° F., it be exposed to a heat of 240° F., "it will generally increase in weight, owing to the absorption of oxygen."

Two coals which at 212° F. lost 7·70 and 7·40 p. c. in weight, regained, on cooling, in 5 hours, 4·20 and 4·50 parts; and in 20 h., 4·70 and 5·10 parts.

The average of *ash* in 88 bituminous coals examined, south of the line of the Central Ohio Railroad, was 4·718 p. c., and in 64 coals north of said line, 5·120 p. c. The mean average of ash in 11 cannel coals was 12·827 p. c.

With regard to the *sulphur in coal*, Prof. Wormley says:—

"In the report for last year, Prof. Andrews drew attention to the fact that our analyses had shown, contrary to the usually received opinion, that the *sulphur* present in coals was not always, at least, wholly in combination with iron. A number of additional examinations have been made, all of which confirm this view.

"A sample of Straitsville coal contained 0·57 per cent of sulphur, of which 0·26 were left in the coke. Of iron, the coal contained only 0·075 per cent. This amount of iron would require, to form bisulphuret of the metal, only 0·086 parts of sulphur, thus showing that about 0·48 of the 0·57 parts of the sulphur present in the coal were in some other combination than with iron.

"Again, another sample of coal containing 0·98 per cent of sulphur, of which 0·66 parts remained in the coke, contained only 0·086 per cent of iron, which would require only about 0·097 parts of sulphur, leaving about 0·90 parts of sulphur uncombined with iron.

"The following table exhibits the amount of sulphur and of iron found in several different coals, and the proportion of the sulphur that could have been combined with iron:—

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sulphur in coal, | 0·57 | 1·18 | 0·98 | 2·00 | 0·91 | 0·86 | 0·57 | 0·74 | 4·04 |
| Iron in coal, | 0·075 | ·742 | ·086 | ·425 | ·122 | ·052 | ·102 | ·102 | 2·05 |
| Sulphur required by iron, | 0·086 | ·848 | ·097 | ·486 | ·139 | ·06 | ·116 | ·116 | 2·343 |

The analyses of the limestones of the State show that the most of them are *magnesian;* the Cincinnati or Blue limestone contains ordinarily little magnesia; yet an analysis of the Blue limestone of Miami valley gives 5·06 p. c. of carbonate of magnesia. The Clinton group limestone contains in general about 12 p. c. of the magnesian carbonate, the Niagara 35 to 49 p. c.; the Corniferous 28 to 40 p. c.; the Water-line mostly 38 to 44 p. c. The facts, with others through the country, show that, if the making of dolomites required the presence of mineral springs, such springs must have been in almost universal outflow throughout most limestone-making regions.

The remainder of the volume is occupied by the reports on local geology by M. C. Read and G. K. Gilbert; a sketch of the present state of the manufacture of iron in Great Britain, by W. B. Potter, E. M.; and a sketch of the present state of the Steel Industry, by Henry Newton, E. M. Mr. Read speaks of the abundance of glacial markings in Geauga Co., and states that their direction varies much, but has a close relation to the topography.

Mr. Gilbert, speaking of the Lake beaches in Fulton Co., states that the highest beach, on which the village of Fayette is situated, is 220 feet above the present level of Lake Erie; a second is 25 feet lower; and the third, which is an excellent site for a road, and is so used through half of the county, has a height of 165 feet above the Lake.

2. *On new Tree Ferns and other Fossils from the Devonian;* by Dr. J. W. Dawson. (Quarterly Journal of the Geological Society for August, 1871.)—Of the numerous ferns now known in the Middle and Upper Devonian of North America, a great number are small and delicate species, which were probably herbaceous; but there are other species which may have been tree ferns. Little definite information, however, has, until recently, been obtained with regard to their habit of growth.

The only species known to me in the Devonian of Europe is the *Caulopteris Peachii* of Salter, figured in the Quarterly Journal of the Geological Society for 1858. The original specimen of this I had an opportunity of seeing in London, through the kindness of Mr. Etheridge, and have no doubt that it is the stem of a small arborescent fern, allied to the genus *Caulopteris* of the Coal-formation.

In my paper on the Devonian of Eastern America (Quart. Journ. Geol. Society, 1862) I mentioned a plant found by Mr. Richardson at Perry, as possibly a species of *Megaphyton*, using that term to denote those stems of tree ferns which have the leaf-scars in two vertical series; but the specimen was obscure, and I have not yet obtained any other.

More recently, in 1869, Prof. Hall placed in my hands an interesting collection from Gilboa, New York, and Madison county, New York, including two trunks surrounded by aerial roots, which I have described as *Psaronius textilis* and *P. Erianus* in my 'Revision of the Devonian Flora,' now in the hands of the Royal Society.* In the same collection were two very large petioles, *Rhachiopteris gigantea* and *R. palmata*, which I have suggested may have belonged to tree ferns.

My determination of the species of *Psaronius*, above mentioned, has recently been completely confirmed by the discovery on the part of Mr. Lockwood, of Gilboa, of the upper part of one of these stems, with its leaf-scars preserved and petioles attached, and also by some remarkable specimens obtained by Prof. Newberry, of New York, from the Corniferous limestone of Ohio, which indicate the existence there of three species of tree ferns, one of them with aerial roots similar to those of the Gilboa specimens. The whole of these specimens Dr. Newberry has kindly allowed me to examine, and has permitted me to describe the Gilboa specimen, as connected with those which I formerly studied in Prof. Hall's collections. The specimens from Ohio he has himself named, but allows me to notice them here by way of comparison with the others. I shall add some notes on specimens found with the Gilboa ferns, and on a remarkable plant from the Devonian of Caithness, kindly placed in my hands by Dr. Wyville Thomson.

It may be further observed that the Gilboa specimens are from a bed containing erect stumps of tree ferns, in the Chemung group of the Upper Devonian, while those from Ohio are from a marine limestone, belonging to the lower part of the Middle Devonian.

The paper continues with descriptions of *Caulopteris Lockwoodi* Dawson, *C. antiqua* Newberry, *C. peregrina* Newberry, and some other species, and is illustrated by a plate.

3. *Supposed legs of Trilobites.*—Mr. Henry Woodward, of the British Museum, in a reply to the paper by the writer in volume i, p. 320, of the present series of this Journal, supports the view that the supposed legs are real legs. He says that the remark that the calcified arches were plainly a calcified portion of the membrane or skin of the under surface is "an error, arising from the supposition that the matrix represented a part of the organism." But Prof. Verrill, Mr. Smith and myself are confident that there is on the specimen an impression of the skin of the under surface, and that this surface extended and connected with the arches, so that all belonged distinctly together.

Moreover the arches are exceedingly slender, far too much so for the free legs of so large an animal; *the diameter of the joints is hardly more than a sixteenth of an inch outside measure; and hence there is no room inside for the required muscles.* In fact, legs with such proportions do not belong to the class of Crustaceans. Moreover the shell (if it is the shell of a leg instead of a calcified arch) is relatively thick, and this makes the matter worse.

* Abstract in Proceedings of Royal Society, May, 1870.

We still hold that the regular spacing of these arches along the under surface renders it very improbable that they were legs. Had they been closely crowded together, this argument would be of less weight; but while so very slender, they are a fourth of an inch apart. Mr. Woodward's comparison between the usual form of the arches in a Macrouran and that in the tribolite does not appear to us to prove anything. We therefore still believe that the specimen does not give us any knowledge of the actual legs of the trilobite. Mr. Woodward's paper is contained in vol. vii No. 7, of the Geological Magazine. J. D. D.

4. *Report on the Geological Structure and Mineral Resources of Prince Edward Island;* by J. W. DAWSON, LL.D., assisted by B. J. HARRINGTON, PH.D. 52 pp. 8vo, with 3 lithographic plates. (Printed by authority of the Government of Prince Edward Island). —We gather from this excellent report the following facts.

The rocks are (1) newer Carboniferous, red-brown and gray sandstones like those of Nova Scotia, and New Brunswick, occurring principally between Orwell and Pownal Bays in Governor's Island, and in Hillsborough Bay, and near the line of coast facing northwest; (2) Triassic bright red sandstones, much like those of Nova Scotia and the Connecticut Valley; (3) drift deposits, and (4) those of later date. The unconformability of the red sandstones of the Trias over those of the Carboniferous is "not very perceptible," and in aspect they are often very similar.

In the Carboniferous there are numerous trunks of coniferous trees, the largest observed a foot in diameter, which are of the species *Dadoxylon materiarum* Dawson, a Nova Scotia species. They have afforded also in some localities *Calamites Suckovii* Brngt., *C. cistii* Brngt., *C. gigas* Brngt., *C. arenaceus* Jäger, *Cordaites simplex* Daws., *Walchia* (*Araucarites*) *gracilis* Daws., *Walchia* (*A.*) *robusta* Daws., *Pecopteris arborescens* Schloth., *P. rigida* Daws., *P.* near *oreopteroides* Brngt., *Neuropteris rarinervis* Bunbury, *Alethopteris nervosa* Brngt.

The Triassic beds have a thickness not exceeding 500 feet, and the lower 270 feet are regarded as constituting a lower division. The dip is very small, and the beds are often characterized by oblique lamination. The fossils are almost the only means of distinguishing the beds from those of the Carboniferous. At New London, in the lower part of the Upper Trias, or upper part of the Lower, was found the jaw of the *Bathygnathus borealis* described by Leidy. Besides this species, the Trias of the island has afforded remains of *Dadoxylon* (*Araucaroxylon*) *Edvardianum* Daws., *Cycadoidea* (*Mantellia*) *Abequidensis* Daws., a *Knorria?* *Sternbergia*, *Fucoids*.

5. *Peculiar Phenomena observed in Quarrying;* by W. H. NILES, Prof. Phys. Geol. and Geogr. in the Massachusetts Institute of Technology.—The phenomena here described are fractures, sudden movements, and expansions of beds of stone connected with quarrying, and due apparently to the state of tension to which the bed was subjected when in its original state in the

quarry. The author mentions a spontaneous fracture in a bed of gneiss three feet and nine inches thick, which was sixty-one feet long, and mainly in the direction of the strike, but in the southern half with some abrupt transverse (to the east) turns. The transverse fractures were opened wider than the north and south, —in two and a half months, the former five-eighths of an inch, the latter nowhere over one-fourth—showing that there was less resistance to motion in the direction of the strike. He mentions cases of anticlinals formed by movements in beds. In one instance a bed of gneiss twenty inches thick had been elevated an inch and a half, the northern slope of the anticlinal measuring twenty-three feet. The fold trended east and west, and at one end there was a crack three-sixteenths of an inch wide. In another instance in a bed three inches thick, the amount of elevation at the center was one inch, and there was a fracture along the whole length of the crest, trending east and west. Prof. Niles observed a bend form in a bed two and three-quarter inches thick; in a few hours the portion of the bed forming the crest was elevated three inches and a quarter, and the crest—five and a half feet long—had a fracture along it. He learned that sudden sounds or explosions sometimes attend the movements and fracturings; and the sounds occur in all seasons, though more frequent in summer. Sometimes they are louder than the report from a blast, and at one time led to the supposition that the powder magazine had exploded.

The following is an example of the expansion of the rock during quarrying. A mass split off along one side, by wedges in a series of drill holes, for a length of 354 feet (requiring 1,200 wedges) in the direction of the strike, or nearly north and south, had a width of eleven feet and a thickness of three. By one end it was still attached. Soon after the fracture was made, it was observed that the halves of the drill holes were not opposite, and at the free extremity the amount of dislocation amounted to an inch and a half; or in other words, the stone was an inch and a half longer after the fracture than before. The subsequent exposure of the stone to the varying temperature and conditions of the weather for two months produced no change. As the free extremity was higher than the other, the phenomenon was not produced by gravity. Three other instances are mentioned of similar effects, on a smaller scale.

6. *Fossils from the so-called Huronian of Newfoundland.*—Mr. E. Billings read a paper on this subject before the Natural History Society of Montreal, on the 29th of January. The Huronian of Newfoundland includes, according to the geologist in charge of its survey, A. Murray, sandstones, slates and conglomerates, lying unconformably beneath the Primordial beds, which latter are largely developed and abound in fossils. The fossils in the Huronian are of two species. One is broad ovate (6 lines long by 5 broad), with a ring-like border, inside of this a groove, and the interior raised roof-like, with an angular ridge or crest along the middle. In allusion to the shield-like form, a little like

an oblong Patella, it is named by Billings *Aspidella Terranovica.* Two specimens occur on one slab of stone. The relations of the fossil are not determined. The other fossil is regarded by Billings as identical with the *Arenicolites spiralis*, found in Sweden below or at the base of the Primordial.

These fossils were first found by Mr. Murray in 1866, and others were subsequently obtained by Capt. Kerr, Mr. Robinson and Mr. Howley.

7. *Bathmodon, a new genus of fossil Mammals;* by E. D. Cope. (Read before the Am. Phil. Soc., Feb. 16, 1872.)—This genus has a remote affinity to Palæosyops and Titanotherium. The characters of the molar teeth indicate that it belongs to a new family. Two species are described, *B. radians* and *B. semicinctus.* They were from the Tertiary beds of the Wahsatch group, near Evanston, Utah, where they were obtained by Dr. F. V. Hayden. The beds are inferior to the Bridger group, and are supposed to be Lower Eocene. Prof. Cope writes us, that by the printer's neglect, the date to his paper is wrong; it should be, as above given, Feb. 16th.

8. *Illustrated Catalogue of the Museum of Comparative Zoölogy. Supplement to the Ophiuridæ and Astrophytidæ;* by Theodore Lyman.—In this little volume, which will be heartily welcomed by those zoölogists who have been obliged to form their ideas of the new deep-sea *Ophiuridæ* discovered by Mr. Pourtales in the Florida Straits, from Mr. Lyman's descriptions in the tenth Bulletin of the Museum of Comparative Zoölogy, is included: 1st, a list of publications in this part of actinology, published since 1865, to which is added some papers not included in the previous list;* 2nd, descriptions of one new genus (*Ophiomaza*) and five new species of Ophiuridæ (*Ophiomaza, Ophiothela, Ophiocnida, Ophioglypha,* and *Ophiomastix*); 3rd, a note on nomenclature and classification; 4th, two plates, representing in an analytical manner the new species mentioned above, and all the new genera and some of the new species established by the author in his preliminary report.

* Among these is a little pamphlet by Mr. Duchassaing (Animaux Radiaire des Antilles, 1850). Owing to the kindness of Mr. Rüse, I was well acquainted with this pamphlet before the publication of my Additamenta, part ii, and I have cited it in my other papers on the West Indian Echinodermata; but being totally incapable of guessing what species were really hidden under the names most absurdly applied, or under the completely inexplicable diagnoses, I thought it best to let this part of Mr. Duchassaing's on the whole not highly creditable publication rest in darkness; the more so, as the attempt I made through Mr. Rüse, to procure the original specimens of Mr. Duchassaing's Ophiuridæ, failed altogether, and I was told that they had not been preserved at all. Now I learn from Mr. Lyman (in a letter dated Dec. 11, 1871), that he has discovered the greater part of Duchassaing's species in the collection of the late Mr. Michelin (now in the "Jardin des Plantes"), and has been able to identify them. Of course I quite agree with Mr. Lyman that "the short Latin descriptions are so incomprehensible and vague," that the claim of priority for Duchassaing's new species can without any injustice or inconvenience be totally disregarded; fortunately the species that might make such a claim are very few.

Respecting the plates—whose execution leaves nothing to be desired—the only thing I have to say, is to give vent to a gentle sigh that a greater number has not been given; several species that are now only figured from one side might otherwise have been figured from both; but as the author has no doubt done in this respect what he could, or what he deemed necessary for enabling the student to form a fair conception of the new genera, we must be grateful for what we have got, and not grumble that he did not satisfy our thirst for information in a more copious manner. I would also ask permission to intimate that it would have been more convenient for the student if the descriptions of the new genera and species had been reprinted from the "Bulletin," as he will now be obliged to seek the figures and descriptions in two different works; but perhaps a future number of the Catalogue will embrace them, as well as the other new observations of Mr. Lyman on this branch of the animal kingdom.

On some of the new genera established in these two works, and of which a full conception could be formed only after the publication of figures illustrating their character, I have a few remarks to make. I do not see in what respect *Ophiomaza* is generically different from *Ophiocnemis;* its diagnosis will apply equally well to *Ophiocnemis obscura* Ljn.; in fact, I entertain a strong suspicion that this species is identical with *O. cacaotica*, and I see no reason to separate it generically from *O. marmorata.* Further, *Ophiomitra* is separated from *Ophiacantha*, because of its "naked scales and conspicuous radial shields" as opposed to "the long, very narrow radial shields, covered, together with the disk, by a thick skin," in the latter genus. But the small difference that may perhaps exist as to the thickness of the skin, in which the grain or thorn-bearing scales are imbedded in both genera, is certainly not of generic importance, and the radial shields are often partly visible quite in the same manner in *Ophiacantha spinulosa* as in *Ophiomitra.* The diagnosis of this genus, therefore, agrees very well with *Ophiacantha*, and I have failed to find in the detailed descriptions of the species anything to prevent its union with the latter. As far as I can judge from the description and figure, *Ophiothamnus* also agrees very well with *Ophiacantha*, the differences being I think, only of specific value. Not having access to the species or specimens myself, it is not my intention to enter into further details on this occasion, but only to state my personal impression, that these three presumed new genera are not distinct genera at all, in the commonly accepted sense of the word; and my belief that if, after this suggestion, Mr. Lyman will reconsider the question, on the base of the lately acquired fuller knowledge of the genus *Ophiacantha*, he will feel himself satisfied as to its confluence with *Ophiomitra* and *Ophiothamnus.*

[This notice, by Dr. Lütken of Copenhagen, will be continued in the next number of this Journal.]

## III. Astronomy.

1. *Eclipse of the Sun, Dec.* 12, 1871.—Extract of a letter of Dr. Janssen to Prof. Newton, dated Sholoor, Nilgherry, Dec. 26th, 1871.—I have the honor to send you the results of my observations upon the eclipse of the sun on the 12th of Dec., made at Sholoor, Nilgherry, Hindostan.

I was favored with a sky of almost absolute transparency. This circumstance, and the wholly novel optical arrangements which I had made, have enabled me to establish facts about the corona which prove its solar origin, at least for the greater part.

In my telescope * the spectrum of the corona does not appear as continuous, but is remarkably complex. I have found in it:

I. The bright rays of hydrogen gas, which forms the principal element of the protuberances and the chromosphere;

II. The bright green ray, previously remarked in the eclipses of 1869 and 1870, and certain other fainter ones;

III. The dark rays of the ordinary solar spectrum, particularly D. These rays are much more difficult to detect.

My observations prove that, independently of the cosmical matter which should be found near the sun, there exists, about this body, an atmosphere of great extent, exceedingly rare, and with a hydrogen base. This atmosphere, which, doubtless, forms the last gaseous envelope of the sun, is fed from the matter of the protuberances which is shot up with great violence from the interior of the photosphere. But it is distinguished from the chromosphere and the protuberances by a much smaller density, a lower temperature, and perhaps by the presence of certain different gases. There is a reason then for distinguishing this new solar atmosphere. I propose to call it the *coronal atmosphere*, a name which indicates that it is this atmosphere which produces the large part of the phenomena hitherto denoted by the name *solar corona.*

In announcing this result, I do not, on my part, forget how much we are indebted to the labors of those who have prepared the way for it, especially to the labors of the American astronomers who observed the eclipses of 1869 and 1870.

I do not doubt that the observations of others this year will agree with mine.

2. *On the Solar Eclipse of December* 12, 1871; by J. Norman Lockyer.— * * * As the mail, the first available one after the eclipse, leaves this place to-day, I must lose no more time in recording preliminaries. I will therefore at once state the general arrangements of the parties, and what I at present know of the observations. The stations and observers as finally arranged were as follows:—

*Bekul*—Analysing Spectroscope, Capt. Maclear and Mr. Pringle. Polariscope, Dr. Thomson. Photography, Mr. Davis.

*Manantoddy*—Analysing Spectroscope, Mr. Friswell; Integrating Spectroscope, Mr. Abbay.

* This telescope has an opening of 37 centimeters, and a focal distance of only $1^{m}\cdot42$. The images of objects are 12 to 16 times as bright as in an ordinary astronomical telescope. The spectroscope was so constructed as to use all this light.

*Poodocottah*—Spectroscope, Professor Respighi; Sketches of Corona, Mr. Holiday.

*Jaffna*—Integrating Spectroscope, Capt. Fyers and Mr. Ferguson; Polariscope, Capt. Tupman and Mr. Lewis; Photography, Captain Hogg.

*Trincomalee*—Spectroscope, Mr. Moseley.

Besides these observers, we had at Bekul the valuable assistance of General Selby, commanding the troups in Canara and Malabar (for whose help in supplying guards, tents, &c., the friends of science cannot be too thankful), Colonel Farewell, Judge Walhouse, and others, in sketching the corona. At all stations, of course, most precious help in various ways was given by all present who volunteered for the various duties, though some of them lost a sight of the eclipse in consequence. Among those who helped in this way at Bekul were Mr. McIvor, Mr. Pringle, Captain Bailey (who timed the eclipse), Mr. Cherry, and Captain Christie, the Inspector of Police, whose presence there turned out to be of the most serious value, for the natives seeing in the eclipse the great Monster Rahoo devouring one of their most sacred divinities, not only howled and moaned in the most tremendous manner, but set fire to the grass between our telescopes and the sun to propitiate the representative of the infernal gods. Captain Christie, with his posse of police, stopped this sacrifice at the right moment, and no harm was done.

Now for the observations. Perhaps I may be permitted to begin with my own, as at the present moment I know most about them. I determined to limit my spectroscopic observations to the spectrum of a streamer, and to Young's stratum, thereby liberating a number of seconds which would enable me to determine the structure of the undoubted corona with a large refractor, to observe the whole phenomena with the naked eye, and through a train of prisms with neither telescope nor collimator, and finally with a Savart and biquartz. I found the 120 seconds gave me ample time for all this, but owing to a defect in the counterpoising of my large reflector, which disturbed the rate of my clock, I missed the observation of the bright line stratum (assuming its existence) at the first contact. At the last contact Mr. Pringle watched for it and saw no lines.

Having missed this, I next took my look at the corona. It was as beautiful as it is possible to imagine anything to be. Strangely weird and unearthly did it look—that strange sign in the heavens! What impressed me most about it, in my momentary glance, was its serenity. I don't know why I should have got such an idea, but get it I did. There was nothing awful about it, or the landscape generally, for the air was dry and there was not a cloud. Hence there were no ghastly effects, due generally to the monochromatic lights which chase each other over the gloomy earth, no yellow clouds, no seas of blood—the great Indian Ocean almost bathed our feet—no death-shadow cast on the faces of men. The whole eclipse was centered in the corona, and there it was, of the purest silvery whiteness. I did not want to see the prominences then, and I did not see them. I saw nothing but the star-like decoration, with its rays arranged almost symmetrically, three above and three below two dark spaces or rifts at the extremities of a horizontal diameter. The rays were built up of innumerable bright lines of different lengths, with more or less dark spaces between. Near the sun this structure was lost in the brightness of the central ring.

But from this exquisite sight I was compelled to tear myself after a second's gazing. I next tried the spectrum of a streamer above the point at which the sun had disappeared. I got a vivid hydrogen spectrum, with 1474 (I assume the point of this line from observation) slightly extended beyond it, but very faint throughout its length compared with what I had anticipated, and thickening downwards, like F. I was, however, astonished at the vividness of the C line, and of the continuous spectrum, for there was no prominence on the slit. I was above their habitat. The spectrum was undoubtedly the spectrum of glowing gas.

I next went to the polariscope, for which instrument I had got Mr. Becker to make me a very time-saving contrivance—a double eye-piece to a small telescope, one containing a Savart and the other a biquartz. In the Savart I saw lines vertical over everything—corona prominences, dark moon, and unoccupied sky. There was no mistake whatever about this observation, for I swept three times across and was astonished at their unbrokenness. I next tried the biquartz. In this I saw wedges, faintly colored here and there; a yellowish one here, a brownish one there, with one of green on each side the junction, are all the colors I recollect. Then to the new attack—the simple train of prisms which, the readers of *Nature* know, Professor Young had thought of as well as myself; its principle being that, in the case of particular rays given out by such a thing as the chromosphere, or the sodium vapor of a candle, we shall get images of the thing itself painted in that part of the spectrum which the ray inhabits, so to speak, we shall see an image for each ray, as if the prisms were not there. What I saw was four exquisite rings, with projections where the prominences were. In brightness, C came first, then F, then G, and last of all 1474! Further, the rings were nearly all the same thickness, certainly not more than 2′ high, and they were all enveloped in a line of impure continuous spectrum.

I then returned to the finder of my telescope, a 3¾ inch, and studied the structure of the corona and prominences. One of the five prominences was admirably placed in the middle of the field, and I inspected it well. I was not only charmed with what I saw, but delighted to find that the open-slit method is quite competent to show us prominences well without any eclipse. I felt as if I knew the thing before me well, had hundreds of times seen its exact equivalent as well in London, and went on to the structure of the corona. Scarcely had I done so, however, when the signal was given at which it had been arranged that I was to do this in the 6-inch Greenwich refractor. In this instrument, to which I rushed, for Captain Bailey had just told us that we had "*still* 30 seconds more"—which I heard mentally, though not with my ears, as "*only* 30 seconds more"—the structure of the corona was simply exquisite and strongly developed. I at once exclaimed, "like Orion!" Thousands of interlacing filaments varying in intensity were visible, in fact I saw an extension of the prominence-structure in cooler material. This died out somewhat suddenly some 5′ or 6′ from the sun (I could not determine the height precisely), and then there was nothing; the rays so definite to the eye had, I supposed, been drawn into nothingness by the power of the telescope; but the great fact was this, that close to the sun, and even for 5′ or 6′ away from the sun, there was nothing like a ray, or any trace of any radial structure whatever to be seen. While these observations were going on, the eclipse terminated for the others, but not for me. For nearly three minutes did the coronal structure impress itself on my retina, until at last it faded away in the rapidly increasing sunlight. I then returned to the Savart, and saw exactly what I had seen during the eclipse; the vertical lines were still visible!

Captain Maclear has promised to forward to you himself an account of his observations. I need only here therefore refer to their extreme value, adding what I should have stated before, that I saw the bright lines at the cusps, as he was so good as to draw my attention to them. I am, however, not prepared to say that they were visible through a large arc of retreating cusp.

Dr. Thomson confined his observations to the polariscope, using the Savart. He states that his observations were identical with my own.

Mr. Davis's photographic tent was below the cavalier in which our telescopes had been erected; and immediately after the observations I have recorded were over, I went down to see what success had attended his efforts. I was hailed when half-way there with the cheering intelligence "five fine photographs," and so they are, those taken at the beginning and end of the eclipse being wonderfully similar, with, I fancy, slight changes here and there; but on this point I speak with all reserve until they have been examined more carefully than the time at our disposal has permitted, and until they have been compared with those taken at Ootacamund, Avenashi, and, I hope, at Jaffna and Cape Sidmouth.

This exhausts the principal work done by the Bekul party, with the exception of the sketchers, with General Selby at their head, who have recorded most marked changes in the form of the outer corona, and Mr. Webster, who was so good as to photograph the eclipse from a fort some eight miles away, with an ordinary camera, and obtained capital results.

Next a word about the Poodocottah, the other fortunate Indian party. Prof. Respighi has promised to send his results to you with this. About Mr. Holiday's labors I know nothing, except that he has obtained three sketches.

Concerning the Ceylon parties, I give you a verbatim extract from the telegrams. From Jaffna: "Exceedingly strong radial polarisation, 35′ above the prominences; corona undoubtedly solar to that height, and very probably to height of 50′." From Trincomalee Mr. Moseley informs me that he carefully watched for Young's bright line stratum, and did not see it, and that 1474 was observed higher than the other line.

This is the sum total of the information which has at present reached me. It is clear there are discordances as well as agreements, the former being undoubtedly as valuable as the latter. It remains now to obtain particulars of all the observations of all the parties, before a final account can be rendered of the eclipsed sun of 1871. This, of course, will be a work of months; but if all goes well, I trust to obtain information shortly of the outlines of the work done by the Indian observers and M. Janssen, as I am now remaining in India for that purpose, and this I will communicate to *Nature* by the earliest opportunity. In the meantime I hope the good people at home will think we have done our duty, and that all the members of the Government Eclipse Expedition of 1871 will soon be safely with them to give an account of their work.—*Nature, Jan.* 18.

Ootacamund, Dec. 19, 1871.

3. *Inauguration of the Cordoba Observatory.*—This event, one of great importance to astronomical science, as well as to the country which has the honor of establishing the observatory, took place on the 24th of October last. The Standard of Buenos Ayres, of October 27th, contains an account of the inauguration. together with the address on the occasion of Professor B. A. Gould, the director of the observatory. The address is published in English, but was delivered in Spanish. The Standard says, by way of introduction:

"The formal inauguration of the Argentine Observatory at Cordoba took place with all the pride, pomp and circumstance of glorious science, on Tuesday last, in the presence of the dignitaries of the land and the *élite* of Cordoba. The Bishop took the initiative by blessing the enormous telescope, the largest instrument of the kind on the South American continent. Professor Gould then stepped forward and pronounced the following remarkable address; we make no apology for its length, but commend it to the attentive perusal of our readers. It is a document for history, beautiful in its composition, and highly felicitous in its remarks. Even amongst the audience every pause of the Professor was welcomed with applause."

Most of the facts in the very able address have been already communicated to this Journal by Dr. Gould. We cite the following paragraphs:

"In the year 1751 a French astronomer, Abbé de la Caille, visited the Cape of Good Hope for the purpose of determining the positions of the principal southern stars. With a little telescope of comparatively insignificant dimensions, he succeeded in obtaining the materials for so complete a catalogue—as far as the limit of brightness which his telescope permitted—and in determining the positions of those stars so well, that this catalogue of about 9,800 stars constitutes to-day the chief reliance of astronomers for their knowledge of a large portion of the southern sky. Since that time a permanent observatory has been established by the British Government at the same place, and a large number of valuable observations have been made by various eminent men. Other observatories in the southern hemisphere have been founded at Paramatta, Santiago de Chile, and Melbourne, all of which have contributed essentially to our knowledge of the southern sky; as also has the observatory at Madras, which, although north of the equator, commands a view of the greater portion of the southern heavens. Yet how much remains to be done in this direction will be very evident when I state that, while the numbers of stars in the northern hemisphere whose positions and magnitudes have been determined cannot fall short of about 330,000, the number in the southern hemisphere whose observed places have been published does not probably exceed 50,000. But this is not all. The greater portion of those which have been observed lie in that part of the sky which is clearly visible in Europe: and if we consider the regions beyond 30 deg., there are scarcely 13,000 southern stars whose places and magnitudes have been determined and made available for scientific use, while the corresponding portion of the northern sky contains something like 164,000 such stars. The late astronomer Gilliss, the originator of what is now the National Observatory of Chile, as well as of the Naval Observatory at Washington, of which latter he was the Director at the time of his death, devoted much time and labor to the effort to supply this pressing need; and while at Santiago, he made the requisite observations for determining the places of no less than 23,000 stars within 40 deg. of the South Pole. The computations were carried on at the expense of the U. S. Government, and were nearly completed at the time of his death, in 1865, after which the work was unfortunately suspended: but I have lately received the gratifying assurance that the calculations are now to be completed, and the resulting catalogue published by the Observatory at Washington. * * * * * * *

Nor has the progress of the work failed to afford its due share of discoveries. It has given us the knowledge of a considerable number of stars which possess the singular character that their brightness is not always the same, but undergoes systematic variations. Some have been seen to rise to considerable brilliancy, and then fade away until telescopes of some power are needed for rendering them visible. Others still are now found to possess a brilliancy decidedly greater or decidedly less than that which has been assigned to them by more than one astronomer in times past. Such stars must be carefully watched, and the fact of any regular and periodic fluctuation in the amount of their light either established or disproved. Of such cases there are already many on our records, thanks to the assiduity and zeal of the assistant astronomers, no one of whom has failed to make manifest the existence of several. One of those most remarkable for the rapidity of its changes is a little star in the constellation "Musca," which is invisible to the unaided sight during one half its period, and visible during the other half, while the observations of Mr. Rock show that it goes through all its changes within the short interval of 21¼ hours. Another in the constellation of the "Southern Triangle," which has been regularly observed by Mr. Davis, exhibits regular fluctuations of light, comprised within a period of about 3½ days, similarly alternating between visibility and invisibility. These two exhibit the most rapid changes of any of the stars which we have hitherto observed; but there are others not less interesting, observed not only by the two gentlemen mentioned, but also by Messrs. Thome and Hathaway, who are likewise pursuing these investigations with much success.

The transparency of the sky of Cordoba upon favorable nights may be judged of by a single additional fact. You will find in the treatises on astronomy, as I have already mentioned, the total number of stars in the entire heavens visible to the naked eye, estimated at from 5,500 to 6,000. Now, we have already recorded in the "Uranometria Argentina" the places of not less than 6,400 stars, visible to the unaided sight of every one of our observers, in the southern hemisphere alone; while in the 1st 10 deg. of the northern hemisphere we have 800 more, making in all at least 7,200 stars; so that we are justified in the belief that were the sky equally transparent for astronomers in the northern hemisphere, the total number of stars visible to the ordinary eye would be estimated at certainly not less than 11,000, instead of half that number."

## IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Exploration in Southern Nevada and Arizona.*—An expedition under the auspices of the Department of Engineers, U. S. A., for the exploration of unexplored territory in Southern Nevada and in Arizona, and placed under the immediate charge of Lieut. GEO. M. WHEELER, took the field early in May last, and continued its labors until December. The snow blockade on the Rocky Mountains and other difficulties delayed, until late in January, the arrival of the scientific corps in Washington, where they are now engaged in preparing an official report. The principal object of the expedition was to map and describe a portion of inhospitable territory, of which our previous knowledge was limited to the incoherent accounts of a few bold "prospectors." With this view, a large topographical force was organized, and though it was afterward reduced from seven to three members, an average of four topographical parties was maintained through the season.

Messrs. E. P. Austin and A. R. Marvine were the astronomers of the expedition, Dr. W. J. Hoffman the naturalist, Messrs. F.

Bischoff and J. Köhler the collectors, and Messrs. G. K. Gilbert and A. R. Marvine the geologists. The entire company, including escort, &c., numbered eighty or ninety persons, and was divided into two principal parties, meeting at designated points once in every month. These were subdivided as circumstances allowed, so as to deploy over as great an area as possible. Leaving the Central Pacific Railway at Carlin and Battle Mountain in Northern Nevada, the parties moved rapidly southward to Belmont, where the main exploration commenced. Thence to the Colorado the lines of survey were spread in a connected web over the entire width of Nevada, and even into California and Utah. With some contraction of its field, the survey was carried south across Arizona, and terminated at Tucson. A small party with boats explored the Colorado from Fort Mojave 200 miles to the mouth of Diamond Creek, more than 100 miles above the point attained by Lieut. Ives, and 40 above the mouth of the Big Cañon. Numerous photographs were made in the celebrated Black and Big Cañons, as well as at many other points of interest. Besides the usual sextant observations, accurate astronomical determination, by zenith telescope, was made of the latitude and longitude of six points. Barometric profiles and meteorological observations were made throughout.

In natural history extensive collections were made, which cannot fail to afford a considerable number of new species, and a mass of information has been acquired in regard to the distribution of animals and plants. In geology material has been collected for a proximate map of the region explored, connecting the work of Newberry, Blake and Antisell in Arizona with that of King on the fortieth parallel.

While returning by stage, Mr. P. W. Hamel, chief topographer, and two other members of the expedition, were killed by Apaches. Mr. Hamel had a deserved reputation as a topographer of rare skill, and his loss was a great one to the cause of geographical science. The results of his last work, however, are not entirely lost, as his notes were carefully kept, and will be of great use in the compilation of the map.

A preliminary report and map will be published in a few weeks.

2. *Notice of the Earthquake in New England of January 9th;* by Prof. C. G. Rockwood. (Communicated.)—At a few minutes before 8 P. M. of January 9, 1872, an earthquake was experienced over a considerable portion of eastern New England and the St. Lawrence valley. It was felt along the St. Lawrence river to a distance of 200 miles N. E. and 60 miles S. W. from Quebec, and at various points of New Hampshire and Maine between this locality and the Atlantic coast at Portland and Belfast, Me. The disturbance was greatest at Quebec, where some walls were cracked and large fissures were caused in the ice bridge over the river. The shock occurred there at $7^h\,54^m$ P. M., and lasted about thirty seconds, being accompanied by a low rumbling sound. At Lancaster, N. H., there were two distinct shocks, each lasting but a

few seconds, and the last being the more violent. The shocks were nowhere very severe, and being of very short duration, were generally unnoticed, except by those who happened to be favorably situated to perceive them. The direction of the vibrations was well defined and approximately from west to east. Probably the true direction was from a point somewhat *south* of west, which would coincide nearly with the course of the St. Lawrence river, and with the shorter diameter of the region shaken.

At Quebec and at Bangor, Me., slight tremors were also felt about 3 P. M. and 11 P. M. of the same day.

Brunswick, Me., Feb. 3, 1872.

3. *Monthly Rainfall at San Francisco*; by PLINY EARLE CHASE, Professor of Physics in Haverford College. (Communicated to the Meteorological Section of the Franklin Institute, Jan. 1, 1872.)—Mr. Thomas Tennent has published a chart, compiled from his own observations, of the monthly amounts of rain in San Francisco for twenty-two years, from July 1, 1849, to July 1, 1871. I have grouped the amounts in seven short periods, and computed the normal ordinates (N) for the several curves, which are given, together with the observed amounts (R), in the following table.

SAN FRANCISCO RAINFALL.

| | 1849-52. | | 1852-55. | | 1855-58. | | 1858-62. | |
|---|---|---|---|---|---|---|---|---|
| | R | N | R | N | R | N | R | N |
| July, ..... | .... | 3 | .... | 3 | ·02 | 2 | ·26 | 6 |
| Aug. ..... | .... | 9 | ·05 | 6 | ·05 | 3 | ·18 | 4 |
| Sept. ..... | 1·03 | 41 | ·61 | 23 | ·07 | 16 | ·05 | 19 |
| Oct. ..... | 3·35 | 111 | 3·33 | 65 | 1·38 | 57 | 3·70 | 64 |
| Nov. ..... | 12·03 | 196 | 7·93 | 116 | 6·47 | 136 | 12·65 | 142 |
| Dec. ..... | 14·35 | 228 | 16·33 | 176 | 13·65 | 219 | 23·41 | 220 |
| Jan. ..... | 9·64 | 191 | 11·47 | 193 | 16·21 | 249 | 29·75 | 248 |
| Feb. ..... | 2·45 | 155 | 14·23 | 194 | 10·92 | 217 | 19·17 | 208 |
| Mar. ..... | 13·15 | 136 | 13·01 | 185 | 8·77 | 156 | 13·29 | 140 |
| Apl. ..... | 1·95 | 90 | 13·49 | 142 | 4·49 | 92 | 4·65 | 83 |
| May, ..... | ·99 | 34 | 2·28 | 74 | 1·12 | 40 | 6·15 | 46 |
| June, ..... | .... | 8 | ·08 | 21 | ·20 | 12 | ·22 | 21 |

| | 1862-65. | | 1865-68. | | 1868-71. | | 1849-71. | |
|---|---|---|---|---|---|---|---|---|
| July, ..... | .... | 5 | .... | 2 | .... | 1 | ·28 | 3 |
| Aug. ..... | ·21 | 3 | .... | 1 | .... | 3 | ·49 | 4 |
| Sept. ..... | ·04 | 20 | ·39 | 11 | ·15 | 12 | 2·34 | 20 |
| Oct. ...... | ·53 | 84 | ·46 | 58 | 1·44 | 44 | 14·19 | 67 |
| Nov. ..... | 9·38 | 187 | 10·95 | 155 | 2·80 | 115 | 62·21 | 149 |
| Dec ...... | 13·06 | 252 | 26·43 | 249 | 12·03 | 206 | 119·26 | 221 |
| Jan....... | 10·60 | 229 | 25 54 | 267 | 13·31 | 257 | 116·52 | 235 |
| Feb....... | 4·53 | 161 | 15·45 | 210 | 12·44 | 235 | 79 19 | 200 |
| Mar. ..... | 4·32 | 113 | 10 92 | 135 | 6.43 | 171 | 69·89 | 148 |
| Apl....... | 4·12 | 82 | 4·79 | 73 | 5·65 | 101 | 39·14 | 94 |
| May, ..... | 1·64 | 48 | 1·49 | 31 | ·49 | 44 | 14·16 | 45 |
| June, ..... | .... | 17 | ·27 | 9 | ·02 | 11 | ·79 | 15 |

There is so much similarity between the different curves, their general character is so much like that of the Lisbon curves, and they accord so nearly with the annual temperature curve, that they may reasonably be regarded as typical, and the daily records may probably furnish materials for more minute and detailed profitable investigation.

Among the deductions in my paper on the "tidal rainfall of Philadelphia" (Proc. Amer. Phil. Soc., x, 530), were the two following:

"(1.) The tidal rainfall, like the ocean tides, is affected by 'establishments,' which depend upon ocean currents, mountain ranges, prevailing winds, and other climatic influences.

"(2.) It is also, like the ocean tides, more marked in low than in high latitudes."

These inferences are strikingly corroborated by the Lisbon records, and I look confidently for equally striking additional confirmation from observations on our Pacific coast. Moreover, I think that my previous discussions, combined with generalizations from the meteorological reports of the Signal Service Bureau and with well known tidal laws, are sufficient to justify the following predictions.

(1.) The tidal rainfall will generally be found more strongly marked on the western shores of the several continents, than in the same latitudes on the eastern shores.

(2.) When the rainfalls, at any given station, are grouped both in accordance with the age of the moon and the direction of the wind which brings the rain, opposition of winds will be found to affect the tidal curves similarly to opposition of direction from large bodies of water.

(3.) A certain degree of apparent opposition will be found to exist between the lunar influence upon the upper and lower cloud strata, dependent upon the normal difference of position in the tidal crests of deep and shallow-fluid envelopes.

(4.) The satisfactory determination of the lunar influence upon atmospheric currents will be found practicable, although vastly more laborious than the determination of the laws of tidal rainfall. Glaisher has already shown that there is such an influence, but there have been no published discussions of its amount or general character.

4. *Meteor in Mexico.*—For the following communication the Journal is indebted to the favor of Prof. Henry, Secretary of the Smithsonian Institution.

The observations relate to the meteor of the 22nd of last month [in 1871, but the month not stated in the communication] and are from an article in the "Corréo del Comercio," published by José de la Vega, director of the telegraphic line from Vera Cruz to Mexico.

Being in the telegraph office, we have been enabled to follow telegraphically the meteor from one point to the other. The following are the reports received.

*Mexico.*—At a quarter past eight o'clock P. M., a red streak appeared in the blue sky, and turned afterwards into a whitish luminous band. It moved from west to east with a slight inclination towards the W. S. W. and E. N. E., and lasted ten minutes.

*Apizaco.*—When the advice reached me, I could only see a handsome light, which vanished in the horizon. It may have lasted about ten minutes.

*Puebla.*—After eight o'clock a fire-ball was seen to start from the direction of Popocatepetl, running toward the top of Orizaba and leaving in its course a cloud of dense reddish smoke.

*Huamantla.*—At fourteen minutes past eight o'clock there was seen a fire-ball about the size of the face of a large clock, which coming from the west disappeared in the horizon toward the east, somewhat inclining to the south. It looked as if coming from the moon, and illuminated extraordinarily the earth, leaving in the sky a track of light which lasted about ten minutes and showed the course of the inflamed body.

*San Andres.*—The meteor has been observed here, and left a line from east to west.

*Perote.*—At forty minutes past eight o'clock the meteor was observed here and lasted four minutes, leaving in its course a luminous band.

*Tehuacan.*—At a quarter to nine o'clock the meteor was observed here. It moved from west to east, looked like an inflamed cannon-ball, and left in its course a luminous track which remained perfectly distinct for the space of ten minutes, and then gradually disappeared about five minutes past nine o'clock.

*Jalancingo.*—As a very dense fog was prevailing, we were able to see only for a moment a light in the sky in the form of a rainbow.

*Jalapa.*—At forty-five minutes past eight o'clock there was noticed here a whitish luminous band only; but other persons saw the meteor itself.

*Vera Cruz.*—At nine o'clock the meteor was observed here. It moved from west to east, and lasted about a minute. Its wake was brilliant and extensive, lasting about five minutes.

Forty-five minutes elapsed from the moment the meteor was observed at Mexico, till the moment it made itself visible at Vera Cruz, three hundred and twenty kilometers distant.

I shall be very glad if this information may serve as a means of ascertaining at what distance from the earth the meteor occurred, and what was the velocity of its motion.

5. *Catalogue of the Meteoric Collection of* Charles Upham Shepard, deposited in the Wood's building of Amherst College, Amherst, Mass.—Prof. Shepard has one of the largest collections of meteorites in the world. It embraces, according to his enumeration in this catalogue, 146 different meteoric stones and 93 meteoric irons. The heaviest specimen of the irons is one from Aeriotopas, weighing 438 pounds, and the largest of the stones is that from New Concord, weighing 52 pounds.

Speaking in the latter part of the pamphlet of a collection of serpentine rocks from Havana (W. I.), which he had arranged in the same room, he introduces the name *Antillite* for a bronzite-like, serpentine mineral, which he supposes to be new, an analysis affording the composition $\overset{..}{Si}$ 39·30, $\dot{Mg}$ 36·12, $\dot{Fe}$ 6·79, $\dot{H}$ 16·79, with traces of $\dot{Cr}$, $\dot{Ca}$, $\dot{K}$. It is in dark greenish-brown laminæ, with a fibrous cleavage and also occurs massive infusible B. B. except on the edges. [The analysis affords very nearly the oxygen ratio for the protoxides, silica and water $3:4:2\frac{2}{3}$; or the composition of a ferriferous serpentine with excess of water.] Prof. Shepard observes that, among the serpentines, numbers of the series of specimens, even when several inches across, are *plainly pseudomorphs after chrysolite, amphibolite, augite and titanite; and that these pseudomorphs so abound in the matrix that they constitute the largest portion of the mass, and may be easily separated by a blow of the hammer.*

6. *The Rumford Medals.*—At the last annual meeting of the American Academy of Arts and Sciences held in Boston, May 30th, 1871, the Rumford premium was awarded to Mr. Joseph Harrison, Jr., of Philadelphia, "*for his method of constructing steam boilers, by which great safety has been secured.*" According to the directions of Count Rumford, this premium was given in two medals—one of gold and one of silver—together of the intrinsic value of three hundred dollars; and at the last monthly meeting of the Academy a formal presentation of the medals was made.

The medals presented to Mr. Harrison are the sixth award of the Rumford premium, made by the American Academy. The other awards have been as follows:—

In 1839 to Dr. Robert Hare, of Philadelphia, for his invention of the compound blow-pipe and his improvements in galvanic apparatus.

In 1862 to Mr. John B. Ericsson, of New York, for his caloric engine.

In 1865 to Professor Daniel Treadwell, of Cambridge, for his improvements in the management of heat.

In 1867 to Mr. Alvan Clark, of Cambridge, for his improvements in the manufacture of refracting telescopes, as exhibited in his method of local correction.

In 1870 to Mr. George H. Corliss, of Providence, for improvements in the steam engine.

It was directed by Count Rumford that the premium should be given "to the author of the most important discovery or useful improvement which shall be made and published by printing, or in any way made known to the public, in any part of the Continent of America, or in any of the American Islands, during the preceding two years, on Heat or on Light; the preference always being given to such discoveries as shall in the opinion of the Academy tend most to promote the good of mankind." In Count Rumford's original letter of donation, dated London, July 12th, 1796, besides the above, several other directions are given, with which the Academy found it impossible, or at least very inexpedient, to comply literally, and for this reason the premium was not awarded during a long series of years. The Academy is now acting under a decree of the Supreme Judicial Court of the Commonwealth of Massachusetts, especially authorized by an Act of the Legislature of the State, approved by the Governor, March 16th, 1831. This decree enables them to award the premium at any annual meeting, and relieves them from the necessity of limiting it to discoveries or improvements made during the two years immediately preceding the award.

All interested in the subject will find a full statement of the facts in the Life of Count Rumford, by the Rev. George E. Ellis, D.D., recently published for the Academy (in connection with an edition of Rumford's complete works) by Claxton, Remsen and Haffelfinger, 819 and 821 Market street, Philadelphia.

A committee consisting of seven Fellows, called the Rumford Committee, is annually appointed by the Academy, and it is their duty to investigate all claims for the Rumford premium. The premium is awarded only on the recommendation of this committee, and at the "annual meeting" of the Academy, held on the fourth Tuesday of May. The Rumford fund would enable the Academy to give the medals every year; but the premium can be awarded only for a new discovery in light and heat, or a substantial improvement in the application of these agents to the arts of life, whose usefulness has been tested by experience. All communications on the subject of the Rumford premiums should be addressed to the Chairman of the Rumford Committee, American Academy of Arts and Sciences, Boston.

7. *Light of the bottom of the Ocean.*—In the Annals and Magazine of Natural History for January, W. C. M'INTOSH discusses the question whether the idea that the bottom of the ocean is rendered light by the phosphorescence of its life, and concludes that the abysses of the ocean are not better supplied in this respect than the littoral region or the shallow Laminarian zone—indeed, than the surface of the sea itself. The question whether this luminosity is given to marine animals for the purpose of preying or being preyed upon, suggested in the Reports of the dredging expeditions of H. M. S. Porcupine, is decided adversely.

Mr. McIntosh also combats the conclusion of Dr. Carpenter that the turbidity of the lower waters of the Mediterranean renders the bottom barren of life, pointing out many facts with regard to the growth of life, in great variety, over the muddy bottom of seas.

8. *Manna from a Linden in the Vosges.*—BOUSSINGAULT has made the following observations on a manna obtained from the leaves of an old linden, in the Vosges. In composition it is almost identical with that of Mt. Sinai, studied by Ehrenberg and Berthelot. It contains, in round numbers, 55 p. c. of cane sugar, 25 of inverted sugar, and 20 of dextrine. It occurred on the upper part of the tree, not the lower. Although there were other trees of the same kind in the vicinity, only this one afforded the manna. The manna of Mt. Sinai was attributed by Ehrenberg to the puncture of an insect; but Boussingault thinks that this is not the source of it in the case of the linden manna; for he had seen no in-

sect on the tree which could have produced such a result.—*Acad. Sci. Paris, L'Institut, Jan.* 10.

9. *Hailstones of salt and sulphide of iron.*—Prof. KENNGOTT, of Zurich, states that in a hailstorm, lasting five minutes, on the 20th of last August, the stones, some of which weighed twelve grains, consisted essentially of common salt, mainly in imperfect cubical crystals. He supposes that the salt had been taken up from the salt plains of Africa, and brought over the Mediterranean.

Hailstones containing each a small crystal of sulphide of iron are reported as having fallen recently, by Prof. Eversmann of Kasan. The crystals were probably weathered out of some rocks in the vicinity.—*Nature, Jan.* 11.

10. *Temperature of the Sun.*—The temperature of the sun, according to Secchi's calculations, is at least 10,000,000° C.; and according to Mr. Spœrer's, 27,000° C.; while Pouillet placed it between 1461° and 1761° C. Mr. Vicaire, in a note to the French Academy of Sciences, objects to Secchi's use of Newton's law of radiation, because applicable only in case of low temperature, and, accepting that of Dulong and Petit, arrives at the more probable conclusion that the temperature does not exceed 3000° C. (5400° F.). He observes that the greatest heat of the oxyhydrogen blowpipe is 2500° C. (4500° F.), and the highest furnace heat not above 2000° C. (3600° F.).

## V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Catalogue of Photographic Illustrations by* WM. H. JACKSON, Photographer to the Survey of the Territories under Dr. F. V. HAYDEN, Department of the Interior, Washington, D. C., 1871.—This catalogue contains the titles of over four hundred Rocky Mountain photographs, mostly eight by ten inches in size, representing scenery of geological as well as general interest, Indian villages, Indians, etc. We have seen eighteen of them taken in the Geyser region of the Yellowstone, and they are admirable as photographs, and wonderful in beauty and interest, supplementing well the articles by Dr. Hayden in this Journal. By their high character, they speak well for the rest in the list. They represent lakes and boiling springs, basins and cones, and geysers, quiet and in action, and show even the texture of the deposits of silica and carbonate of lime which constitute the cones and the borders of the basins. They enable the geologist to realize what kind of deposits springs or chemical depositions make, presenting nothing to favor the idea that beds like those of ordinary even-grained limestones, however pure and free from fossils, are possible results of such action.

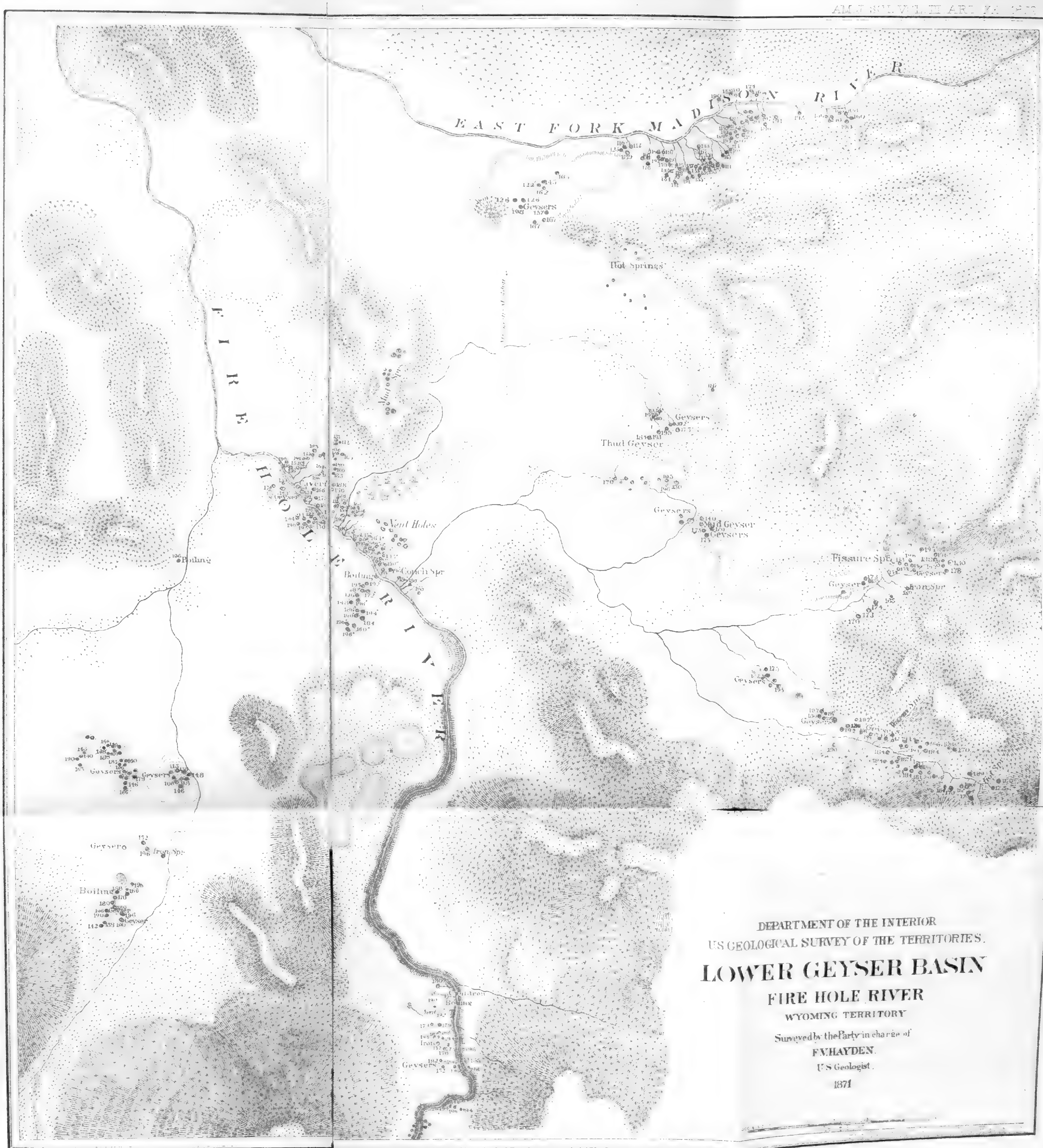
2. *Fireside Science. A Series of Popular Scientific Essays upon Subjects connected with Every-day Life;* by JAMES R. NICHOLS, A.M., M.D. New York, 1872. 12mo, pp. 283. (Hurd & Houghton.)—Dr. Nichols has made a valuable contribution to the fireside literature of science in these essays, which present in a clear manner many important facts and principles in familiar

language, adapted to the tastes of all intelligent people. In some of the essays the author states important results from his own researches, as in his "Experiments with air furnaces," and the agricultural papers. Many of these essays, in substance at least, have already appeared in the author's Boston Journal of Chemistry. s.

3. *A Treatise on Localized Electrization, and its applications to Pathology and Therapeutics;* by Dr. G. B. DUCHENE. Translated from the 3d edition of the original, by HERBERT TIBBITS, M.D., Royal Coll. Phys., London. With numerous illustrations and notes and additions by the Translator. Philadelphia, 1871. 8vo, pp. 322. (Lindsay & Blakiston.)—This is Part First of the great work of Duchene on Localized Electrization, and its translation is a good service done to English and American students. Its value is by no means confined to the physiological or medical student, as nowhere else can the physicist and chemist find a better statement of the fundamental principles and structural details of electrical apparatus and methods of producing electrical currents. The publication of the original work was suspended by the investment of Paris by the German army, so that the translation appeared before the original was published. The American edition is an impression from the English types, and is most excellent in its execution. s.

4. *The Lens: A Quarterly Journal of Microscopy and the allied Natural Sciences;* with the Transactions of the State Microscopical Society of Illinois. Edited by S. A. BRIGGS. Publishing Committee: C. Biggs, E. H. Sargent, C. Adams. No. 1. 64 pp. 8vo. Chicago, January, 1872.—We have barely space to announce the appearance of the first number of this new scientific journal. While especially devoted to Microscopy, it will also include articles on other branches of natural science, especially those "illustrative of the Natural History of the Mississippi Valley and the Far West," together with notices of other publications and results. It states that its "aim is to be thoroughly scientific, advanced and comprehensive;" and it has made a good beginning in this direction in its first number.

5. *Elementary Treatise on Natural Philosophy;* by A. PRIVAT DESCHANEL. Translated and edited, with extensive additions, by J. D. EVERETT, M.A., D.C.L., F.R.S.E., in four parts of about 250 pp. each, 8vo. 1872. (D. Appleton & Co., New York.)—The publishers of this work have done the American public a good service in setting before it a book so well fitted for the general reader or student. The treatise is especially adapted for the use of those who desire to make themselves familiar with the general principles of Physics, but are not in a position to go into the mathematical difficulties of the subject. It is popular in style, though with no consequent lack of precision, and profuse and unsurpassed in its illustrations. The explanations and descriptions are clear and concise. The English editor has largely increased the value of the original work by the additions he has made.


EAST FORK MADISON RIVER
FIRE HOLE RIVER
Geysers
Hot Springs
Thud Geyser
Mud Geyser
Vent Holes
Couch Spr
Boiling
Fissure Spr
Iron Spr
Cauldron
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY OF THE TERRITORIES.
LOWER GEYSER BASIN
FIRE HOLE RIVER
WYOMING TERRITORY
Surveyed by the Party in charge of
F. V. HAYDEN.
U. S. Geologist.
1871


A. E. V. from nature.

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

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ART. XXIX.—*Discovery of Additional Remains of Pterosauria, with Descriptions of two new Species;* by Professor O. C. MARSH, of Yale College.

THE first remains of Pterodactyls detected in this country were found in the upper Cretaceous shale of Western Kansas, by the writer, during the explorations of the Yale College party in the autumn of 1870. The specimens then obtained, although very fragmentary, were deemed sufficiently characteristic for determination, and the gigantic species they were believed to represent was briefly described under the name *Pterodactylus Oweni.** The great interest attached to these remains led to a careful reëxamination of the same region by the Yale party of the following year, and with most gratifying results. An excavation at the point where the first specimens were found yielded further portions of the same skeleton, and, at various localities in the same strata, other specimens were secured, which not only throw much light on the species first discovered, but also prove the existence of two other Pterosaurians, likewise of great size, showing that these peculiar reptiles, so long deemed wanting in America, were apparently well represented here during the later Cretaceous.

*Pterodactylus occidentalis* Marsh.

The additional remains of this species, discovered by our party during the past summer, consist of portions of five indi-

* This Journal, vol. i, p. 472, June, 1871. As this name had already been applied provisionally by Seeley to a Pterodactyl from the Greensand of England, the present species may be called *Pterodactylus occidentalis.*

viduals, which differed somewhat in size, but all tend to confirm the conclusions based on the fragments first examined. From the locality which furnished one of the original specimens, we recovered the proximal end of the right wing-finger metacarpal, which evidently belonged with the distal extremity described, and proves the entire bone to have been at least fifteen inches in length, or much more elongated than any hitherto known. With this specimen were found portions of the second and third phalanges of the same wing-finger, all indicating the great size and power of the wings. Another specimen, found by the writer at a higher level, in the yellow chalk, pertained to a larger individual, and is of much interest. It consists of the distal extremity of the left-wing metacarpal, articulated to the adjoining proximal end of the first phalanx. Both bones are in excellent preservation, and show this characteristic joint most perfectly.

The most important remains of this species yet discovered, however, consist of nearly all the bones of a right wing, from the humerus to the last phalanx inclusive, which were found by the writer in place in the gray Cretaceous shale, during our investigations near the Smoky River. Although more or less fractured, the bones are in general well preserved, and show clearly the peculiar structure of the Pterosaurian wing, as well as the especial characters that mark the present species.

The humerus, which is nearly perfect, is remarkably short and robust, and in its main features surprisingly bird-like. The articular head is large and crescentic, convex on its anconal face, and concave on the opposite side. Its proximal outline is concave transversely, thus differing widely in this respect from the avian type. The ulnar crest is very prominent, and its proximal extension is continued to the line joining the radial and ulnar angles of the articular head. The radial crest is prominent, but scarcely exceeds the ulnar ridge in size, and is hence proportionally much smaller than in most of the Pterodactyls described. Its point of greatest extension is nearly opposite the distal subsidence of the ulnar crest. There is no pneumatic foramen on the anconal side of the proximal extremity. The shaft of the humerus is smooth, sub-cylindrical in transverse outline, and apparently less sigmoid longitudinally than in the species already known. The osseous walls are thin, and very compact. The distal extremity is much flattened, and has the articular condyles very similar to those in the humerus of birds. The radial condyle is the larger, and more prominent. It is oval in outline, and extends obliquely rather more than half way to the ulnar side. Near its termination on the palmar surface, and on the ulnar side of the median line, is a large, oval, pneumatic foramen. There is here no indication of an impression for the attachment of the anterior brachial muscle, as in the humerus of birds. The ulnar condyle is transversely oval in form, and is separated from the radial condyle by an oblique groove. The principal dimensions of the humerus are given in the table below.

The fore-arm in the present specimen was composed of two separate bones, which differ much in size. The larger bone was apparently the ulna, and its proximal end covered with its articular faces the greater portion of the condyles of the humerus. The smaller or radial element was closely attached to the larger bone on its front or palmar side. Both of these bones had unfortunately been crushed, and the shafts badly fractured, so that their exact length cannot be accurately ascertained. They were, however, at least thirteen and a half inches long, and probably much more. With exception of the much greater difference of the two bones in size, they appear to resemble most nearly the anti-brachial bones of *Pterodactylus Suevicus*, as figured by Quenstedt.* With the above specimens were exhumed three bones belonging to the wrist; a large proximal carpal, a distal one of nearly equal size, and a third, much smaller, which is probably a lateral carpal. The two larger bones correspond essentially in their main features with those of *Pt. Sedgwickii*, figured by Owen,† although they indicate a superior size for the present species.

The metacarpal of the wing-finger in this series of specimens is represented only by its distal extremity, so that its dimensions must be determined mainly from a comparison with the other specimens pertaining to this species. The part preserved resembles strongly the distal end of the tibia of a bird, but differs essentially in the obliquity of its condyles—which have a sweep of about two thirds of a circle—and in the presence of a large pneumatic foramen on the palmar side, in the depression between the condyles. On the opposite side there is no indication of a similar opening. There was also, apparently, no median rising in the groove of the distal end, either in the present specimen, or in others of the same species. The outer trochlear surface is most developed, and has its exterior margin angular. In its proximal extension on the palmar side, it bends outward, and terminates in an obtuse lateral tubercle, which forms, on its articular surface, nearly a right angle with the side of the adjoining shaft. The inner trochlear surface has a rounded interior margin, and, on the anconal side, ends abruptly in a prominent ridge, which limits the lateral motion of the joint.

There were four phalanges in the wing-finger, and the greater portion of all of them is preserved. The first phalanx is almost

* Ueber *Pterodactylus Suevicus*, 4to, Tübingen, 1855.
† Fossil Reptilia from Cretaceous, Third Supplement, pl. iv.

entire, and measures about seventeen inches in length. Its proximal end presents the peculiar articulation for union with the metacarpal, which is well shown in the figures given by Quenstedt, von Meyer and Seeley. The outer articular face, or that on the ulnar side, is broad, nearly flat transversely, and forms almost a right angle with the adjoining side of the shaft. The inner face is shorter, deeply concave transversely, with a thin exterior edge. The two articular faces converge, and unite on a sub-triangular olecranoid process, which projects proximally from the anconal side of the shaft, thus moving between the condyles of the adjoining metacarpal, and preventing the flexure of the joint beyond the full extension of the wing. On the opposite side, between the articular faces, there is a deep groove, which is continued some distance distally. It apparently contains a large pneumatic foramen. The distal end of this bone presents an elliptical, convex, articular face, which does not entirely cover the distal surface. The second phalanx has its proximal extremity adapted to this articular face by a shallow elliptical cup, which does not extend over the most proximal portion of the extremity. The distal end resembles in everything but size the corresponding part of the first phalanx. The next or third phalanx is quite similar to that which precedes it, except that it is more attenuated. The slender terminal phalanx appears to have been more nearly circular at its proximal end, although apparently compressed toward its other extremity. The articular surfaces of all the bones preserved are smooth and well defined, like those of mammals and birds. All the bones of the wing, moreover, even the carpals, appear to have been pneumatic.

The teeth found with remains of this species, and supposed to belong with them, are very similar to the teeth of Pterodactyls from the Cretaceous of England. They are smooth, compressed, elliptical in transverse outline, pointed at the apex, and somewhat curved.

The following are the principal dimensions of the specimens mentioned in the previous description. Some of the measurements are only approximately correct, owing to the distortion by pressure of several of the specimens:

*Measurements.*

| | |
|---|---|
| Length of humerus on radial side, | 163· mm· |
| Length on ulnar side, | 174· |
| Greatest diameter of articular head, | 38· |
| Least diameter of articular head, | 12· |
| Greatest diameter or width of proximal end, | 63· |
| Greatest diameter of distal end, | 64· |
| Vertical diameter of shaft, where least, | 29· |
| Length (minimum) of ulna, or larger bone of fore-arm, | 336· |

| | |
|---|---|
| Greatest diameter at proximal end, | 48· mm. |
| Greatest diameter of articular surface, | 46· |
| Greatest diameter of distal end, | 42· |
| Greatest diameter of radius, at proximal end, | 33· |
| Greatest diameter at distal end, | 28· |
| Transverse diameter of proximal carpal, | 51· |
| Antero-posterior diameter of proximal carpal, | 28· |
| Greatest diameter of articular face of distal carpal, | 42· |
| Length of lateral carpal, | 24· |
| Length (minimum) of metacarpal of wing-finger, | 412· |
| Length of first phalanx of wing-finger, | 428· |
| Transverse diameter of proximal end, | 53· |
| Chord of greater articular surface, | 30· |
| Length of olecranoid process, | 20· |
| Greatest diameter of distal end, | 29· |
| Greatest diameter of distal articular surface, | 35· |
| Least diameter, | 8· |
| Greatest diameter of second phalanx, at proximal end, | 35· |
| Greatest diameter of proximal articulation, | 28· |
| Greatest diameter of distal articulation, | 20· |
| Least diameter, | 6· |
| Greatest diameter of proximal articulation of third phalanx, | 18· |
| Least diameter, | 7· |
| Greatest diameter of proximal articulation of fourth phalanx, | 10· |
| Length of crown of tooth, | 25· |
| Antero-posterior diameter at base, | 9· |
| Transverse diameter at base, | 5·5 |

The above measurements of the wing-bones would indicate for the entire wing a length of at least eight and a half feet, and, for the full expanse of both wings, a distance of eighteen to twenty feet. The present species, therefore, contains some of the largest "flying dragons" yet discovered. Its main distinctive features are readily seen in the very short and stout bird-like humerus, with its moderate radial crest, and large distal pneumatic foramen; in the separate radius and ulna, differing greatly in size; and in the extremely elongated wing-metacarpal. The latter character renders it almost certain that the species belonged to the short-tailed or true Pterodactyls, as in the other groups this bone has been found to be invariably less than one-half the length of the fore-arm. The large laniary teeth clearly indicate the carnivorous and predacious habits of the species, and its food was doubtless fishes, which it captured probably by plunging into the water, like the Pelicans and other similar birds.

All the known remains of this species were found in the upper Cretaceous strata, near the Smoky River in Western Kansas.

*Pterodactylus ingens*, sp. nov.

The existence of a second and much larger species of Pterodactyl, in the same strata with the remains just described, is clearly indicated by a number of specimens, pertaining to four individuals, which were discovered last summer during the explorations of the Yale party along the Smoky River and its tributaries. One series of these specimens consists of the greater portion of an ulna, part of a radius, the distal end of a wing-metacarpal, and portions of the corresponding phalanges, evidently belonging to the right wing of the same animal The other specimens secured are equally characteristic, and serve to supplement this series.

A comparison of these various remains, especially the bones of the fore-arm, with the corresponding parts of the preceding species, shows several important differences, aside from that of size. In the former species, the ulna, or larger anti-brachial bone, has, on its proximal end, two large articular faces for union with the condyles of the humerus, and between them a low elevation, which extends only to a line joining the proximal margins of these surfaces. In the large species, this elevation is represented by a very prominent, flattened protuberance, which projects far beyond the rest of the proximal extremity. The smaller articular face in this specimen, moreover, is much less inclined from the axis of the shaft. The distal ends of the same bones show equally marked differences. In *Pt. occidentalis*, the articular face on the outer side extends transversely only to the margin of the central tubercle. In the species under consideration, this face does not terminate until it reaches a point opposite the middle of the corresponding projection, which is much more compressed than in the smaller specimen. The radii, also, of the two species exhibit essential differences, especially in their proximal extremities.

The metacarpal bone of the wing-finger is very similar at its distal end to that of the species above described. It shows, however, unmistakable indications of a median ridge on its anconal side; and since this is also the case with all the other specimens preserved, there can be little doubt that this feature was a specific character. The remaining portions of the phalanges, so far as the present material allows of comparison, show no essential differences in the two species.

With one series of the above specimens, a small bone was found, which is probably the distal end of a metatarsal. In its general features it agrees most nearly with the bone figured by Seeley as a metacarpal or metatarsal.* The fact that this specimen is nearly solid bone would be an argument for considering

* Ornithosauria, plate vi., figures 8 and 9.

it the latter, as all the wing-bones examined during the present investigation are clearly pneumatic.

The dental characters of this species are at present only known from a single crown of a tooth, found with one series of the specimens, and from two larger and very perfect teeth found by themselves, which agree so closely with the former that they deserve notice in this connection. These specimens are less curved and less compressed than the teeth referred to *Pt. occidentalis*, but in other respects they are nearly identical.

***Measurements.***

| | |
|---|---|
| Greatest diameter of ulna, at proximal end, | 67· mm. |
| Greatest diameter, at distal end, | 68· |
| Greatest diameter of radius, at proximal end, | 44· |
| Transverse diameter of wing-metacarpal, at distal end, | 38·75 |
| Transverse diameter of shaft, at junction with condyles, | 32· |
| Antero-posterior extent of outer condyle, on palmar side, | 34· |
| Antero-posterior extent of inner condyle, on palmar side, | 35· |
| Transverse diameter of proximal end of first wing-phalanx, | 41· |
| Length of olecranoid process beyond outer articular face, | 32·5 |
| Transverse diameter of supposed metatarsal, at distal end, | 14· |
| Length of crown of small tooth found with above remains, | 18·6 |
| Antero-posterior diameter, at base of crown, | 7·25 |
| Transverse diameter, | 5· |
| Length of large isolated tooth, | 48· |
| Antero-posterior diameter at base of crown, | 14· |
| Transverse diameter, | 11·3 |

The present species was evidently one of the most gigantic of Pterosaurs. It was at least double the bulk of *Pterodactylus occidentalis*, and probably measured between the tips of the fully expanded wings nearly twenty-two feet!

The various remains on which the species is based were discovered, in July last, by Lieut. J. H. Whitten, U. S. A., Mr. O. Harger, of Yale College, and the writer. The localities were in the blue shale and yellow chalk of the Upper Cretaceous, near the Smoky River, in Western Kansas.

## *Pterodactylus velox*, sp. nov.

This species, which was apparently about two thirds the size of *Pterodactylus occidentalis*, is at present represented, so far as known, by the distal end of a right metacarpal of the wing-finger, and by the proximal extremity of the adjoining first phalanx. These bones, however, are among the most characteristic parts of the Pterosaurian skeleton, and in the present instance the specimens appear to show several points of distinction from the species already described.

In the metacarpal bone, the articular distal extremity is smaller in proportion to the size of the shaft which supports it, than in either of the species above described. In other respects it appears to present no essential difference except that of size. The first phalanx, however, shows in its proximal end several differences which are clearly of specific importance. The outer articular surface in the present specimen is proportionally much narrower, and has its posterior margin more extended proximally. There is, moreover, no indication, on the inner side of the bone, of the large obtuse tubercle which is a prominent feature in all the corresponding specimens of the other two species. The epiphysis which bears the olecranoid process has disappeared from the present specimen, leaving an elongated oval depression, with a well defined margin. Both of the above bones are somewhat distorted by pressure.

***Measurements.***

| | |
|---|---|
| Transverse diameter of wing-metacarpal, at distal end, | 26· mm. |
| Proximal extent of outer condyle, on palmar side, | 22·6 |
| Proximal extent of inner condyle, | 20· |
| Transverse diameter of shaft at junction with condyles, | 21· |
| Antero-posterior diameter of proximal end of first phalanx, | 38· |
| Greatest transverse diameter, | 12· |

The specimens of this species at present known do not afford perfectly reliable data for estimating the size of the animal, but the wings, when fully expanded, were probably from twelve to fifteen feet in extent. The fossils here described were found by the writer, in July last, in the gray cretaceous shale, on the south side of the Smoky River, in Kansas.

Yale College, New Haven, Conn., Feb. 26th, 1872.

## ART. XXX.—*On a new method of measuring the Velocity of Rotation;* by Prof. A. E. DOLBEAR.

WHILE experimenting with the gyroscope, I have often wished to know its velocity, but knew of no way to determine it when it was set in motion in the usual way with a string. I have lately found a simple and exact way of doing this, and a description of the plan may be of interest to others, as it can be used to measure the velocity of wheels of every size, and every possible speed, without inconvenience and without expense.

If a short piece of wire be soldered to the end of one branch of a common tuning fork, one end of the wire projecting a little on one side, and the fork made to vibrate at the same time that the point of the wire is drawn over a piece of smoked glass, an undulating line is made, and if the rate of vibration of the fork is known, the velocity of the moving hand can be found by counting the number of undulations in an inch on the glass. This has been used to determine linear velocity; but it can also be applied to rotary with great precision. I have a large fork with branches eight inches in length that vibrates one hundred and seventy-one times in a second as determined by a resonant tube; it has copper wire fastened to one branch and projecting about one-fourth of an inch,—made for showing to a class the waving line upon smoked glass. A brass disk four inches in diameter, mounted gyroscopically, was smoked upon one side and set revolving by a string. The vibrating fork was then brought to it in such a manner that its vibrations were along the radius of the disk, but as soon as it touched it bounded away and nothing could be determined with it. A *cone of india rubber*, about a quarter of an inch in height, was then fastened with sealing wax near one end of the branch, and this tried as before with entirely satisfactory results, the markings being well defined and unmistakable.

When the number of vibrations the fork makes a second is known, and the number of undulations made once round the disk, the former number divided by the latter will give the rate per second of velocity. Thus if the fork made 100 vibrations in a second and the disk turned round but once in the same time, it is evident that there would be a hundred undulations on it, and if the disk turned 50 times a second, there would be but two undulations for each revolution. In any case, if $a$ equals the number of vibrations per second of the fork, and $b$ equals the observed number of undulations in a single turn of the disk, then $V=\frac{a}{b}$.

A single wave, or even half of one, is sufficient for determination if the length be measured in degrees, in which case if $d =$ the length of one wave in degrees, the formula will stand $V=\frac{ad}{360}$. If the rotation be very rapid the quickest possible touch is needed or the undulations will return and confuse each other; but this is not troublesome at any speed I have been able to obtain, which is in the neighborhood of 90 per second.

I have found that a common pocket tuning fork, either an A or a C, answers very nicely with one of india rubber fastened as before. So far as I now know, the swiftest motion that has been given to a disk was that in Foucault's apparatus for showing the motion of the earth which he estimated at from 150 to 200 revolutions per second. Such a velocity would be recorded by from 2 to 3 undulations of a C fork, making 512 vibrations per second. If it would not be best to smoke the disk, a piece of white paper can be pasted upon it and smoked without burning, and it answers every purpose. To the certainty and ease of this method may be added another advantage, that the slightest touch needed for this cannot sensibly retard the motion of the disk, as any mechanical fixture attached for such a purpose must do.

Physical Laboratory, Bethany College, Bethany, W. Va., January 19.

ART. XXXI.—*Green Mountain Geology. On the Quartzite;* by JAMES D. DANA.

(Continued from page 186).

## 2. QUARTZITE OF POUGHQUAG, DUTCHESS CO., N. Y.

THE town of Poughquag is situated on the road from Pawling (a village on the Harlem railroad) to Poughkeepsie, and is about five and a half miles northwest of Pawling,* near the parallel of 41° 38′.

In order to arrive at the true relations of the Poughquag quartzite, the position and age of the other rocks of the region must be considered.

1. *Taconic rocks.*—As has been stated (p. 184 of this volume) the Stockbridge limestone extends from Canaan, west of south, through Dover to Pawling. It continues beyond this latter place southward along the valley, for seven or eight miles, where both valley and limestone narrow out.†

In the region of Pawling the limestone dips to the eastward at a large angle, between 55° and 70°; and in the two and a half miles of breadth there must be a thickness of at least 3,000 feet, perhaps of 5,000 feet. Supposing that there are no folds—none were detected by us—the thickness would be much greater than this.

West of the Pawling limestone region to Poughkeepsie on the Hudson,—a distance of twenty-one miles, directly across the strikes—the rocks all the way, with some small local exceptions, dip *easterly* (to the south of east) the observations of Mr. Gardner and myself thus confirming those published in Professor Mather's New York Geological Report. This region of easterly dip continues eastward of Pawling to within three miles ‡ of New Milford (on the Housatonic), or twenty-seven miles from Poughkeepsie.

Leaving Pawling on the way to Poughquag, going northwestward, you pass from the Stockbridge limestone (of Pawling) to

* The distances given in this paper are air-line, not road-line, distances.

† I am not yet able to say which of the patches of limestone to the south of this apparent termination is a continuation of the Stockbridge limestone, or that any is so. The abrupt ending of the beds is undoubtedly due to the presence of the Azoic Highland ridges on the west and south, alluded to beyond. The areas about Williamsburg and along the Harlem railroad are probably continuations, not of the Stockbridge band, but of other bands of limestone lying farther to the east—those of Kent and New Milford (see Percival's map, in his Geological Report); which, by the way, according to sections made by Mr. Gardner and myself, in the line of New Milford, and to the north, are opposite sides of a synclinal, and which, with the superincumbent gneisses and schists, overlie the Stockbridge limestone, unless a great fault intervenes.

‡ The position of the synclinal axis referred to in the preceding note.

*mica schist*, part of it gneissoid; and this schist unquestionably *underlies conformably the limestone.* Along the plane of junction of the limestone and schist, both here and to the north, occur beds of limonite, which are a result of the alteration of iron-bearing minerals in the schist, as stated by Percival, the beds often retaining in some parts the structure of the schist.* The strike of the schist is N. 10°–40° E., and the dip about 50° to the eastward. It is a southern extension, as recognized by Percival, of the schist or slate of Taconic mountain. It has the same lithological characters as the rocks of Mt. Washington, the principal elevation of that range, which is situated in Massachusetts but on the borders of Connecticut, and spreads west into New York. The rock passes in some places into what has been called *talcoid schist*, or a smooth fine-grained mica schist, somewhat greasy in feel;† it is often chloritic, and in Salisbury and some parts of Mt. Washington, as Percival states, contains staurolite. Quartz seams and veins are common in many parts, and nests of chlorite occur occasionally in the quartz.‡

The same rock occurs also in Graylock, near Williamstown, Mass., which may be looked upon as a northern part of the range; and even a chloritic variety occurs in the Graylock region. It is not an irrelevant fact that the schist of Mt. Mansfield, Vermont, is a very similar mica schist to that of Graylock, and that on the highest point of this mountain I broke off a piece of chloritic mica schist not distinguishable lithologically from a specimen I collected from one of the ridges on the ascent of Graylock.

About a mile and a half southeast of Poughquag (and four from Pawling) the mica schist is left for a *light-gray fine-grained thick-bedded gneiss*, partly granitoid. The gneiss has essentially the same strike and dip as the overlying mica schist, the strike being N. 10°–35° E., and the dip mostly 50° to 60° to the

* Specimens collected by Mr. Charles A. Brinley at Richmond, Mass. show that the principal one of the minerals there altered to limonite is siderite (spathic iron or carbonate of iron). The limestone in some limonite localities is the *underlying* rock.

† The *talcose schists* of early writers on the Taconic rocks and other schistose strata, or *magnesian slates* of Emmons, are shown in the Vermont Geological Report (p. 425) to be mainly a very fine grained mica schist, in which the mica is more or less hydrous; and the term *talcoid schist* is used for it. Although looking and feeling like a talcose schist, it contains only a per cent or two of magnesia. Prof. T. Sterry Hunt has confirmed this conclusion in his study of both Vermont and Canada rocks.

‡ I have examined the rocks of Taconic Mountain myself only in Mt. Washington. Percival, in his Geological Report of Connecticut, describes the rock of "Taconic Mountain" as fine-grained micaceous or talco-micaceous schist, containing garnet and staurolite. He adds, "Sometimes it is greenish and sub-chloritic, with seams and patches of compact green chlorite, and yet accompanied with the same minerals [garnets and staurolites]. This is particularly the case in the south and northeast part of Taconic Mountain."

eastward. *This gneiss is, therefore, conformable to the schist, and an inferior bed of the Taconic series.*

2. *Poughquag and more western limestones.*—West of this gneiss, about Poughquag, there is a great limestone formation, which, judging from the width of the area and its dip, is as thick as that at Pawling. It has the same strike with that rock, or N. 30°–40° E., with the dip also about the same, or 40° to 60° to the southeastward. This range of limestone extends northward, and although interrupted for some distance, appears to be the same with that which Percival and Mather lay down as passing through eastern Washington, western Amenia, Boston Corners, by the east side of Winchell's Mountain (a ridge just southwest of Boston Corners), to Copake on the east side of Ancram Creek valley. It is distinct, according to Mather, from another limestone range in Copake, which lies on the *west* of Ancram Creek valley, and stretches south on the west of Winchell's Mountain to Pine Plains and Stissing, and thence, by Wappinger Creek valley, to Barnegat on the Hudson—a range of limestone called by Mather the *Barnegat* limestone. Mather speaks of another intermediate line, extending from Stamford, through Washington, and half a mile east of Verbank; and this line appears again at Arthursburg and Beekman, and continues down Fishkill Creek to Matteawan on the Hudson.*

Calling the Pawling (or Stockbridge) limestone No. I, the Poughquag and eastern Copake is No. II; the Arthursburg and Fishkill Creek, No. III; the western Copake, Pine Plains, Stissing and Barnegat (Barnegat limestone), No. IV.

In an excursion to Poughkeepsie, we passed No. III at Arthursburg, ten miles from Poughkeepsie, and No. IV, or the Barnegat limestone, at Manchester, three miles from Poughkeepsie. Barnegat is a place on the Hudson, about four miles below Poughkeepsie.

The limestones in Nos. III and IV may in many places be seen to be underlaid and overlaid by clay-slate, the prevailing rock of the region from the meridian of Poughquag to the Hudson River.† Whether the four ranges of limestone differ in age is not yet ascertained. Faults undoubtedly occur over the region, so that the uniform easterly dip is no proof that the western strata are the older. The folds in the slates sup-

* Mather has an obvious error in his statements about this band and the first of the bands here mentioned; for he makes the first to extend to Fishkill, and the one last mentioned to *cross* that and extend to Poughquag. The great bands of limestone are not continuous lines, owing probably to the irregular manner in which the rocks have been faulted and the subjacent slates uplifted; but the parts of each have a nearly common direction. The region requires a careful survey.

† With the slate there are extensive beds also of compact slate-rock or argillaceous sandstone.

posed to exist there by the Professors Rogers we found no certain proof of, but were rather disposed to believe in a series of faults and monoclinal uplifts.

The Poughquag limestone is bluish and less perfectly crystalline than the Pawling; and, both the limestones and the slates show a *continued diminution in the degree of metamorphic changes as you go farther west.* The Barnegat is very slightly crystalline, and evidently contains fossils, as has been reported, although none have yet been found that could be determined; and the slates pass from micaceous or talcoid schists to simply glistening slates, and in some places to earthy slates, which are almost shales.

The question is especially important here, whether the Poughquag limestone (No. II) is older than the Pawling (Stockbridge), or whether it is the same rock, separated from the Pawling by a fault along the eastern side of the Poughquag limestone, accompanied by an uplift carrying upward the mica schist and the subjacent gneiss. The existence of such a fault was strongly suspected both by Mr. Gardner and myself, on the ground of the nearly equal extent of the Poughquag and Pawling limestones; and it further seemed probable that this fault and the uplift were but a southern portion of a north and south series of similar faults and uplifts, which resulted in the making of Mt. Washington and the rest of the Taconic range; these elevations, like the elevated gneiss near Poughquag, stand along the *east* side of this supposed line of fault. Gneiss is only an occasional rock as far west as Poughquag, and wherever it occurs among the schists and clay-slate it appears to be evidence of a great uplift. The identity of the two limestones is also favored by the fact that limonite beds occur in Amenia between the limestone range No. II and the underlying schist, just as they do in Pawling between No. I and the underlying schist.

3. *Archæan rocks.*—Besides the limestones and Taconic schists and gneiss, there is, near Poughquag, in still more intimate connection with the quartzite, rocks of the Azoic age, a continuation of the Highland range of New Jersey—a range recognized as Azoic first by H. D. Rogers, and shown to continue into Dutchess county by Logan and Hall (this Journal, II, xxxix, 96). They are probably Laurentian, as stated by Logan and Hall, that is, they are equivalents of the oldest known Azoic rocks of Canada. But as this point is not definitely settled, and since the term Azoic has been ruled out by facts proving that the era was not throughout destitute of life, I propose to use for the Azoic era and its rocks the general term *Archæan* (or Arche'an), from the Greek *ἀρχαιος, pertaining to the beginning.**

* Whatever part of the Archæan beds are proved to belong to an era in which there was life, will be appropriately styled the *Archeozoic.* This term avoids the objection which Eozoic derives from the doubtful nature of the Eozoum.

These Archæan rocks of the Highland range are exposed to view in a deep cut on the unfinished Hartford & Fishkill Railroad, within a mile of Poughquag. The light-gray gneiss east of Poughquag, above referred to, lies to the north of the stage-road; while 300 or 400 yards to the south of it, and in sight from it, there is a high railroad embankment, leading westward into the cut. The Archæan rock is a coarsely crystallized gneiss, containing red orthoclase (feldspar), some white albite (or possibly oligoclase), and in places a little hornblende, with a few spots of magnetic iron. Some portions were a blackish gneiss. The strike is N. 40°–55° E.; the dip is nearly vertical, but varies from 65° to the southeastward, to 80° to the northwestward, while mostly 70° to 80° to the southeastward. This gneiss was thus wholly unconformable to that before described, and also widely different in its lithological characters. Some layers of it at Brewster, fifteen miles to the east of south, on the Harlem railroad, contain zircons and are really a zircon syenite; but they alternate with others that are simply gneiss. A bed of magnetic iron ore is worked in the vicinity of Brewster.

It should be here stated that the lithological distinction of this Laurentian area in Dutchess county was first noticed by Percival, who defines it on his map, and numbers it K 3. The locality above described is situated at the very extremity of his area K 3.

4. *Quartzite formation.*—The quartzite constitutes a northeast and southwest ridge on the west side of the Archæan range, the two being parts of the same elevated region. The height of the ridge is by estimate two or three hundred feet above the Poughquag plain. The railroad track, after leaving the Archæan cut, enters a deep cut through the quartzite. The latter rock appears to rest in nearly horizontal layers on the flanks of the Archæan or Laurentian ridge. The contact of the two is not in sight; but only sixty to seventy yards intervene between their nearest outcrops, and the small valley along the junction is just such as usually occurs when two meeting rocks are of unequal hardness.

The quartzite is in general evenly bedded. While there are hard compact layers, many are very thin and friable, looking sometimes as if argillaceous, though really consisting of fine quartz sand. This finer kind is often a little silvery, with micaceous or talcoid scales, and sometimes contains traces of chlorite. The stratification varies but little from horizontality, and the variations are in large undulations toward different points of the compass, the dip being mostly but 5° or 10°, though sometimes 15°. There is hence *no conformability to the Archæan gneiss, and none to the gneiss, mica schist, or limestone, of the*

*Taconic series.* The nearly horizontal beds of quartzite lie on the nearly vertical Archæan, and both occur within a few hundred yards of the steeply inclined Taconic beds. The rocks are sparingly faulted; but in some narrow vertical sections this faulting has been carried so far as to obliterate the stratification; a case of this kind is represented in the figure on page 182.

5. *Relation of the Quartzite to the Poughquag limestone adjoining it.*—At the west end of the cut we open upon the plain of Poughquag, and come immediately to the Poughquag limestone (No. II). There is no section exhibiting the quartzite and limestone together; yet it is obvious that the quartz is the inferior rock, and that the two are unconformable.. Outcrops of the two occur within 200 yards of one another and on the same level; and while the quartzite is nearly horizontal in these outcrops as elsewhere, the limestone in the nearest exposure has a strike of N. 45° to 50° E., with a dip to the northwest of 40° to 45°; showing not only unconformability to the quartzite, but also a wide divergence from its ordinary dip in the region, which is 40° to 50° to the eastward.

The Poughquag limestone continues westward for two miles, and becomes to the west interstratified with the glistening clay-slate of the region, the rock which is the prevalent one all the way to the Hudson, fifteen miles. In this clay-slate, there are intercalations of limestone, as has been already stated, but *none of quartzite.*

6. *Conclusions.*—The conclusions that appear to be sustained by the observations are:

1. That the quartzite is older than the Poughquag limestone, and was consolidated and jointed before the deposition of the latter.

2. That the quartzite is older than the rocks of the Taconic beds that outcrop between Poughquag and Pawling, and unconformable to them. For (1) the two are widely diverse in position; (2) beds of quartzite are nowhere found intercalated among the Taconic beds, or overlying them; and (3) the Taconic beds are not found underlying the quartzite between it and the Archæan rocks, but each is wholly independent in all respects of the other, although in so close proximity.

3. That the Archæan or Highland ridges of Dutchess and Putnam Counties, N. Y., were Green Mountain heights standing in the sea in which the sands of the quartzite were accumulated; for (1) the beds of quartzite rest unconformably on the Archæan rocks, and (2) their sands were evidently sea shore or sand-flat depositions. [The heights were probably the southern extremity of a range of Archæan ridges, now lying underneath the Green Mountain formations, the origin of which was the

initial step in the making of these mountains, and the position of which modified the action of the causes depositing later beds, and also, by their unyielding nature or resistance, the action of forces uplifting them.]

4. That, *either* the quartzite was a ledge within or along the shores of the sea in which the limestone was deposited, the two being unconformable and no intermediate beds being present; *or else* there is a fault between the quartzite and limestone, along which the Archæan rocks (overlaid by the quartzite) were brought up to their present position so as to be on a level with the limestone beds.

The latter view is favored by the fact that the line of this supposed fault nearly accords with that to the north between the limestone and Taconic gneiss. The former view is supported by the facts that (1) the Taconic slates, schist or gneiss, which ought to have been carried up on top of the Archæan rocks and quartzite, in case of such a fault or uplift on its east side, nowhere exist in the vicinity of Poughquag, and are not known to the south, along the Highland range. It is in its favor (2) that the irregular or westward dip of the limestone where it borders on the quartzite, although a possible result along a fault, is such as might naturally have arisen from pressure during a period of uplift against a resisting ridge like that of the Archæan; and (3) that a similar contact of limestone and quartzite exists in the Canaan region (p. 183 of this volume) which cannot be due to faulting, since the knolls and ledges of quartzite stand isolated in the limestone area, so that faults adequate to produce their present position, cutting around the irregular areas, are not supposable. The facts which I propose to communicate in a continuation of this paper may throw some light on this doubtful point.

5. That the clay-slates which directly underlie the Poughquag limestone on the west, having a thickness of at least 10,000 feet, probably represent the mica schists west of the Pawling (Stockbridge) limestone, and therefore have the same relation to the limestone and the quartzite.

It is a remarkable fact that in this Poughquag region no beds intervene between the Archæan and the quartzite, although some pre-Silurian strata might reasonably be looked for, and none between the quartzite and the limestone, although so great a thickness of strata really exists in the vicinity inferior to the limestone.

ART. XXXII.—*Descriptions of two new star-fishes, and a Crinoid, from the Cincinnati group of Ohio and Indiana;* by F. B. MEEK.*

## PALÆASTER? DYERI Meek.

AMONG the specimens loaned to me for study and description by Mr. Dyer, there is a very imperfect example of one of the largest known Silurian star-fishes. When entire, it must have been from five to five and a half inches in diameter across from end to end of the rays of opposite sides; while its disc, as seen in a flattened condition, measures about two inches in diameter. As near as can be determined from the published description of *Palæaster granulosa* of Hall (which has not yet been figured), this very large specimen would seem to be related to that species, and may possibly be the same. Still, from its much larger size (*P. granulosa* being described as "of medium size"), as well as from the want of exact conformity of some of its details of structure, I am led to believe it distinct. The specimen, however, is unfortunately much obscured by the adhering matrix, and detached and confusedly mingled spines. Like *P. granulosa*, it has the dorsal side composed of numerous small pieces, bearing very small short spines.† These pieces, however, are not, as described in that species, "tuberculose," but merely convex, while the dorsal pores passing through the sutures between them, are apparently so large that the pieces only seem to connect with each other by a few salient points, so as to form a kind of reticulated structure; a feature not mentioned in *P. granulosa*.

Again, while agreeing with that species in having its marginal and adambulacral piece convex, small, tuberculose or coarsely granular, as wide as long, and alternately arranged, it apparently presents the important difference of having very nearly the same number of pieces in each of these ranges, instead of nearly twice as many in the inner as in the outer range. It likewise shows indications of a few disc plates intercalated, on the ventral side, between the marginal range and the inner adambulacral pieces in the only axillary space of that side exposed; which character, if it really exists, would separate it perhaps generically from *P. granulosa*. A comparison of better specimens would probably also show other differences.

Each piece, on the ventral side, shows a small central pit for

* Figures and descriptions of these fossils are to appear in the Ohio Geological Report.

† The spines are articulated, and not merely projecting points of the dorsal pieces themselves.

the articulation of a spine, measuring from 0·16 to 0·23 inch in length, and about 0·04 inch in thickness, and consequently, distinctly larger than those of the dorsal side. On the dorsal side, the so-called madreporiform body can be seen near the margin of the disc, in one of the axils between two of the ranges. It is nearly flat, of a transversely suboval or subtrilobate form, the lobed side being directed inward; while the little divisions are seen radiating and bifurcating inward on the middle lobe, and laterally on the lateral ones, like the nerves of the pinules in some kinds of ferns.

From some of the characters imperfectly seen in the species, it is possible that better specimens may show it to belong to the genus *Petraster*, and render it necessary to write its name *Petraster Dyeri*. The structure of the dorsal side of *Petraster* is, I believe, not certainly known. In the published species of *Palæaster*, the dorsal pieces are illustrated as if close-fitting, or at least without very obvious pores passing between the pieces. Indeed, it was originally supposed that the dorsal pores passed *through these pieces*, instead of through the sutures between them, and this was mentioned in the generic description as one of its most important characters. I have no typical examples of that genus at hand, showing the dorsal side; but as no such characters are shown in the figures of any of the published species, or alluded to in connection with the genus, in later publications, we may perhaps infer that it would not now be insisted upon as an essential character of the genus.

*Locality and position.*—Cincinnati group of the lower Silurian; from the horizon of about one hundred feet below the tops of the hills at Cincinnati, Ohio; where it was discovered by Mr. C. B. Dyer, to whom I have dedicated the species.

### Stenaster grandis Meek.

Attaining a very large size, with the body or disc comparatively small, or only of the breadth of the united inner ends of the five rays. Rays long, slender, gradually tapering, and very flexible, widest at their immediate connection with the body, where they seem to be more or less depressed, but becoming more nearly terete farther out. Dorsal side of body and arms composed of numerous subtrigonal pieces that rise into pointed tubercles, or sometimes assume almost the character of short spinules, and are arranged in quincunx, so as to form about eight rows near the middle of the rays; those of the outer two rows being a little larger than the others. Dorsal pores apparently rather large, and passing through between the concave sides of contiguous pieces. Ventral side of body unknown. That of the rays composed of the usual single row of transverse adambulacral pieces on each side of the well defined, rather deep, and moderately wide ambulacral furrows. Adambulacral pieces rather more than twice as long as wide, with their longer diameters at right angles to the ambulacral furrows, and rounding over from end to end so as to be most prominent in the middle; while they do not connect with each other by flat sides, but have little projecting processes, and corresponding sinuses, apparently for the purpose of imparting greater flexibility to the rays.

Breadth of body, 0·63 inch; length of rays, 2·40 inches; breadth of same at their connections with the body, 0·36 inch. Diameter across from the tips of rays on opposite sides, about 5·50 inches.

Not having seen the under side of the body of this species, I am not quite sure that it is exactly congeneric with Mr. Billing's typical species of *Stenaster*. It does not show the peculiar contraction of the inner ends of the rays, seen in his *S. Salteri*, from which it also differs in a marked degree in the much greater length and slenderness of its rays. In these characters, however, it agrees more nearly with his *S. pulchellus* and *S. Huxleyi*; though it differs from the first specifically, in having proportionally larger rays, with more numerous dorsal pieces, and in attaining a much larger size. I had suspected that it might possibly be the *S. Huxleyi*, but on comparing drawings, and the foregoing description, sent to him for that purpose, with his typical specimen of *S. Huxleyi*, Mr. Billings writes that he has no doubt whatever that it is entirely distinct.

The specimen shows a few short spines connected with the adambulacral pieces; but neither their exact mode of attachment, nor their arrangement, can be very clearly made out. They seem, however, to connect with these pieces along their joining edges, instead of springing from their crests.

Adopting the suggestion already made by another, that the name *Stenaster* for this group should be replaced by McCoy's name, *Urastrella*, previously suggested, incidentally, for apparently congeneric forms, the name of the species here described would become *Urastrella grandis*.

*Locality and position.*—Upper part of the Cincinnati group at Richmond, Indiana. I am under obligations to Mrs. M. P. Haines of Richmond, for the use of the only specimen I have seen of this species, which was discovered by her at that place, some time back. It may not be out of place to state here, that this lady has by her own zeal and industry, stimulated by a taste for scientific studies, succeeded in getting together one of the finest and most valuable private collections of minerals and fossils in the West.

### Glyptocrinus Baeri Meek.

Body of about medium size, globose-obconoidal. Sub-basal pieces apparently not developed, or very small.* Basal pieces short and pentagonal. First primary radials of comparatively moderate size, presenting a general pentagonal outline; second a little narrower than the first, but of nearly the same length, with a general heptagonal outline; third a little narrower than the first, but of nearly the same length, with a general pentagonal form. Secondary radials, consisting of about four pieces in succession, on each upper sloping side of each third primary radial; the first two or three of each series only about one-third smaller than the second primary radials, while above these the succeeding pieces soon become much shorter free brachials. Interradial pieces numerous, small, of very unequal size, and without any regularity of arrangement. Anal series unknown, but probably consisting of a mesial series of hexagonal pieces resting one upon another, and a greater number of much smaller pieces irregularly arranged on each side. Axillary spaces each occupied by some six or more very small pieces.

Arms ten, rather long, simple, widest a little above their bases, and thence gradually tapering to their ends; composed of very short pieces, so strongly cuneiform as to appear almost to taper to nothing alternately on opposite sides, while each supports a pinnule at its thicker end, along the inner margins. Pinnules very long, moderately short, nearly in contact, and composed of pieces three to four times as long as wide. Surface of body plates without costæ or striæ; those of the primary and secondary radial series more prominent than the much smaller pieces filling the interradial spaces, and thus forming somewhat flattened ridges, more or less interrupted at the sutures, and abruptly beveled at the sides; interradial and axillary areas roughened by a minute projecting central point on each of the little pieces filling them.

Column of moderate thickness, apparently nearly round, or perhaps sub-pentagonal near the base, and composed of alternately thicker and thinner pieces, the former of which project a little beyond the others.

The body of the only specimens of this species I have seen, are too much distorted by pressure to afford accurate measurements, but it seems to have been about 0·45 inch in height, by

* I prefer to designate the minute pieces sometimes seen at the connection of the body and column, in species of this and some other Silurian types, as sub-basal pieces, rather than as true basals, not only because they are sometimes absent in species of the same genera, but because precisely similar pieces are sometimes intercalated between the segments of the column, in the types in which they occur, for some distance below the body, thus indicating that they belong to the column.

a little less in breadth; while its arms measure 0·07 inch in breadth at the widest part, a little above the top of the body, where about eight arm pieces may be counted in a length of the same extent.

This species will be readily distinguished from all of the described forms of the genus, resembling it in other respects, by having only ten simple arms, and by the large number and small size of its interradial pieces. In the latter character it resembles *G. Nealli*, of Hall, from which, however, it differs materially in almost every other respect, but more particularly in having only ten instead of twenty arms, which are also stouter. Its interradial and axillary spaces likewise differ materially in not being distinctly excavated, and in having each of the little pieces by which they are filled provided with a little projecting point.

The specific name is given in honor of Dr. O. P. Baer, of Richmond, Indiana, to whom I am indebted for the use of the specimens from which the description has been prepared.

*Locality and position.*—Upper part of the Cincinnati group of the Lower Silurian, at Richmond, Indiana.

NOTE ON THE GENUS LICHENOCRINUS.

Since the publication of the note on the genus *Lichenocrinus*, issued in the January number of this Journal, Mr. Dyer, at my request, sent on a specimen of this type which I had seen in his collection last summer, that shows the disc separated from the matrix in such a manner as to expose both the upper and the lower sides. In this one alone, of all the numerous specimens that have been found, there is on the flat or under side, a small central opening, that I have supposed to be due to some accident, and radiating from this, are seen numerous regular fine raised lines, with little linear furrows of the same breadth between them. In looking at this specimen alone, without any knowledge of others, one could scarcely entertain a doubt that this opening, situated so exactly at the center of radiation, must be the mouth, and the minute radiating furrows the ambulacral canals. A careful examination under a magnifier, however, shows that the little raised lines between the furrows *bifurcate* regularly several times, so that the little furrows, in part, do not reach the central opening, but end abruptly at the points of bifurcation. Again, as has already been several times stated, specimens that grew attached to the surface of some smooth body, have been separated from the same, so as to show the under surface of the basal layer, or platform, as it may be called, of the disc; and here we find it without any opening whatever, or traces of radiating striæ, on the under surface. But when moistened, and examined under a magnifier, these regular radiating striæ can be seen through its thin translucent substance within. In numerous other instances where these basal platforms can be seen still firmly attached to their original station, with the plates of the upper side and the internal lamellæ wholly, or in part removed, the inner, or upper side of this platform can be clearly seen to be without a trace of a central or other opening, and marked by numerous slender radiating lines corresponding to the lamellæ of the interior. A portion of these striæ can be distinctly traced to the central point, where, instead of an opening, there is often even a minute elevation. It is also worthy of note, that here, on the inner surfaces of these basal layers, the little raised radiating lines, like the lamellæ within the disc, do not increase by *bifurcation*, but by the *intexcalition* of shorter ones between the longer; so that if we were to place the specimen mentioned above, showing the central opening and striæ of its under side, on one of these basal platforms, the elevated striæ of its under side would conform to the little furrows of the platform in such a manner that these little furrows would all be closed.

If it were not for this fact, and the absence of any indications, so far as yet known, of any minute openings around the base of the periphery of the disc, at their connection with the bodies upon which they grew, I should be half inclined to suspect that there might be a double basal layer sometimes capable of accidental separation, with a central opening to an internal mouth through the upper one, and numerous minute ambulacral canals passing to this opening *between the two layers.* The bifurcating striæ on the flat under side of this specimen showing the opening, can hardly be, as I at one time supposed, the edges of the internal lamellæ exposed by weathering, because their bifurcating character would seem to show that they do not coincide with the lamellæ within, but with the *interstices between them*; while there are no open slits between these striæ, as we would expect if they were the edges of lamellæ, but mere furrows.

As I have already remarked, if these discs are really *bodies*, they must belong to a form constituting the type of a strongly marked family of the *Cystoidea*, if not typical of a more important section.

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## ART. XXXIII.—*Note on Recurrent Vision;* by Prof. C. A. YOUNG, of Dartmouth College.

IN the course of some experiments with a new double plate Holtz machine, belonging to the college, I have come upon a very curious phenomenon, which I do not remember ever to have seen noticed. The machine gives easily intense Leyden jar sparks from seven to nine inches in length, and of most dazzling brilliance. When, in a darkened room, the eye is screened from the direct light of the spark, the illumination produced is sufficient to render everything in the apartment perfectly visible; and what is remarkable, every conspicuous object is seen *twice* at least, with an interval of a trifle less than one-quarter of a second—the first time vividly, the second time faintly; often it is seen a third, and sometimes, but only with great difficulty, even a fourth time. The appearance is precisely as if the object had been suddenly illuminated by a light at first bright, but rapidly fading to extinction, and as if, while the illumination lasted, the observer were winking as fast as possible.

I see it best by setting up in front of the machine, at a distance of eight or ten feet, a white screen having upon it a black cross, with arms about three feet long and one foot wide, made of strips of cambric. That the phenomenon is really subjective, and not due to a succession of sparks, is easily shown by swinging the screen from side to side. The black cross, at all the periods of visibility, occupies the same place, and is apparently stationary. The same is true of a stroboscopic disc in rapid revolution: it is seen several times by each spark, but each time in the same position. There is no apparent multiplication of a moving object of any sort.

The interval between the successive instants of visibility was measured roughly as follows: A tuning fork, making 92½ vibrations per second, was adjusted, so as to record its motion upon the smoked surface of a revolving cylinder, and an electro-magnet was so arranged as to record any motion of its armature upon the trace of the fork: a key connected with this magnet was in the hands of the observer. An assistant turned the machine slowly, so as to produce a spark once in two or three seconds, while the observer manipulated the key.

In my own case the mean of a dozen experiments gave $0^s{\cdot}22$ as the interval between the first and second seeing of the cross upon the screen; separate results varying from $0^s{\cdot}17$ to $0^s{\cdot}30$. Another observer found $0^s{\cdot}24$ as the result of a similar series.

Whatever the true explanation may turn out to be, the phenomenon at least suggests the idea of a *reflection of the nervous impulse* at the nerve extremities,—as if the intense impression upon the retina, after being the first time propagated to the brain, were there reflected, returned to the retina, and from the retina traveling again to the brain renewed the sensation. I have ventured to call the phenomenon "Recurrent vision."

It may be seen, with some difficulty, by the help of an induction coil and Leyden jar; or even by simply charging a Leyden jar with an old fashioned electrical machine, and discharging it in a darkened room. The spark must be, at least, an inch in length.

Hanover, Feb. 9, 1872.

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ART. XXXIV.—*Observations on the Total Eclipse of the Sun of 1869*; by CLEVELAND ABBE, Director of the Cincinnati Observatory, Assistant in the Office of the Chief Signal Officer, Washington.

AMONG the parties organized to observe the total eclipse of 1869, Aug. 7th, that sent from the Cincinnati Observatory was probably favored above all others in the advantages of having a comparatively elevated station and exquisite atmosphere. The publication of the work done by this party has been delayed by the fact that, for a year subsequent to the eclipse, I was wholly absorbed in the labor attending the maintenance of the "Weather Bulletin of the Cincinnati Observatory," and my subsequent occupations in the present office have entirely prevented me thus far from even attempting the reduction of our observations; the original note books are at present packed away with the library of the observatory, awaiting the removal and rebuilding of that institution.

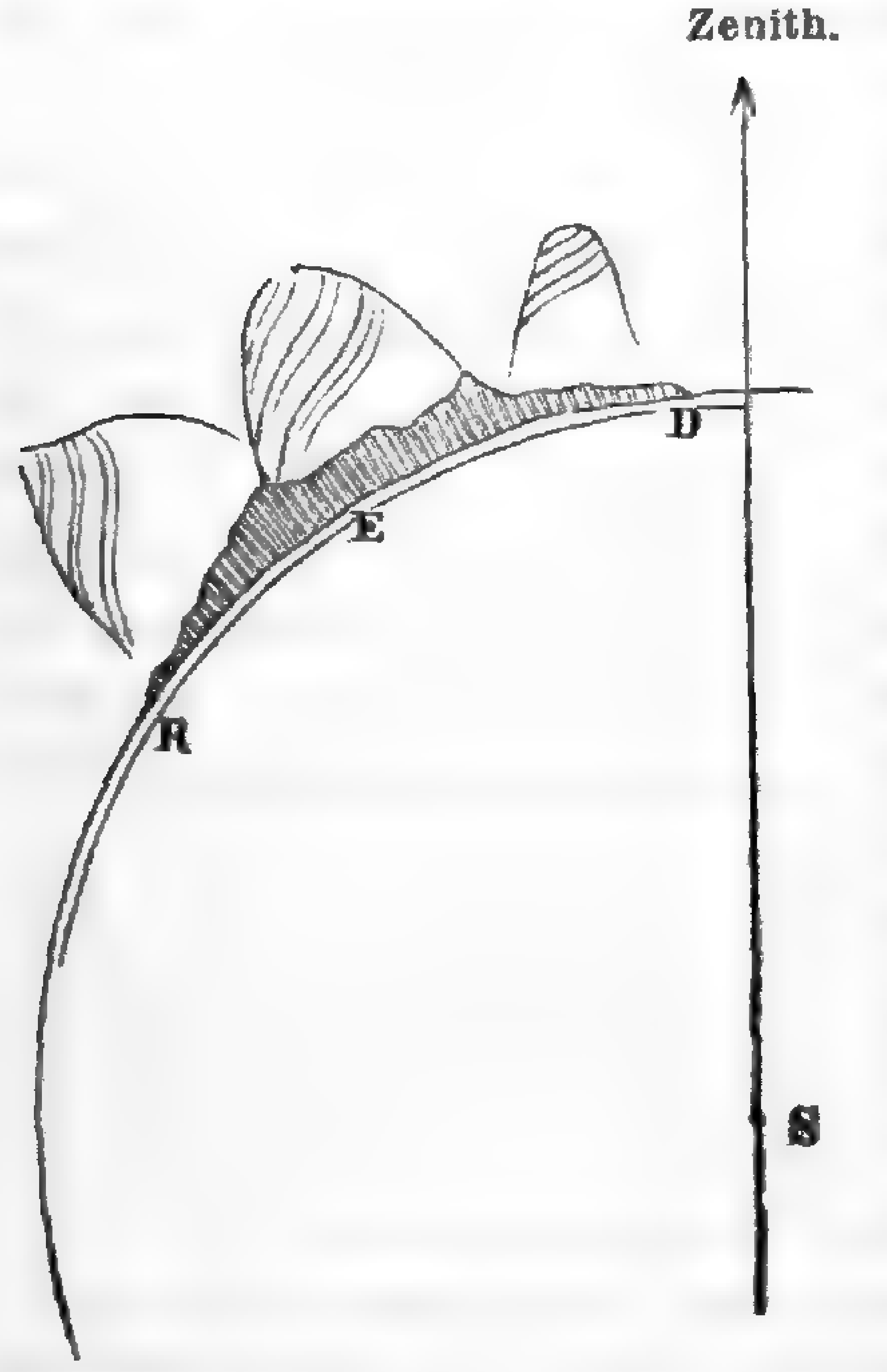
My own attention was expressly given to the structure of the corona and coronal streamers, for which I used the full aperture of an exquisite six-inch objective (one that had received a prize at the Paris Exposition Universelle), and which was loaned to the eclipse expedition by Mr. T. G. Taylor of Philadelphia. A short notice of the principal features noted by myself was sent at once to the editor of the Astronomische Nachrichten, but has not yet been published, and I therefore take the liberty of restating, through your Journal, the simple phenomena that I then saw.

Our station was at Sioux Falls City (formerly Ft. Dakotah), in the southeastern corner of Dakotah Territory, latitude 44°, longitude 97°, elevation about 1,500 feet above sea level, in the midst of an extended plateau.

Rain and cloud had continued up to a few hours previous to the critical moment, but the atmosphere during the eclipse was of surpassing steadiness and clearness. The altitude of the sun at the time of totality was about 40°, the local time 3½ P. M., the duration of totality four minutes. No sooner had totality begun than after sketching in most of the prominences as points of reference, I viewed the corona without darkening glasses, and with a magnifying power of probably 120 diameters.

The whole interval of totality was unfortunately not at my disposal, owing partly to the very rough and faulty stand supporting the telescope (everything had to be transported an hundred miles by mules into a wilderness), and partly to an interruption by one of the members of the party; but there seemed to me to be no doubt of the facts as recorded, nor was I conscious of the least undue emotion that might have interfered with my reliability as a witness, although it was the first total eclipse I have ever had the pleasure of observing.

As seen through my inverting telescope, the structure of the largest protuberance on the right hand lower limb was well made out. The neighborhood of the sun was examined to a distance of its own diameter (a radius of possibly one degree from the sun's center), but no trace of the coronal rays as they were seen by others of my party. The evidence as to the existence, shape and positions of these streamers as given by my six assistants, was conclusive as to their actual appearance, with the usual variations as to details. That they were not detected by the six-inch glass was probably due to their diffused light and the small field of view. On the apparent upper and right hand limb of the sun, the six-inch glass showed the long series of red prominences depicted in the photographs published by the Naval Observatory; above the greater portion of the arc of the sun's limb thus covered, and extending somewhat further to the right, appeared to rise up three, and possibly more, conical masses of pearly light. These were distinctly contrasted against the light diffused as the background of the field of view, and there was every evidence that they had an identical structure and cause. The outline of each of the pearly mountains was that of a rounded cone, as shown in the drawing, exactly resembling the kilns used in some branches of pottery, and other manufactures. The apices of the cones were blunted or truncated, and not well defined; the outlines of the sides of the cones were quite sharp down to within a few minutes of the sun's limb, when all three appeared to begin to lose their distinctive characteristics.




The height of the apices above the limb varied between one half and two thirds of the solar radius: the diameters of the bases of the cones was probably included between seven and three minutes. Each apex was of a slightly dusky shade compared with the body of the cone.

The most interesting feature was an unmistakable striation upon the surface of each cone, the striæ apparently twisting spirally around up to the apex opposite to the movement of the hands of a watch as represented on the accompanying drawing.

I noticed no colorations of these striæ other than their darker hue. The details of this striking and new phenomenon interested me so much that I naturally enough lost the observation of the third contact. The pearly cones were on that limb of the sun from which the moon was moving, and the details were every moment becoming more distinct, when the growing height of the bank of red protuberances was followed by the too speedy apparition of the glowing sun beneath.

Chagrin at the loss or imperfect observation of the third contact, caused me to forget to note whether the three cones continued in view for any number of seconds thereafter. From the time of first recognizing the pearly cones until their disappearance probably thirty seconds elapsed (I am writing without my note book or other aid to memory), and I did not note any change in the appearance of the striæ. The middle one of the cones caught my eye more particularly, and the impression was that the other two, especially that on the right, was some distance behind it, or possibly obscured by a cloud of haze in the solar atmosphere.

At the time it seemed to me that I saw in the central cone a column of smoke and hot gas ascending high above the area of red flame, then visible on the surface of the sun, and that the other two cones corresponded to other areas of red flame far behind. The difference in character and position between these cones and the coronal streamers, as observed by the others with the naked eye, and with opera glasses, seemed to argue that the latter were very probably individual and subjective phenomena or that they originated in the earth's atmosphere, while the pearly cones existed in the solar atmosphere and constituted a true solar corona.

My long delay in making this communication to the scientific world will be excused, I trust, in view of the imperative demands made upon my time during the two years that have elapsed since the eclipse of 1869. I shall be deeply interested to learn whether the phenomena seen by myself may not be repeated on some other occasion and be studied by more experienced observers.

I may add that I had hastily provided myself with a Nicol's prism, in hopes to make at least some trial of the nature of the coronal light; but the rude apparatus did not work satisfactorily, and I confined myself to details of structure; indeed in my earnest gaze upon the novel phenomena I quite forgot the polarizing apparatus.

Washington, D. C., Feb. 6th, 1872.

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ART. XXXV.—*Acoustical experiments, showing that the translation of a vibrating body causes it to give a wave-length differing from that produced by the same vibrating body when stationary;* by ALFRED M. MAYER, Ph. D., Professor of Physics in the Stevens Institute of Technology, Hoboken, N. J.

### THE APPARATUS.

FOUR tuning-forks mounted on resonant cases and giving the note $UT^3$, =256 complete vibrations per second, were obtained. I will designate them as Nos. 1, 2, 3, and 4.

Nos. 1 and 2 were brought into perfect unison by a process to be described.

No. 1 was placed before a lantern, and just touching one of its prongs was a small ball (5 or $6^{mm}$ diam.) of good cork, suspended by a silk fiber. The images of the fork and of the cork-ball were projected on a screen.

No. 3 had one prong weighted with wax, so that it gave two beats a second with No. 1 or 2.

No. 4 had the ends of its prongs filed off, until it also gave two beats per second with 1 or 2; thus No. 4 gave two vibrations a second more than No. 1, while fork No. 3 gave two vibrations a second less than No. 1.

### THE EXPERIMENTS.

In the experiments, one to seven inclusive, fork No. 1 remains before the lantern, with the suspended cork-ball just touching one of its prongs.

*Exp.* 1. Fork No. 2, screwed on its case, was held in the hand, at a distance of 30 to 60 feet from No. 1, and sounded; the ball was projected from the prong of fork 1, which vibrated in unison with 2.

*Exp.* 2. I stationed myself 30 feet distant from fork No. 1, and fork No. 2 was screwed off its case and vibrated in one hand, while the case was held in the other. I now walked rapidly toward fork 1, and after I was in regular motion, I placed the fork on its case, and just before I ceased walking I took it off; although, when I did so, I was only about a foot from fork 1, yet the cork-ball remained at rest against its prong.

*Exp.* 3. Again I walked toward 1 as in Exp. 2, *but* I did not remove the fork from its case after it was placed on it. The ball remained at rest until the moment I suddenly stopped walking; at that instant, the ball flew from the fork, while an assistant, whose ear was close to the case of fork 1, while his eye was directed to the screen, found that at the instant I stopped walking, the fork 1 sounded, while the ball jumped from its prong.

*Exps.* 4 and 5. These experiments were exactly like Exps. 2 and 3, except that I walked away from fork 1 instead of approaching it. The results were the same as in Exps. 2 and 3.

*Exp.* 6. Fork No. 3, giving 254 vibrations per second, was sounded as in Exp. 1. It had no effect in moving the ball. I now screwed the fork off its case, and standing about 30 feet from fork 1, with my arm, I swung the case toward fork 1, and while it was approaching it, I placed fork No. 3 on the case; the proper velocity (from eight to nine feet per second) having been obtained, the ball was suddenly projected from fork 1. On greatly increasing or decreasing the above velocity of the moving case, the vibrations of fork 3 produced no effect on fork 1.

*Exp.* 7. Fork No. 4, which gives two vibrations per second more than No. 1, was substituted in Exp. 6, *but* was placed on its swinging case, when this was *receding* from fork 1. The effect of this motion and of varying velocities was the same as in Exp. 6.

*Exp.* 8. I placed fork 3 before the lantern, and swung fork 1 as in Exp. 7. The effects were the same as described in Exp. 7.

*Exp.* 9. I now placed fork 4 before the lantern, and moved fork 1 as in Exp. 6. The effect on the ball was the same as in Exp. 6.

By these simple experiments I have shown the change of wave-length produced by the translation of the vibrating body, and have given an experimental proof of the important theorem which Doppler established in 1841. By analogy they clearly unfold that exquisite modern method of determining the motions of a heavenly body by variations in the refrangibility of the rays which it emits—motions often impossible even to detect by any other means. I, therefore, deem it proper that I should proceed to state the delicate conditions on which depend the perfection of experiment, which so satisfactorily elucidate the nature of those grand and refined problems offered to spectral observation.

It is, first of all, essential that forks 1 and 2 should really be in unison. Two forks, sounded together, may give no perceptible beats, for they may constrain each other into a common forced oscillation, and thus both will give the same number of vibrations, yet may be removed from equality when separately vibrated. The process I have adopted is as follows:

Three forks are taken which are supposed to give the same number of vibrations in a given time. They are supported on india rubber tubing, and are thus insulated. One of the forks is now loaded so that it gives two or three beats in a second, with one of the other two that are to be brought into exact unison. The interval of time occupied by 20 or 30 of these beats, is accurately determined by means of a chronograph (one of Casella's registering stop-watches does very well). The interval occupied by the same number of beats given with the second fork, is now ascertained, and if it differs from that given by the first, the quicker vibrating fork is made to give the same number of beats as the slower by loading it with wax. When the forks have thus been carefully adjusted, I have had no difficulty in projecting the ball, in Exp. 1, at a distance of 60 feet, and I believe that it could have been accomplished at a distance of 100 feet. The ball of cork should be *spherical*, so that it will always just touch the fork, no matter how much it may rotate around its suspending thread; which latter should consist of only one or two fibers of unspun silk. The cork is rendered as smooth as possible and is then *varnished:* this is important, for the varnish gives a firm coating to the ball, without sensibly increasing its weight, and is especially useful in covering the minute asperities or elastic projections on its surface, which otherwise would act as "buffers" to the impacts of the fork and deaden its projectile effects.

The above stated conditions having been obtained, no physicist will have any difficulty in repeating these experiments.

A machine has been devised by which a uniform motion of translation can be given to the forks, and with this I propose making a quantitative investigation of the phenomena, using an apparatus essentially the same in its action as the one here described.

We may substitute for the suspended cork-ball a light plane mirror, held between two stretched vertical fibers, while one of its edges touches the fork. The motions of a beam of light reflected from the mirror to a screen, indicate most beautifully the vibrations of the fork. This ingenious and most delicate device for detecting vibrations, is due to Prof. O. N. Rood, of Columbia College, N. Y., who first used it in a public lecture, delivered in New York, on the 28th of last December. We have, however, in our special work, found the image of the projected ball more convenient, and sufficiently delicate, for our experiments.

### *Quantitative relations in the experiments and analogical facts in the phenomena of light.*

The $UT_3$, No. 1 fork, makes 256 complete vibrations in one second, while fork No. 3 makes 254, giving for the respective wave-lengths of these vibrations 4·367 and 4·401 feet, which we will designate in order as $\lambda$ and $\lambda'$ We will take 1118 feet per second as the velocity of sound at 60° Fahr.

Now 256 vibrations in 1118 feet make $\lambda$=4·367 feet.
and 254 " " 1118$-2\lambda$ (=1109·266) give $\lambda$=4·367 feet.

As the velocity of propagation of the vibrations and $\lambda$ are the same in both cases, it follows that $\left(n=\frac{V}{\lambda}\right)$, the number of vibrations in a second, reaching a distant point, is the same, and, therefore, 256 vibrations from a body at rest will produce the same effect on a distant surface, as 254 vibrations emanating from a body which moves toward that surface, with a velocity of $2\lambda$, or of 8·734 feet per second; and this is the velocity we gave the fork in Exps. 6 to 9.

We will now examine the analogical phenomena in the case of light. Let fork No. 1, giving 256 vibrations a second, stand for 595 millions of millions vibrations a second, which we will take as the number of vibrations made by the ray $D_1$ of the spectrum. Then fork No. 3 will represent 590 millions of millions vibrations per second; which give a wave-length ·0000042 millimeter longer than that of $D_1$; and nearly corresponds with an iron line situate ·42 div. below $D_1$ on Angström's chart. We saw that fork No. 3, giving 254 vibrations a second, had to move toward the ear with a velocity of 8·734 feet, to give the note produced by 256 vibrations per second, emanating from a fixed point; so a star sending forth the ray which vibrates 590 millions of millions a second, will have to move toward the eye with a velocity of 28470 miles per second to give the color produced when ray $D_1$ emanates from a stationary flame.

February 8th, 1872.

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ART. XXXVI.—*Note on a Question of Priority;* by E. BILLINGS, Paleontologist of the Geological Survey of Canada.

IN the Canadian Naturalist, published on the 29th of Dec., 1871, I proposed two new genera of Brachiopoda, *Monomerella* and *Obolellina*, both belonging to that group which includes *Trimerella*, so abundant in the Guelph limestone of Canada. *Obolellina* is intended to include at least one of the forms described by me under the name of *Obolus Canadensis*, in the report of our survey published in 1858.* A second species is

* The form here alluded to is fig. 20, p. 189, of the report. It shows the interior of a dorsal valve imperfectly. This may not be *O. Canadensis*; but at present I think it is. Should it be otherwise, it does not affect the question. The fossil will only require another specific name.

*O. Galtensis*, an imperfect cast of a dorsal valve of which was figured in my Pal. Foss., p. 108, in 1862. Neither of these species, so far as I know, has ever been found in New York.

About three weeks after my paper was published, I received information from Thos. Davidson, Esq., of Brighton, England, the eminent Brachiopodist, that Prof. Hall had descibed *Obolellina*, under the name of *Rhynobolus*, in a pamphlet of five pages, purporting to have been published in March, 1871. As no copy of this paper had been received at our survey, I immediately caused extensive enquiries to be made in the United States, among those who would have been the first to have procured it, had it been regularly published. I have heard from a number of geologists, professors in colleges, and scientific institutions, including five geological surveys, besides that of Canada. With a single exception, no one had received the pamphlet. Several expressed the opinion that the copy sent to Mr. Davidson was the only one that had been issued. One gentleman, on the 12th Feb., sent me a copy, but did not state when he received it, probably because he did not like to meddle with the matter. I cannot find that it is noticed in any of the scientific journals of the United States or Europe. We know that in America, where geology and paleontology, are so actively and ably cultivated, any book or pamphlet relating to these two branches very speedily finds its way to those interested. It is almost impossible for this pamphlet to have been regularly published, in the United States, for the long period of ten months, and yet to have remained totally unknown to the leading geologists of the country. It seems quite certain that it was not published, but only printed, and perhaps two or three copies privately distributed.

As I understand the laws laid down by both the British and the American Associations, a species or a genus must be published in a book, or in a journal circulating among scientific men. The book or the journal must be obtainable by the public, by purchase. If an author having a book in the press, should make an abstract of four or five pages, and give away a few copies to his friends, it would not be publication, but only private distribution. This cannot take priority over fair and open publication in a scientific journal. Yet this is exactly the case with Prof. Hall's pamphlet. The laws in question are good and wise rules, intended to prevent disputes among naturalists, and also to afford the public a means of deciding questions of priority, without resorting to the testimony of either of the parties disputing. He who claims that printing is sufficient desires to make himself judge and witness in his own case. He and his printer can evade the law whenever they think proper. If printing is sufficient, then let us strike out the word "priority" from the pages of science. A rule that can be evaded by every one is a dead letter.

In addition to the above, I beg to give a short statement of facts, to prove that I am not to blame for the unfortunate collision that has occurred. During the winter of 1871 there was a correspondence in progress, between Mr. Davidson, Mr. Dall, myself and others, on the subject of the genus *Trimerella.* In February and March, Prof. Hall, on two occasions, applied to Mr. Selwyn for the loan of specimens of *Trimerella, Kutorgina,* and *O. Canadensis.* He stated that he wanted them in order to decide a question relating to his species, *O. Conradi.* He gave no notice of his intention to found a new genus on any Canadian specimens. I consented to the loan of all but *O. Canadensis.* I was then studying this species in connection with the *Trimerella* question. I afterward arrived at the conclusion, that at least one of the forms figured under that name might constitute a new sub-genus along with *O. Galtensis.* In a letter to Mr. Selwyn, dated April 10th, 1871, in allusion to my declining to lend *O. Canadensis,* Prof. Hall says: "I certainly have no wish to take advantage of Mr. Billings in any way, and desired only to make my position as secure as practicable." How this assertion can be sustained, by what came to light nine months afterward, I leave the public to judge. In the same letter he intimated that he had made a little abstract of his investigations,—that he had saved a few copies from the fire that had occurred at Albany about that time, and that he would send Mr. Selwyn one. He never sent it, however, as he afterward admitted.

On the 6th Dec. I received a letter from Mr. Davidson, in which he mentions Prof. Hall's pamphlet, but makes no allusion to *Rhynobolus.* My paper was at this time in print, and I sent Mr. Davidson a proof of it on, or about, the 8th of Dec., and at the same time some specimens. I heard no more from Mr. Davidson until the 17th of Jan., 1872. On that day I received several letters from him, some of which had been delayed at sea. From these letters I first learned that Prof. Hall had proposed the name *Rhynobolus* for my genus *Obolellina.* I then made the inquiries above mentioned, and having satisfied myself that the paper had not been regularly published, asked Mr. Selwyn to apply to Prof. Hall for a copy. He wrote on the 30th Jan., and the pamphlet arrived here on the 9th Feb. There is a plate stitched to it, with a manuscript description of the figures. The genus is proposed on a Canadian specimen from Galt, the original *Trimerella* locality. Prof. Hall says he procured the specimen there, "many years since." It thus appears that at the time he borrowed our specimens, he was engaged upon one from the same locality, and wanted ours for comparison. Mr. Selwyn, when he lent the specimens, gave him notice of the correspondence then going on between Mr. Davidson, Mr. Dall and myself, and also that I was at work upon *O. Canadensis.* Prof. Hall should have notified Mr. Selwyn that he was engaged on the Canadian specimen, or he should have published his genus. He did neither, and it remains for the public to decide whether he was right or not.

It appears from Mr. Davidson's letters, that *Rhynobolus* was to have been brought out in England, in a paper which he (Mr. Davidson) and Prof. King had in preparation on the *Trimerella* group. I knew nothing of this. We can now see why it was kept so quiet in America. Fortunately, Mr. Davidson delayed his paper for a box of specimens I had promised him, and these I could not well spare until my own paper was finished. Mr. Davidson appears to be under the impression that Prof. Hall's pamphlet has been regularly published.

What is stated above, can be authenticated by a number of letters written by Prof. Hall, Mr. Davidson, and some of the best scientific men in the United States.

Montreal, 26th Feb., 1872.

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## ART. XXXVII.—*The Aurora of February 4th*, 1872; by Prof. ALEX. C. TWINING.

EXCEPTING the auroral cloud-band of October 24th–25th, 1870—an account of which was given by the writer of this article in volume i, No. 2, of this series—no aurora ever before observed in the United States has exhibited, so far as our knowledge extends, any feature essentially identical with the crimson band or belt in the south seen here throughout Sunday evening, the 4th of February last. It was composed of large illuminated clouds or banks of red light, aggregated in the form of a zone, which began far down in the east and passed south of the zenith far on to the west. Its visible parts shifted place a few degrees, from time to time, but without altering very much the general position of the zone. No "aurora's bow" ever possessed half, and rarely more than one-third its breadth, or had either the like consistence or constitution, or the like color and time of continuance, or the like invariableness of position. Indeed, it is a fact which the writer can avouch from his own observations, that—excepting the extreme western parts, which he did not observe early in the evening—the zone maintained essentially the same extent and situation, relative to the stars, at a quarter past ten o'clock in the evening which it had here at New Haven at a quarter before seven. The same fact, it will be noticed farther on, was observed for a much longer time—four hours and a half—by intelligent and trustworthy witnesses, at Brunswick, Maine, and at Hudson, New York,—respectively 170 miles N.N.E., and 80 miles N.W. from New Haven. This anomaly, however, is no more than was noticed for a much longer period in 1870—essentially for not less than a full twenty-four hours, as will be seen by referring to the writer's account of it in the article above quoted. Besides all this, it is curious—whatever want of significance there may be in the coincidence—that this new manifestation, after a year and four months, almost, from its predecessor, was posited in the celestial vault much like the zone of 1870, only advanced upon the ecliptic over one sign, but keeping its inclination to that circle nearly the same: for, in 1870, the middle line, as seen here, was a great circle crossing in 18° of Pisces, and inclined 40°, while the same line, in this last instance, crossed at about 24° of Aries, and was inclined 37°. The zone, certainly, was *not* cosmical; for it embraced auroral streamers, both red and white, although, in this instance, very short. It was also part of a display which was showing itself simultaneously in the opposite quarter, as the ordinary "Northern Lights." Besides these things, it was affected by parallax, as will be seen abundantly from the concurring testimony of observers at distant places, when compared together; and it also showed the usual spectrum lines of the aurora. The fixed position among the stars, although extremely surprising, may be explained, perhaps, by a reference to facts which are known respecting the frequent western movement (although sometimes eastern) of auroral clouds, arches and streamers; but the coincidence of inclinations to the ecliptic cannot be surmised to be more than fortuitous, so long as it does not appear from known facts that the earth, by motion in its orbit, crosses lines of magnetic force which can exercise an exciting and determining influence upon its electric currents.

Another respect in which these zones of 1870 and of 1872 are distinguished is their great height above the earth's surface. In both instances the data for computing this element are but rude, yet they are unmistakable in their reality and general result. The former height (339 miles) is less to be relied upon as a near approximation to the truth than this last ($352\frac{1}{4}$ miles), because, for this last, the observations are more ample and more definite. What the writer himself saw, both north and south, may be described briefly, as follows:—At $7^h$ P. M. there were three bands, apparently parallel, from east to west, having their general aspects and their general situation the same as observed accurately half an hour later. At $7^h\ 30^m$ the most northern appearance was a white and moderately brilliant arch that crowned a dark space or disc beneath it. Its breadth was 16°, and its upper boundary lay at or closely contiguous to Regulus and to Delta Ursa Maj. Thus it enveloped the handle of the "Dipper," and it extended down to the horizon both on the east and on the west. Between this and the zenith there was a rosy band, obviously parallel to the last described, rising from the eastern horizon, and passing up between and grazing Gamma Gemin., on the north and Betelgeux on the south, but becoming diffused and indefinite soon after passing the meridian. South of this a streak, partly white and partly azure, adjoined the last named, separating it from the cloud-band of red lights in the S.E., the S., and the S.W. This last began a few degrees below Canis Major, and just enveloped the bright stars of that constellation. Its north margin passed 1° south of Beta Orionis, and its south margin nearly reached Epsilon Leporis. Farther west the north margin reached 1° or more above Alpha Ceti,—from which star the band passed far westward, irregular and less brilliant, but in the same circle and of about the same breadth. About 8 o'clock it all became temporarily faint. At $10^h$ $15^m$ both margins remained, in general situation as before, and also the eastern extremity nearly or exactly, and apparently also the western extremity, which faded out at about the distance of Andromeda. Thus the arch was about 123° in extent and 11° in breadth, conforming substantially in these respects with the similar arch of 1870. At the time of last observation the band was equally brilliant as at first, but clouds rapidly formed and covered it from sight.

The well known and accurate observer, B. V. Marsh, Esq., of Philadelphia, among other observations, has obligingly communicated the following, made by himself at Haverford, ten miles west of that city:—

"Feb. 4th, $7^h$ $20^m$ P. M. Brilliant crimson light in S.E., principally in Canis Maj. and Orion; Sirius was near the center of an exceedingly fiery patch, which extended some 5° or 6° below and eastward, and in the west joined another but little less brilliant, enveloping the brightest part of Orion.

$7^h$ $23^m$–$7^h$ $30^m$. Several crimson streamers in Canis Maj. and Orion, with one crimson and white from the west, and one faint white from the north, form a partial corona, which dissolved before $7^h$ $35^m$.

$7^h$ $55^m$. Yellowish white glow [continues] over N. and N. E., especially the latter, involving the whole handle of the "Dipper." Sirius still nearly central in large patch of crimson, extending 5° to 10° below, and about the same distance toward the E., connecting in S.W. with another at about the same level under Orion. Crimson less splendid than at $7^h$ $20^m$.

$8^h$ $40^m$. Canis Maj. and Orion still enveloped in crimson light, higher than at $7^h$ $55^m$. Sirius still in brightest part.

10$^{h}$ 20$^{m}$. Crimson in S.E., S., and S.W.—especially in Canis Maj. and *lower* half of Orion,—extending 10° to 20° E. of Sirius, which was still in brightest part. Upper margin perhaps 10° N. of Sirius—lower as much S. of it."

Respecting this same aurora, Prof. C. G. Rockwood of Bowdoin College, obligingly communicates, among other things, the following:—

"On the evening of Feb. 4th, at Hudson, I saw it first a little before 7 P. M., being a brilliant patch of red light in the S.E. It was of irregular shape, the brighest part being about over the three stars Alpha, Beta and Gamma Leporis—say in A.R. 82° Dec. −20°, and extending with a variable breadth, like a bank of colors, toward and over the triangle formed by Delta, Epsilon and Eta Canis Maj.—say across a point in A. R. 105°, Dec. −28°. At 7 P. M. there were visible two or three faint white streamers stretching far up toward the zenith and resting upon the red as a base. The red mass continued visible, though varying in intervals, until after 11 o'clock. At 11$^{h}$ 30$^{m}$ P. M. it had faded away.

I had given up all hope of any parallax, from the remarkable fact that the red patch *retained the same position among the stars* all the evening, moving with them from west to east. Prof. Brackett, who observed the phenomenon *here* [Bowdoin Coll., lat. 43° 54′ long. 69° 57′], noticed the same thing."

In addition to the foregoing, Assistant Arthur Searle of Harvard Coll. Observatory, has obligingly communicated the following:

"The red southern arch of Feb. 4 was very ill defined. I have the following notes: 'At 6$^{h}$ 25$^{m}$ P. M. reddish light diffused from below Orion to square of Pegasus' [90° extent]; at 7$^{h}$ 35$^{m}$ band in the south nearly white, covering most of Canis Major. Mr. Trouvelot, observing here, made the following notes: 'At 8$^{h}$ 15$^{m}$ P. M., arch dark purple, about 8° or 10° wide where it was broadest; its northern edge nearly reaching the nebula of Orion, very vaporous and ill defined.' At 8$^{h}$ 40$^{m}$ it just reached the Orion nebula. At 10$^{h}$ 50$^{m}$ lower than before, and almost exactly resembling in form the pale arch in the north, as if it were a reflection of it."

The problem relative to actual height in the early evening is somewhat *refractory*. The displacement of the zone, measured in a direction across itself, appears to have been 8° between the station of Hudson and that of Haverford, 179¼ miles S., 28½° W. from it,—and 5⅓° between New Haven and the same, being 158¾ miles, S. 54° W. These give, consistently, 10° and 7⅓° of parallax in the *azimuthal* planes. An extraordinary height would seem to be indicated by the foregoing, but specific results cannot be attempted at this point.

This aurora was observed with the spectroscope by Professor

Brackett of Bowdoin College. He obtained *two* lines in the white aurora, one of which was wanting in the red. Prof. Geo. F. Barker, of Yale University, has obligingly furnished the following observations of his own:

"The aurora was observed with the spectroscope about 8 P. M. Three bands were then plainly visible, two of them quite sharply defined. The least refrangible of these was the well-known red line, first observed by Zöllner. On measurement, it gave a wave-length of 623 millionths of a millimeter. The second in order was the bright line of wave-length 557, as given by Angström. The third was a nebulous band slightly more refrangible. Mr. C. S. Hastings informs me that at seven o'clock he was able to detect five lines in the auroral spectrum. Beside the three above mentioned, there were two others more refrangible. These were, however, too feeble for measurement.

The white auroral cloud which lay for a time beneath the western end of the fiery red tract, and the white streamers which shot up from the north, afforded a similar spectrum, but without the red line."

The illustrated British journal "Nature" is our authority for the statement that this display was very brilliant over all England and Ireland; also in France, Turkey and Egypt. A telegram from Alexandria is therein quoted, as saying that a large space of the sky was seen illuminated at that place for five hours. Varying descriptions by different observers abound in the same journal, and are very glowing; but nothing new appears beyond the splendor, variety and duration, unparalleled for those parts. In several instances the green and red lines of the spectrum were recognized, and in some instances blue also. Red is mentioned as the prevailing color of the auroral clouds and sometimes of the streamers; and the illumination at times was so great that large print could be read by it. The dipping needle also was disturbed, in advance of the visible phenomena, and changed all the way from 56° to 45°. The splendor was visible in the bright twilight of sunset, and continued bright from 5 o'clock P. M., until about 10 o'clock.

The same phenomena were witnessed at Rome in Italy, as we learn from the "Bulletino Meteorologico." At $5^h$ $47^m$ P. M. they were visible in the twilight, first in the N. and N.E., but soon after in the N.N.W., and then in an arch of light from E. to N. 60° W.; and a rosy light also, beginning in the N.W., spread over the entire heavens. The yellow light gave, in the spectroscope, one greenish-yellow line, and the red columns gave a red line. At 7 o'clock festoons of light passed the zenith, and appeared at the Pleiades and in Orion. At $7^h$ $7^m$ the corona first formed by rays converging to Aldebaran; and, at $7\frac{1}{2}^h$, a luminous cloud-zone, normal to the meridian, moved from north to south, but became merged in a vivid purple radiance diffused over the whole sky, and streaked with yellow. At $7^h$ $55^m$ the point of convergence was at Alpha Orionis. The whole reminded one of the vast cupola of St. Peters. The apex was and continued at the magnetic pole. About 9 o'clock the illumination became languid, and only remained as a homogeneous rosy radiance from N.E. to N.W. At 10 o'clock this revived somewhat, but disappeared entirely at half-past three in the morning. There were great magnetic disturbances, occasioned by strong electric currents along the wires. Telegraphic communications from Modica and Palermo gave information that the display was seen in Sicily.

The Cologne Gazette of Feb. 9th contains a complete and vivid description of the appearances in that part of Germany. Beginning at $5\frac{1}{2}$ P. M. in the east, in appearance like a reflection of the western twilight, it was attended, after some minutes, by a reddish brightness in the west, and banks of *green* light in the southeast which soon faded, excepting a bright border to the south. Toward 6 o'clock streamers arising disclosed the unmistakable auroral character. The masses became more richly and sharply grouped, and at $6^h{\cdot}25^m$ a corona was formed. Nothing was then in the N. for 20° of altitude; but, in the S.S.E., a dark gray bank of mist, never before seen in the south, culminated in the south magnetic meridian at 30° altitude. Canis Maj. shined through it, and a green shimmering border formed its upper boundary. Above it there was white light passing into bright red crossed with streamers. In the S.E., under the Pleiades, 65° above the horizon, rested its center—in form as a dark circle six to ten moons in diameter, and rays from it on every side,—short to the S., moderately long to the N., long and rich to the east and west. This corona stood five minutes, then was gone; but after five minutes it produced itself with yet greater splendor. Again it formed complete at $6^h$ $37^m$—beautiful to the east, while to the west two mighty red streamers wonderfully enclosed a ruby red space, like a sunken ground, which streamed on nearly in a true line almost to the western horizon. This faded in a few minutes. Just about 7 o'clock a third corona formed, with pale and delicately white rays, in a sky whose lower parts were occupied by irregular luminous mists and streamers. When these were gone they left behind, even so late as 10 o'clock, a weakly shining phosphorescent mist, which showed the bright stars through.

The display was an utter novelty in the region, in these particulars: 1st, the formation and aspects in the east and west at the outset; 2d, in the three coronas,—of which sort of development never one had been witnessed before; 3d, in the dark disc in the south, instead of the north, as usual. Unfortunately science is helpless with reference to these phenomena, because, in these parts (!) "people are more disposed to wonder at the auroras than to observe them." The telegraph reports these appearances in Silesia, Posen, Western Prussia, and in Paris, with much disturbance of the wires,—also at Alexandria, over all the sky, for five hours,—and at Constantinople at 10¼ o'clock, at least, and till 1½ o'clock in the morning. At Cardiff the same was spoken of, as in the zenith, with an elliptical corona of silvery blue streamers toward the north, the east, and the west.

At Cologne Dr. Schellen observed the spectrum for two hours, with three differently constructed instruments. It agreed essentially throughout with that of October, 1870, by Prof. Zöllner, described in Schellen's "Spectrale-Analyse," 2d ed., p. 597. The intense green, 1474 K, was seen in every direction,—the same as in the corona of solar eclipses, and in the zodiacal light, but never identified with a spectrum line of any terrestrial substance. Two dark and apparently absorptive lines were also seen traversing a continuous white band. Transiently and but once a red line appeared in the spectrum of the east only; and not then unless the instrument was so turned as to lose the green. When observed, about 8 o'clock, the magnetic needle was much disturbed; and the telegraph operated with great difficulty or interruption.

It is worth noticing in the foregoing account, and in certain other foreign descriptions, that the aurora of October, 1870, is referred to as a parallel, in its main characteristics, with this of 1872. Also that this last is spoken of as unequalled in variety and completeness, even by the great displays of 1831–36. In these respects, however, there appears little, if anything, to exceed, either in scope or magnificence, a few which the writer has witnessed in northern New England and even here, at times—excepting only the peculiar and novel south developments. But, although in a different mode of manifestation, the phenomena of 1870 and 1872 were, evidently and equally as real and grand an anomaly to the other continent as, in a different way, they have been to our own.

But the fact of a sympathy, and even of a oneness, in and between the distant manifestations is not purely conjectural. As an illustration, Professor E. T. Quimby of Dartmouth College, New Hampshire, in this instance, observed the magnetic needle during much of the day of February 4th. His chart of the curve of disturbance is in possession of Prof. H. A. Newton, who has brought it to the writer's notice. It manifests a surprising amount of disturbance—beginning, in a marked degree, at 10 o'clock A. M. The north end of the needle then pointed 13′ east of the normal variation. In eleven minutes the variation had increased to 50′, where it remained unsteadily for six minutes, and thereafter advanced to 65′ increase at $10^h\ 20^m$. Resting about at this four minutes, it suddenly reached an an eastern variation of 93′, and, at $10^h\ 26^m$, of 113′. Declining back however, in $1^m$ to 82′, it kept traversing, through a range of 10′, at about that average till $10^h\ 35^m$, when observation was suspended an hour and eighteen minutes. On renewed observation, at $11^h\ 53^m$, the same was found at 133′ eastern deviation. It started on in $1\frac{3}{4}^m$ to 173′, and so traversed till just before noon. At $1^m$ before 12 o'clock it started on to 193′, and traversing through a back and forward range of 18′, advanced, at $12^h\ 6^m$ P. M., to 313′, and, at $12^h\ 7^m$, to 323′. At this instant the north end of the needle—which has, normally, 11° of declination W. at that locality (Hanover)—had varied to its eastward extreme, and to the unwonted extent of 5° 23′. It deserves notice that it was but a few minutes after this maximum in absolute time, that the phenomenon was observed to be established in England and at Cologne, and probably it had become established in fact before it. From this extreme the needle fell back 30′ in less than five minutes, and began, three minutes still later, to fall back yet more, and, at $12^h\ 20\frac{3}{4}^m$, to a minimum of 113′, but rallied to 298′ at $12^h\ 22\frac{1}{3}^m$. It found a second minimum of 83′ at $12^h\ 28^m$, and a third of 53′ at $12^h\ 37\frac{1}{4}^m$, and a maximum of between 293′ at $12^h\ 35\frac{3}{4}^m$. It gradually came to a normal position at 2 o'clock, and in after instances deviated to the west. The extreme western deviation was 17′ at $3^h$; but at $9^h$, and for a quarter of an hour later, the deviations were east, about 48′. It will be seen from the above that there were three epochs of extreme and sudden deviation followed by as many of sudden change back again,—that the extreme fluctuation was 5° 40′ in three hours time, and that the violent disturbance preceded the *visible*, although perhaps not the actual, phenomena.

Reverting, in conclusion, to the enquiry concerning the actual *height* of the zone of 1872, although the early observations at Hudson, New Haven, and Haverford, as already admitted, are not favorable for its determination, yet it is evident, on a review of all the observations, that at the two places last named the very latest are so nearly coincident as to time, and so favorable as to situation in azimuth and altitude, as to be available for the object. In fact, having the distance between those stations (158·7 miles) as a base, and the azimuth of the base 54° W. of S. from New Haven, and the observed point of the zone at the star Sirius, the parallax is found by measurement on the globe to be 9° 5′. The oblique azimuthal angle at New Haven is found 36° 40′, and the corresponding zenith distance 65° 10′, and the zenith distance at Haverford 57° 28′.

The computed result is, rigorously, 352·25 miles of height above the earth's surface. The distances of the point observed from the two stations were respectively 720·08 miles and 600·31 miles. This ascertained height, like the same found for the similar zone of 1870 (339 miles), is, no doubt, extraordinary; but, considering the novelty of these zones in other particulars, and the now more advanced state of knowledge respecting auroras, it is less surprising than were the several far lower heights deduced by the author from observations in 1835 and 1836, but received then and for a time with incredulity.* The great circle of the zone of 1870 is cut by the great circle of the zone of 1872 in A. R. 77° and S. Dec. 14½°, and at the corresponding opposite point; but the latter is inclined to the former 24° north.

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Art. XXXVIII.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XX.—*Recent Additions to the Molluscan Fauna of New England and the adjacent waters, with notes on other species*; by A. E. Verrill.

[Continued from page 209.]

*Spiralis balea* (Möll. sp.) =*Heterofusus balea* Mörch; Binney, =*Spiralis Gouldii* Stimpson.

*Heterofusus Alexandri* V. =*H. Flemingii* Binney (non auth.).

*Taonus pavo* Stp. =*Loligopsis pavo* Fer. and D'Orb.; Binney (description)=*Loligo pavo* Les.; but not the *figure* (pl. xxvi), which is an *Ommastrephes* (? *O. illecebrosa*).

*Ommastrephes illecebrosa* (Les. sp.) = *O. sgittatus* Binney (description), but not the figure (pl. xxv, fig. 340), which is a *Loligo* (? *L. Pealii*, female).

*Loligo* = *Ommastrephes Bartramii* Binney (non Les. sp.). The figure (pl. xxv, fig. 339), represents a *Loligo*, but does not show the long tentacular arms.

### *Descriptions of Genera and Species.*

*Scalaria angulata* Say, Amer. Conch., 1831, = *S. Humphreysii* Kiener, 1838.

Say described this species as a doubtful variety of *S. clathrus*, under the above name, which should, therefore, be adopted instead of Kiener's.

*Acirsa borealis* Mörch (Beck sp.).

Shell white or pale flesh-color, elongated, turreted, acute. Whorls ten, convex, with numerous revolving striæ; the upper

* This Journal, I, vol. xxxii, page 217.

whorls with slight transverse undulations or faint costæ, which are wanting on the lower ones; last whorl slightly carinated. Aperture roundish, effuse and slightly angulated in front.

Length about ·75 of an inch; diameter ·28.

Eastport, Me., shelly bottoms, 10 to 40 fathoms, dead shells frequent, rarely living,—A. E. V. and S. I. Smith.

*Lunatia heros, var. triseriata.*

Since there are no positive characters by which the *Natica triseriata* Say can be distinguished from *heros*, except the color, —a character well known to be very unreliable in this family, —I have for several years suspected that the two forms were but varieties of one species. The size and outlines are generally described as different, but the shape varies in both, passing through the same series of forms, while specimens of the *triseriata* type, although usually smaller, are sometimes found as large as the full-grown *heros.*

This view was fully confirmed two years ago at Eastport, by breaking up large and characteristic specimens of *L. heros*, when in one such specimen the inner whorls were found to have the distinct color markings of the *triseriata*. This specimen was a well-marked *triseriata* until half-grown, when it changed to *heros!*

The two varieties are associated and have the same range, being common everywhere on sandy shores from the Gulf of St. Lawrence to Cape Hatteras, and probably farther south.

*Aclis polita* V., sp. nov. Plate VI, figure 5.

Shell white, elongated, regularly tapering, slender, acute. Whorls thirteen or more, convex, rounded, scarcely flattened; surface smooth, polished, shining, with faint or scarcely distinct striæ of growth. Aperture broad oval; outer lip sharp, slightly effuse; columella slightly curved, without a fold. Length ·33 of an inch; breadth ·08.

Eastport Harbor, 20 fathoms, shelly bottom. Only one perfect specimen was obtained.—Exp. 1864, A. E. Verrill and S. I. Smith.

*Turbonilla elegans* V., sp. nov. Plate VI, fig. 4.

Shell light yellowish, elongated, moderately slender, acute. Whorls ten or more, well rounded, not distinctly flattened; suture rather deeply impressed; surface somewhat lustrous, with numerous rounded vertical costæ, narrower than the concave interspaces, fading out below the middle of the last whorl; and with numerous fine revolving grooves, which are interrupted on the costæ, but distinct in the intervals; on the upper whorls there are about five; and on the lower half of the last whorl usually five or six distinct and continuous ones.

Aperture broad oval, anteriorly rounded and slightly effuse; outer lip thin, sharp; columella nearly straight at base within, slightly revolute outwardly, regularly curved anteriorly where it joins the outer lip, and not forming an angle with it. The epidermis is thin, light yellow, sometimes with a darker, yellowish revolving band on the middle of the last whorls, and also with the revolving striæ darker.

Length ·22; breadth ·07 of an inch.

Several living specimens were dredged in Vineyard Sound, in 8 to 10 fathoms, shelly bottom,—A. E. Verrill and S. I. Smith (on U. S. Fish Commission).

This species is allied to *T. interrupta*,* but is less slender and has the whorls more rounded. The sculpture is nearly the same.

*Stylifer Stimpsonii* V., sp. nov.

Shell white, short, swollen, broad oval; spire short, rapidly enlarging. Whorls four or five, the last one forming a large part of the shell; convex, rounded, with the suture impressed, surface smooth, or with very faint striæ of growth; a slightly impressed revolving line just below the suture. Aperture large and broad. Length about ·15 of an inch; breadth ·12. I have seen no specimens with the aperture perfect.

Off the coast of New Jersey, on a bank in 32 fathoms, parasitic on *Euryechinus Dröbachiensis* V.,—Capt. Gedney.

*Cæcum costatum* V. Plate VI, fig. 6.

*Cæcum Cooperi* Smith, Annals Lyceum Nat. History, vol. ix, p. 394, fig. 3, 1870, (non Carpenter).

Mr. Sanderson Smith has described and figured this shell in a later stage of growth than the one here figured. In my figure the longitudinal costæ are, by an error, not so distinctly brought out as they should be, and the annular grooves in the depressions are too distinct.

In the adolescent stage of growth this species enlarges rather rapidly, and has 12 or 13, distinct, elevated, rounded costæ, narrower than the intervals between; the circular grooves are numerous, unequal, interrupted over the costæ, and broader toward the aperture. The aperture is rounded within; its margin is externally stellated by the costæ.

Vineyard Sound, 8 to 10 fathoms,—A. E. V.; Gardiner's Bay, L. I., 4 to 5 fathoms, sand,—Smith.

## Elysiella, gen. nov.

Allied to *Elysia* and *Placobranchus*. Head rounded, with two short, obtuse tentacles; eyes sessile behind the bases of the tentacles, on the neck. Lateral lobes united behind, rounded

* The figure in Gould's Invertebrata (copied in the new edition) is very poor.

and separate in front, and raised from the back, leaving a cavity beneath for respiration. Blood vessels, commencing in the anterior part of the back, extend backward, forking and diverging, in the area enclosed by the lateral lobes.

This genus differs from *Placobranchus* and *Elysia* in having the lateral lobes united together posteriorly over the back, so that the respiratory cavity partially enclosed by them is closed behind.

*Elysiella catulus* V. Plate VII, figures 5, 5[a].

*Placobranchus catulus* Agassiz, MSS.; Gould, Invert. of Mass., 2nd ed., p. 256, pl. xvii, figs. 249, 250, 1870.

This species is well described by Dr. Gould, but the figure is incorrect in representing the lateral lobes as separate posteriorly,—perhaps a theoretical mistake on the part of the artist.

It is common adhering to eel-grass in harbors and estuaries from Boston to New Jersey; Great Egg Harbor,—A. E. V. and S. I. Smith; New Haven, Conn., and Wood's Hole, Mass., —S. I. Smith.

It often floats with the bottom of the foot at the surface of the water.

*Styliola vitrea* V., sp. nov. Plate VI, figure 7.

Shell smooth, polished, diaphanous, almost glassy, long conical, rather slender, slightly curved toward the acute apex. Animal white; swimming organs obovate, with the end broadly rounded, and bearing the slender tapering tentacles near the middle of the anterior edge; intermediate lobe short, rounded in front.

Length of shell ·46; diameter ·08 of an inch.

This species was taken among *Salpæ*, off Gay Head, Martha's Vineyard, in the afternoon, Sept. 9th, 1871,—Dr. A. S. Packard and A. E. Verrill.

*Ensatella Americana* (Gould sp.)

*Solen ensis* of American authors, not of Linnæus.

In addition to the differences in the shells of the American and European species, noticed by Gould and others, there are, apparently, still more marked differences in the soft parts, to judge from the figures and descriptions of the *ensis* of Europe.

In our species, when full grown, the siphonal tubes protrude an inch or more and are united for about half their length, beyond which they are round and divergent, subequal. Both orifices are surrounded by a similar circle of numerous papillæ, of three sizes; the larger ones are enlarged in the middle, acute at tips, with a large black spot on each side of the base; alternate with these are somewhat smaller ones of the same form and with similar basal spots; alternating with the primary and secondary ones are small tapering papillæ, less than half the length of the longest; numerous slender tapering papillæ are also scattered irregularly over the sides of the free portions of both tubes, in some cases in irregular rows of four to six, while on the ventral side of the branchial tube two rows of alternating papillæ extend along the whole length of the siphon. The mantle is open ventrally for more than half its length; the posterior portion of the opening has small conical papillæ along its margin. Foot long; the end bulbous, obliquely truncated and beveled laterally.

*Periploma papyracea* V. Plate VII, figs. 1, 1a, 1b; pl. VIII, fig. 1.

*Anatina papyracea* Say; Gould, Invert. Mass., 2nd ed., p. 67, fig. 382.

An examination of the soft parts of this species (pl. viii, fig. 1) shows that it is very different from *Anatina*, and agrees closely with *Periploma*, with which the shell also agrees well.

The siphonal tubes are separate from the base, slender, subequal; the orifices are both surrounded by a simple row of small papillæ. One pair of gills, with a well-marked longitudinal fold on the dorsal side posteriorly. Palpi with the anterior and ventral margin thickened, revolute, and strongly striated transversely, the ends prolonged and rolled into a point posteriorly. Mantle with thickened margins, united except at the small antero-ventral opening for the foot.

In young shells (pl. vii, fig. 1a) the spoon-shaped tooth is supported beneath by two slender brace-like laminæ, in both valves; in larger shells one of these usually becomes obsolete.

This species occurs from New Jersey to Labrador.

*Angulus modestus* V., sp. nov. Plate VI, figures 2, 2a.

Shell smooth, shining, more or less iridescent, with very fine concentric striæ. Form similar to that of *A. tener*, but more oblong and with the anterior dorsal margin nearly straight or even slightly concave; the beaks are at about the posterior third, and scarcely prominent; the posterior end slopes rapidly, and is subtruncate at the end; the ventral margin is but slightly convex in the middle, and sub-parallel with the dorsal margin. The shell is often a little thickened and firmer than in *A. tener*, but is sometimes as thin. Color pink, light straw-color, or white; often banded concentrically with these colors. The hinge margin is stouter and the teeth stronger than in *A. tener*, and different in relative size and proportions, as may be seen by comparing the figure (pl. vii, fig. 1) with that of *A. tener* (fig. 2) magnified to the same extent. The ligament plate is also longer.

This species occurred sparingly in Vineyard Sound and Buzzard's Bay, in 6–10 fathoms, sand,—A. E. V. and S. I. Smith; it has also been found in Long Island Sound, off New Haven, 4–5 fath., mud,—A. E. V.

## Gastranella V., gen. nov.

Shell oblong, more or less irregular, and sometimes with the ventral margin inflexed; pallial sinus large; ligament external, elongated. Right valve with two small cardinal teeth; the posterior one thin, directed obliquely backward. Left valve with two cardinal teeth; the posterior one stout, bilobed; the anterior one smaller. No distinct lateral teeth. Animal with long, slender, separate siphonal tubes, with a simple circle of papillæ at the ends; mantle well open anteriorly; foot ligulate. The curious little shell for which this genus is constituted apparently resembles *Gastrana* more than any other described genus.

*Gastranella tumida* V., sp. nov. Plate VI, figures 3, 3a.

Shell small, variable in form, swollen above, more or less elongated oval, or oblong, with rounded ends, compressed posteriorly. The beaks are rounded, somewhat prominent, incurved but not approximate, and directed somewhat forward; the anterior dorsal margin is deeply concave in front of the beaks, but without a distinct lunule, at the anterior end regularly rounded or a little prolonged, compressed; ventral margin slightly convex, or nearly straight and sub-parallel with the dorsal margin, or incurved, in the different specimens; posterior end broadly rounded in some, decidedly prolonged in others; dorsal posterior margin usually nearly straight for at least half its length, sometimes a little convex and gradually sloping throughout. Surface with fine, somewhat irregular, concentric striæ, slightly iridescent. Color white, with the umboes purple. Long Island Sound, near New Haven, 4–6 fathoms, shelly and gravelly bottom, among hydroids and sponges,—A. E. Verrill.

This species appears to be a "nestler," and quite variable in form. About 20 specimens were obtained, of different sizes; one of the largest, which may not be mature, is ·18 of an inch long, ·09 high and about the same in thickness.

*Turtonia nitida* V. Plate VII, figures 4, 4a.

*Turtonia minuta* Gould, 2d ed., p. 85, fig. 395 (not of European authors).

The American specimens of this shell differ so widely in form and especially in the structure of the hinge, from all the European specimens with which I have compared them, as well as from the descriptions and figures, that I cannot regard them as identical. Dr. Gould has well defined the form and external characters of our shell. The much enlarged figure of the interior, which is now given, illustrates the structure of the hinge better than any description could. I have seen no European specimens so elongated in form as the American examples seen by me invariably are, but depend less on the external form than on the structure of the hinge for distinguishing them.

*Astarte undata* Gould, Inv. Mass., 1st ed., p. 79, 1840 (provisional name).

*Astarte sulcata* (pars) Gould, op. cit., and most American writers.
*Crassina latisulca* Hanley, Recent Bivalve Shells, p. 87, pl. 14, fig. 35, 1843.

This is by far the most abundant species on the northern coast of New England. It ranges from Cape Cod to Labrador. In the Bay of Fundy it is very abundant at all depths, from 3 to 125 fathoms, on muddy bottoms. It varies greatly in form and sculpture, but can easily be recognized in all its varieties, by any one familiar with the species of this genus. The beaks are less prominent and the lunule less deeply excavated than in *A. sulcata*, and other differences exist in the hinge, etc.

The figure in the new edition of Gould (fig. 432) is not characteristic, having been made from an old eroded specimen, of unusual, if not abnormal, form.

*Astarte lens* Stimpson, MSS.

*Astarte crebricostata* Gould, 2d ed., p. 126, fig. 440 (non Forbes).

This species is very well described and figured in the work referred to. It is unquestionably distinct from the *A. crebricostata* of Europe. It occurs associated with the preceding species in Eastport Harbor and the Bay of Fundy on soft muddy bottoms in 20 to 130 fathoms. This, however, is much more common at 100 fathoms and below, being by no means abundant at 20–30 fathoms, where the former occurs in the greatest profusion.

The two species, although somewhat similar, are easily recognized. This is more compressed, more rounded, lighter and brighter yellowish in color, and generally has much more numerous and regular undulations. The hinge is also quite different.

*Astarte quadrans* Gould, 1st ed., p. 81; 2d ed., p. 123, fig. 434.

*Astarte Portlandica* Mighels, Boston Jour. Nat. Hist., iv, 320, 345, Pl. 16, fig. 2.

Among the specimens dredged in Eastport Harbor are some that agree with the original *Portlandica*, in color, form, and size, while other specimens are intermediate between these and the typical *quadrans*, so that a complete series can be formed connecting the two varieties together. Differences of the same kind and equally great occur in other species of *Astarte*.

*Cryptodon obesus* V., sp. nov. Pl. VII, fig. 2.

Shell white, irregularly and rather coarsely concentrically striated, much swollen in the middle; the transverse diameter nearly equal to the length; the height considerably exceeding the length. The beaks are prolonged and turned strongly to the anterior side. The lunular area is rather large and sunken, somewhat flat, in some cases separated by a slight ridge into an inner and an outer portion. Anterior border with a prominent rounded angle; ventral margin prolonged and rounded in the middle; posterior side with two strongly developed flexures, separated by deep grooves. Interior of shell with radiating grooves, most conspicuous toward the ventral edge.

Length of the largest specimen ·60 of an inch; height ·72; thickness ·52. The smaller specimens have about the same proportions.

Off No-man's Land, in 19 fathoms, muddy bottom,—A. E. V. and Dr. A. S. Packard; Labrador,—Dr. Packard.

Six single valves, some of them quite fresh, were obtained off No-man's Land at several different localities. They were all right valves, and the smallest was ·50 of an inch in height. The specimen from Labrador agrees nearly in form and structure, and is only ·23 in height and ·20 in length.

This species appears to be more nearly related to *C. flexuosus* of Europe than to *C. Gouldii*. The European species is nearly intermediate between the two American shells in form; but judging from the specimens which I have had opportunities to examine, the three forms ought to be kept distinct. *C. Gouldii* is common in Eastport Harbor, and occurs sparingly in Buzzard's Bay and Vineyard Sound. It is a thinner and more delicate shell, more rounded, relatively much longer, and is seldom more than ·25 to ·30 of an inch in breadth.

*Anomia glabra* V.

*Anomia ephippium* (pars) Linn.; Gould and most American authors.
*A. electrica* Binney, in Gould, 2d ed., p. 205, fig. 499 (*non* Linn.).
*A. ephippium* Binney, op. cit., p. 204, fig. 497 (*non* Linn.).

One of the localities given by Linné for *A. ephippium* was "Pennsylvania." He, therefore, doubtless included our common southern *Anomia* under that name, but it appears to be quite distinct from the common European species. Its range is quite southern. It is very abundant everywhere from Cape Cod to Florida, but north of Cape Cod it is rare. Although occasionally found as far north as Nova Scotia, I have never met with it at Eastport or in the Bay of Fundy, where it is replaced by the typical *A. aculeata* and its squamose variety.

*Glandula arenicola* V., sp. nov.

Body sub-globular, rather higher than broad, the whole surface covered with grains of sand forming a continuous layer. When the sand is removed the surface of the test is reticulately wrinkled and pitted, not furnished with fibres, except at base, where there are a few long, slender, thread-like, white ones. Tubes terminal, near together, in the alcoholic specimen short, forming low verrucæ, swollen at base, the ends a little prominent and naked. Apertures square, with four small lobes. The test is tough and opaque. Height ·45; breadth ·35 of an inch.

Murray Bay, Gulf of St. Lawrence,—Dr. J. W. Dawson.

*Molgula pellucida* V. Plate VIII, figure 2.

Body sub-globular with a smooth, thin, pellucid test. Tubes terminal, contiguous, much swollen at base, long, divergent, tapering, reticulated within by longitudinal and circular white lines (muscular fibers). Branchial aperture with six small papillæ. Intestine conspicuously visible through the test; stomach covered by deep orange-colored hepatic glands. Ovaries large, whitish. Color of test, pale hyaline bluish; tubes toward the ends, dull neutral tint.

Diameter of the largest specimens about 1 inch.

Mass. Bay,—L. Agassiz; Long Island,—Coll. Peabody Academy of Science; Bird Shoal near Beaufort, N. C.,—Dr. H. C. Yarrow.

Mr. Binney has published characteristic colored figures of this species under the name of *M. producta* Stimp., which is a very different, sand-covered species, (plate viii, fig. 6).

*Eugyra glutinans* V.

*Cynthia glutinans* Möll., Naturh. Tidsskrift, iv, p. 94, 1842.

Several specimens from Greenland, which I have had opportunity to examine, were sent by Dr. Chr. Lütken to Dr. A. S. Packard as Möller's species, and agree well with his description.

These are subglobular, ·20 to ·35 of an inch in diameter, with a thin translucent test, covered with fine sand, which adheres to very slender and delicate fibers which thickly cover the whole surface, but are longer and more numerous below, those of the base being as long as the diameter of the body and bearing grains of sand along their whole length. The tubes are naked and entirely retractile, connected by a thickened ridge surrounding their bases. The branchial aperture is six-lobed; the anal is square. It is more nearly allied to *E. pilularis* V. than to any other American species.

*Ascidiopsis complanata* V., gen. nov. Plate VIII, fig. 8.

*Ascidia complanata* Fabr.; Verrill, this Journal, i, p. 98, fig. 11, 1871.
*Ascidia callosa* Stimp., Proc. Boston Soc. Nat. Hist., vol. iv, p. 228, 1852.

The remarkable and complex structure of the gill in this species seems to require its separation as a distinct genus. A small portion of the gill is represented in the figure, much enlarged.

*Alcyonidium ramosum* Verrill, sp. nov. Plate VIII, fig. 10.

Much branched, when full grown; the branches irregularly dichotomus, usually crooked. Surface glabrous, smooth, or nearly so, the cells rather small and crowded; zooids with sixteen slender tentacles. Color ashy brown, or dull rusty brown.

Diameter of branches mostly ·20 to ·25 of an inch. Height 10 to 15 inches.

Off South-end, near New Haven, 1–4 fathoms, common,—A. E. V.; Vineyard Sound, Mass. and Great Egg Harbor, N. J.,—A. E. V., and S. I. Smith.

**Errata.**—p. 210, for *Mangelia cerinum*, read *Mangelia cerina*.

### EXPLANATION OF PLATES.

#### Plate VI.

Figure 1. *Angulus tener*, enlarged 5 diameters; 1 *a*, the same, natural size (from Binney's Gould, by E. S. Morse).
" 2. *Angulus modestus* V., enlarged 5 diameters; 2 *a*, the same, natural size.
" 3. *Gastranella tumida* V., enlarged 16 diameters; 3 *a*, another specimen, enlarged 6 diameters.
" 4. *Turbonilla elegans* V., enlarged 5 diameters.
" 5. *Aclis polita* V., enlarged 5 diameters.
" 6. *Cæcum costatum* V., immature, enlarged 24 diameters.
" 7. *Styliola vitrea* V., enlarged 3 diameters.

#### Plate VII.

Figure 1. *Periploma papyracea*, left side, exterior view (from Binney's Gould, by E. S. Morse); 1 *a*, the same, view of the interior of a young specimen, with the ossicle in place, enlarged 3 diameters; 1 *b*, ossicle of the same, enlarged 30 diameters.
" 2. *Cryptodon obesus* V., enlarged 3 diameters.
" 3. *Modiola hamatus* (young), from New Haven, enlarged nearly 2 diameters.
" 4. *Turtonia nitida* V., view of the interior, enlarged 40 diameters; 4 *a*, the same, external view, natural size and enlarged, (from Binney's Gould, by E. S. Morse).
" 5. *Elysiella catulus* V., dorsal view, enlarged nearly 3 diameters; 5 *a*, the same, ventral view, more enlarged.

#### Plate VIII.

Figure 1. *Periploma papyracea*, animal, resting in right valve, with part of the mantle removed from the upper side; *a*, retracted anal tube; *b*, branchial tube; *g*, left gill; *m*, *m*, anterior and posterior adductor muscles; *i*, intestine; *l*, liver; *p*, palpi of left side; *f*, retracted foot; *o*, opening in mantle for protrusion of foot.
" 2. *Molgula pellucida* V., rather more than natural size.
" 3. *Eugyra pilularis* V., enlarged about 2 diameters, with the adhering mud partly removed.
" 4. *Molgula papillosa* V., from off Martha's Vineyard, enlarged 2 diameters, with the adhering sand mostly removed.
" 5. *Molgula arenata* Stimp., natural size, and with its coating of sand.
" 6. *Molgula producta* Stimp., natural size, with its coat of fine sand.
" 7. *Cynthia partita* Stimp., erect variety, showing the outline and the character of the apertures; but the surface of the body appears smoother than is natural.
" 8. *Ascidiopsis complanata* V., small portion of the gill, much enlarged.
" 9. *Pera crystallina* V., from Murray Bay, enlarged 3 diameters.
" 10. *Alcyonidium ramosum* V., a young specimen enlarged 2 diameters, with part of the zooids expanded.

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## Art. XXXIX.—*Discovery of the Dermal Scutes of Mosasauroid Reptiles*; by Professor O. C. Marsh.

The great abundance of *Pythonomorpha* in the Cretaceous deposits of this country is rapidly affording material for a full understanding of the structure of these peculiar reptiles, about which, until recently, so little has been known. The explorations of the Yale College party in Western Kansas, in 1870, first proved the existence of posterior limbs, in three of the genera,* and the same party, during their investigations of the past year in that region, have added several other important facts, one of which is, that these reptiles were protected by osseous, dermal plates, a point of much interest in determining their true affinities. An examination of a large number of specimens has shown that this covering existed in *Edestosaurus*, *Liodon*, *Holcodus* and *Clidastes*, and hence there can be little doubt that it was common to the entire group.

The plates were first observed in a specimen of *Edestosaurus*, on which several were adhering to portions of the skull and lower jaws. A few of these were attached together, apparently in their original position with reference to each other, thus indicating their natural arrangement. There were evidently at least two or three kinds of scutes, and all of those preserved are essentially quadrilateral in form, the posterior margin being the shortest. The lower surface is smooth. The upper side has the margin more or less beveled, to admit an imbricate arrangement when in place, but no true ornamentation. The edges are, in general, quite thin, but one shows that it was united by suture. There are also indications of an imperfect articulation, somewhat like that seen in the plates of some species of *Palæoniscus*.

The exact arrangement of the scutes when in place is difficult to ascertain from the limited number of specimens observed, but a complex pattern was evidently produced by alternate rows of scutes of different shape and size. In some places, the edges overlapped in such a way as to bring three thicknesses together. The position in which the plates were found would indicate that they were mainly from the lower part of the neck.

***Measurements.***

| | |
|---|---|
| Length of large scute of *Edestosaurus*, | 28·mm· |
| Width at anterior margin, | 27· |
| Width at posterior margin, | 9· |
| Greatest thickness, | 3· |
| Length of small scute of *Edestosaurus*, | 18· |
| Width at anterior margin, | 18· |
| Width at posterior margin, | 12· |
| Greatest thickness ? | 1·5 |

In the genus *Liodon*, the scutes are also imbricate, and somewhat similar to those above described; but all observed appear to be proportionally smaller. Those found with one specimen are quadrilateral in form, with the posterior margin shortest. They are smooth below, but the upper surface is rugose. The exposed portion is linguiform, with its longer axis corresponding to that of the scute. One perfect scute was 26 mm. in length, 20 in average width, and 4·25 in thickness. The scutes in *Holcodus*,

* This Journal, vol. i. p. 447, June, 1871.

so far as observed, resemble those of *Liodon*. In *Clidastes*, the only scutes detected were some fragments adhering to the caudal vertebræ of *C. Wymani* Marsh. They are very thin, and quite smooth.

The various specimens examined in this investigation render it probable that the cranium of these reptiles was not covered with plates, but the body only, as in some of the Crocodilia. The scutes are apparently different in each species, and hence are important as a means of identification.

Yale College, New Haven, March 5th, 1872.

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ART. XL.—*A New Method of Estimating the Sun's Mass and Distance, by means of the Heating Energy of Flames;* by PLINY EARLE CHASE, Professor of Physics in Haverford College.

IN a recent paper* I endeavored to demonstrate, from familiar postulates, the following proposition:

*The kinetic energy of dissociated water should be to the kinetic energy of terrestrial revolution, as the mass of the earth is to the mass of the sun;*

And *the energy of hydrocarbons should be to the energy of dissociated water, as elastic energy, under constant volume, is to elastic energy under constant pressure.*

As the proposition has obvious important bearings, I submit to the readers of this Journal the following illustrations of my method.

Various experimenters have estimated the heating equivalents of chemical combination, for hydrogen and other elementary and compound substances. The earlier estimates are very discordant, but successive improvements in apparatus led to a satisfactory approximation of results.

Molecular, as well as cosmical forces, being presumably central, the hypothesis that chemical forces vary as gravitating energies does not seem unreasonable. Stephenson and Herschel, nearly a half century ago, spoke of our various forms of fuel as containing, within themselves, solar energies which had been stored up during the processes of organization. The experiments, to which I have just referred, gave approximate measurements of those energies, but I am not aware that any one, previous to the appearance of my barometrical and magnetical discussions,† attempted to show any direct and commensurable relation, between any forms of cosmical and molecular force.

In Muspratt's Chemistry, I find, among other estimates of the

* Read before the American Philosophical Society, Feb. 16, 1872.

† Proceedings and Trans. Amer. Phil. Soc.; this Journal, 1863–4, et sub.

heating energy of Hydrogen, the reasonably accordant ones of Andrews, Dulong, Favre and Silbermann, Grassi, and Hess. According to the mean of their several results, one pound of H, burned with eight pounds of O, liberates enough heat to lift the nine pounds of gaseous $H_2O$ *in vacuo*, $\frac{34533 \times 772}{9}$ feet. If such a lift were accomplished, it would establish an oscillation, which would be perpetually sustained by terrestrial attraction and elastic rebound, if not counteracted by opposing forces.

Let $h=$ mean height of oscillating vapor $(\frac{1}{2} \times \frac{34533 \times 772}{9}$ feet).*

$m=$ mass of sun, in units of the earth's mass.
$d=$ mean distance of sun in units of earth's equatorial radius = mean height of oscillating earth.
$y_0= 365^d\ 5^h\ 48^m\ 49^s$.
$y_1=$ time of satellite revolution at earth's equatorial surface $= 2\pi\sqrt{\frac{r}{g}}$.
$r=$ earth's equatorial radius (20,923,654 feet=mean of Airy and Bessel.)
$g= 32{\cdot}08744$.

According to my hypothesis

$$h : rd :: 1 : m \therefore m = \frac{rd}{h}.$$

We have also, according to well known mechanical laws, $m = \left(\frac{y_1}{y_0}\right)^{\frac{2}{3}} \times d^3$. Solving the equations, we obtain the following values (C), which I collate with the careful astronomical estimates of Newcomb (N), and Stone (S).

| | C. | N. | S. |
|---|---|---|---|
| Mass of the sun, | 330,260 | 326,800 | 329,000 |
| Distance " " | 92,639,500 m. | 92,380,000 m. | 91,945,000 m. |

If an elastic fluid is lifted above the earth's surface, subject to the (nearly) constant pressure of gravity;

The superficial pressure $\propto \left(\frac{r+h}{r}\right)^2$.

And the volume $\propto \left(\frac{r+h}{r}\right)^3$

Therefore, under equal increments of heat,

vol. under const. press. : const. vol. $\times\ (r+h)^3 : r^3$.

In the case of $H_2O$, from the values already adduced, we obtain $\left(\frac{r+h}{r}\right)^3 = 1{\cdot}488$. This corresponds, approximately, to

* My theoretical mean specific heat of $H_2O$ being $\frac{4}{9}$.

the experimental valuation adopted by Tyndall (1·421), and is virtually identical with the mean result of the experiments of Dulong, and Favre and Silbermann, upon ether and olive oil (1·494 and 1·495), as well as with the theoretical volumetric condensation of $H_2O$ (1·5).

If my postulates are admitted, the field which they open for the verification of astronomical, thermal, electrical and chemical observations and experiments, seems unlimited. I have already in view special researches pertaining to solar temperature, æthereal density, atomicity and valency, specific and latent heats, temperature of fusion, vaporization and dissociation, mixtures of gases and vapors, periods of planetary rotation, terrestrial rigidity and tides.

Philadelphia, Feb. 20, 1872.

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ART. XLI.—*The Yellowstone National Park;* by F. V. HAYDEN. With a Map.

IN order that the Park, or reservation, containing within its limits the wonderful falls, hot springs, geysers, and other objects of interest mentioned in our preceding articles may be more clearly understood by the readers of this Journal, we have prepared a map expressly to show the Park with its surroundings; the scale is ten miles to an inch. The Report of the Committee on Public Lands, as well as the law itself, which are appended to this article, will serve to explain the map in general terms.

A glance at the map reveals to the reader the geographical locality of one of the most beautiful lakes in the world, set like an emerald among the mountains. It will be seen also that the mountains that wall it in on every side, form one of the most remarkable water-sheds on the continent. The snows that fall upon their summits give origin to three of the largest rivers in North America. On the north side are the sources of the Yellowstone; on the west side those of the Three Forks of the Missouri; on the southwest and south those of the Snake river flowing into the Columbia and thence into the Pacific Ocean, and those of Green river rushing southward to join the great Colorado, and finally emptying into the Gulf of California; while on the east are the numerous sources of Wind river. From whatever point of view we survey this remarkable region, it is unsurpassed in interest.

On the 18th of December, 1871, a bill was introduced into the Senate of the United States, by the Honorable S. C. Pomeroy, to set apart a certain tract of land lying near the headwaters of the Yellowstone river, as a public park. About the same time a similar bill was offered in the House of Representatives, by Hon. Wm. H. Claggett, the delegate from Montana. After due consideration in the Committee on Public Lands in both Houses, the bill was reported favorably. In the Senate it was ably advocated by Messrs. Pomeroy, Edmunds, Trumbull, and Anthony. In the House, the objects of the bill were so clearly and forcibly set forth in the remarks of Hon. H. L. Dawes, that it was voted upon at once, and passed.

The above is a brief history of an event which marks an era in the scientific progress of the country. That our legislators, at a time when public opinion is so strong against appropriating the public domain for any purpose, however laudable, should reserve for the benefit and instruction of the people a tract of 3,575 square miles, is an act that should cause universal satisfaction through the land. This noble deed may be regarded as a tribute from our legislators to science, and the gratitude of the nation, and of men of science in all parts of the world, is due them for this munificent donation.

Mr. Dunnell, from the Committee on the Public Lands, made the following Report.

The bill now before Congress has for its object the withdrawal from settlement, occupancy, or sale, under the laws of the United States, a tract of land fifty-five by sixty-five miles, about the sources of the Yellowstone and Missouri Rivers; and dedicates and sets it apart as a great national park or pleasure ground for the benefit and enjoyment of the people. The entire area comprised within the limits of the reservation contemplated in this bill is not susceptible of cultivation with any degree of certainty, and the winters would be too severe for stock-raising. Whenever the altitude of the mountain districts exceeds 6,000 feet above tide-water, their settlement becomes problematical unless there are valuable mines to attract people. The entire area within the limits of the proposed reservation is over 6,000 feet in altitude, and the Yellowstone Lake, which occupies an area 15 by 22 miles, or 330 square miles, is 7,427 feet. The ranges of mountains that hem the valleys in on every side rise to the height of 10,000 and 12,000 feet, and are covered with snow all the year. These mountains are all of volcanic origin, and it is not probable that any mines or minerals of value will ever be found there. During the months of June, July and August, the climate is pure and most invigorating, with scarcely any rain or storms of any kind; but the thermometer frequently sinks as low as 26°. There is frost every month of the year. This whole region was in comparatively modern geological times the scene of the most wonderful volcanic activity of any portion of our country. The hot springs and the geysers represent the last stages—the vents or escape pipes—of these remarkable volcanic manifestations of the internal forces. All these springs are adorned with decorations more beautiful than human art ever conceived, and which have required thousands of years for the cunning hand of nature to form. Persons are now waiting for the spring to open to enter in and take possession of these remarkable curiosities, to make merchandise of these beautiful specimens, to fence in these rare wonders so as to charge visitors a fee, as is now done at Niagara Falls, for the sight of that which ought to be as free as the air or water.

In a few years this region will be a place of resort for all classes of people from all portions of the world. The geysers of Iceland, which have been objects of interest for the scientific men and travelers of the entire world, sink into insignificance in comparison with the hot springs of the Yellowstone aud Fire-Hole Basins. As a place of resort for invalids it will not be excelled by any portion of the world. If this bill fails to become a law this session, the vandals who are now waiting to enter into this wonderland will, in a single season, despoil, beyond recovery, these remarkable curiosities which have required all the cunning skill of nature thousands of years to prepare.

We have already shown that no portion of this tract can ever be made available for agricultural or mining purposes. Even if the altitude and the climate would permit the country to be made available, not over fifty square miles of the entire area could ever be settled. The valleys are all narrow, hemmed in by high volcanic mountains like gigantic walls.

The withdrawal of this tract, therefore, for sale or settlement takes nothing from the value of the public domain, and is no pecuniary loss to the Government, but will be regarded by the entire civilized world as a step of progress and an honor to Congress and the nation.

Department of the Interior,
*Washington, D. C., January* 29, 1872.

Sir: I have the honor to acknowledge the receipt of your communication of the 27th instant relative to the bill now pending in the House of Representatives dedicating that tract of country known as the Yellowstone Valley as a national park.

I hand you herewith the report of Dr. F. V. Hayden, United States geologist, relative to said proposed reservation, and have only to add that I fully concur in his recommendations, and trust that the bill referred to may speedily become a law.

Very respectfully, your obedient servant,

C. DELANO, *Secretary.*

Hon. M. H. Dunnell, *House of Representatives.*

The committee therefore recommend the passage of the bill without amendment.

An Act to set apart a certain tract of land lying near the head-waters of the Yellowstone river as a public park.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the tract of land in the Territories of Montana and Wyoming, lying near the head-waters of the Yellowstone river, and described as follows, to wit, commencing at the junction of Gardiner's river with the Yellowstone river, and running east to the meridian passing ten miles to the eastward of the most eastern point of Yellowstone lake; thence south along said meridian to the parallel of latitude passing ten miles south of the most southern point of Yellowstone lake; thence west along said parallel to the meridian passing fifteen miles west of the most western point of Madison lake; thence north along said meridian to the latitude of the junction of the Yellowstone and Gardiner's rivers; thence east to the place of beginning; is hereby reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people; and all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereinafter provided, shall be considered trespassers and removed therefrom.

SEC. 2. That said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The Secretary may, in his discretion, grant leases for building purposes, for terms not exceeding ten years, of small parcels of ground, at such places in said park as shall require the erection of buildings for the accommodation of visitors; all of the proceeds of said leases, and all other revenues that may be derived from any source connected with said park, to be expended under his direction in the management of the same, and the construction of roads and bridle-paths therein. He shall provide against the wanton destruction of the fish and game found within said park, and against their capture or destruction for the purposes of merchandise or profit. He shall also cause all persons trespassing upon the same after the passage of this act to be removed therefrom, and generally shall be authorized to take all such measures as shall be necessary or proper to fully carry out the objects and purposes of this act.

Approved, March 1, 1872.

## SCIENTIFIC INTELLIGENCE.

### I. CHEMISTRY AND PHYSICS.

1. *On the wave-lengths of Fraunhofer's lines.*—DITSCHEINER has recomputed the values of the wave-lengths determined by himself after again counting the lines upon his ruled plate of glass. The total breadth of the ruled surface was found to be 13·8765 millimeters and the number of lines 3001. Ditscheiner's values, with the corresponding ones as determined by Angström and van der

Willigen, are given in the table below, which is taken from his paper. A comparison of the results of the measurements of these different observers, provided apparently with equally good instruments, will serve to show that the subject is by no means exhausted, and that new series of determinations are required.

| | Kirchhoff. | D. | Angstrom. | v. d. Willigen. |
|---|---|---|---|---|
| *B* | 593 | 687·41 | 686·67 | 687·132 |
| *C* | 694 | 656·23 | 656·18 | 656·557 |
| | 711·5 | 651·71 | 651·55 | 651·961 |
| | 719·5 | 649·67 | 649·45 | 649·817 |
| | 783·5 | 633·87 | 633.58 | ---- |
| | 831 | 623·24 | 623·14 | ---- |
| | 850 | 619·26 | 619·05 | 619·423 |
| | 860 | 617·14 | 616·82 | 617·201 |
| | 864 | 616·37 | 616·12 | 616·510 |
| | 874·5 | 614·38 | 614·05 | 614·451 |
| | 877 | 613·88 | 613·55 | 613·973 |
| | 885 | 612·40 | 612·11 | 612·559 |
| | 895 | 610.46 | 610.13 | 610·554 |
| | 959 | 597·79 | 597·70 | ---- |
| *Da* | 1002·8 | 589·74 | 589·49 | 589·844 |
| *Db* | 1006·8 | 589·10 | 588·90 | 589.230 |
| | 1029·4 | 585·92 | 585·65 | ---- |
| | 1096·1 | 576·39 | 576·20 | ---- |
| | 1103 | 575·44 | 575·20 | ---- |
| | 1135 | 571·17 | 570·83 | ---- |
| | 1155·7 | 568·37 | 568·14 | ---- |
| | 1174·4 | 566.00 | 565·77 | ---- |
| | 1200.4 | 563·93 | 562·23 | 562·336 |
| | 1207·5 | 561·65 | 561·45 | 561·809 |
| | 1218 | 560·44 | 560·16 | 560·599 |
| | 1231·6 | 558·80 | 558·55 | 558·933 |
| | 1242·5 | 557·45 | 557·18 | ---- |
| | 1280 | 554·21 | 552·75 | 553·214 |
| | 1303·7 | 550·80 | 550.05 | ---- |
| | 1307 | 550·37 | 549·65 | ---- |
| | 1324·8 | 547·81 | 547·60 | 548·186 |
| | 1337 | 546·46 | 546·23 | 546·551 |
| | 1343·5 | 545·73 | 545·46 | 545·813 |
| | 1351·3 | 544·76 | 544·58 | 544·946 |
| | 1367 | 543·10 | 542·88 | ---- |
| | 1389·6 | 540·60 | 540·48 | ---- |
| | 1410·5 | 539·71 | 538·23 | ---- |
| | 1421·6 | 537·20 | 537·05 | 537.409 |
| | 1451 | 534·20 | 534·02 | ---- |
| | 1463 | 532·98 | 532·75 | 533·070 |
| | 1492·5 | 529·91 | 529·70 | ---- |
| | 1500·5 | 528·39 | 528·26 | ---- |
| | 1515·5 | 527.71 | 527·50 | ---- |
| *E* | 1523·5 | 527·13 | 526·90 | 527·203 |
| | 1542 | 525·68 | 525·42 | ---- |
| | 1569·8 | 523·43 | 523·23 | 523.520 |
| | 1577·5 | 522.79 | 522·64 | 522·968 |
| | 1589·1 | 521·69 | 521·50 | ---- |
| | 1601·6 | 521·01 | 520·75 | ---- |
| | 1622·4 | 519·37 | 519·18 | --- |
| | 1634 | 518·43 | 518·31 | 518·605 |
| *b* | 1648·8 | 517·40 | 517·22 | 517·522 |
| | 1655·6 | 516·85 | 516·68 | 516·985 |
| | 1693·8 | 514·34 | 513·85 | ---- |
| | 1737·6 | 511·12 | 510·70 | ---- |
| | 1750·4 | 510·00 | 509.88 | 510·199 |
| | 1777·4 | 508·11 | 507·88 | 508·268 |
| | 1799 | 506·61 | 506·40 | ---- |
| | 1834 | 504·26 | 504·13 | 504·390 |
| | 1854·5 | 502·96 | 502·70 | --- |
| | 1867 | 501·97 | 501·75 | ---- |
| | 1873·5 | 501·38 | 501·32 | ---- |
| | 1885·8 | 500·78 | 500·50 | ---- |
| | 1908·5 | 499·43 | 499·02 | ---- |
| | 1920 | 498·48 | 498·20 | ---- |
| | 1961 | 495·87 | 495·65 | 495·979 |
| | 1975·6 | 494·75 | 494·56 | ---- |
| | 1983 | 494·05 | 493·85 | ---- |
| | 1989·5 | 493·46 | 493·32 | ---- |
| | 2005 | 492·03 | 491·99 | 492·265 |
| | 2018 | 491·12 | 491·10 | ---- |
| | 2041·4 | 489·25 | 489·05 | 489·378 |
| | 2058 | 487·89 | 487·75 | ---- |
| | 2067 | 487·26 | 487·10 | ---- |
| *F* | 2080·1 | 486·22 | 486·08 | 486·400 |
| | 2103·3 | 484·34 | 483·90 | ---- |
| | 2121·5 | 482·53 | 482·24 | ---- |
| | 2148·9 | 480.28 | 480.00 | ---- |
| | 2157·4 | 479·27 | 479·20 | ---- |
| | 2160·6 | 478·95 | 478·86 | ---- |
| | 2187·1 | 476·53 | 476·50 | ---- |
| | 2201·9 | 475·62 | 475·35 | ---- |
| | 2221·7 | 474·07 | 473·60 | ---- |
| | 2233·7 | 473·08 | 472·66 | ---- |
| | 2250 | 471·53 | 471·35 | ---- |
| | 2264·3 | 470·43 | 470·20 | ---- |
| | 2309 | 466·80 | 466·65 | 467·026 |
| | 2416 | 460·36 | 459·20 | ---- |
| | 2436·5 | 458·40 | 458·10 | ---- |
| | 2457·5 | 456·53 | 455·50 | ---- |
| | 2467·4 | 455·45 | 454·90 | ---- |
| | 2489·4 | 453·49 | 453·30 | 453·632 |
| | 2537·1 | 450·29 | 450·05 | --- |
| | 2547·2 | 449·86 | 449·40 | ---- |
| | 2566·3 | 448·20 | 448·20 | ---- |
| | 2606 | 445·74 | 445·40 | ---- |
| | 2627 | 444·39 | 444·20 | ---- |
| | 2638·6 | 443·59 | 443·45 | ---- |
| | 2670 | 441·63 | 441·48 | ---- |
| | 2686·6 | 440·62 | 440·40 | 440·771 |
| | 2721·6 | 438·50 | 438·40 | 438·558 |
| | 2734·9 | 437·55 | 437·51 | ---- |
| | 2775·6 | 435·42 | 435·18 | ---- |
| | 2797 | 434·08 | 434·00 | 434·263 |
| | 2822·8 | 432·56 | 432·50 | 432·691 |
| *G* | 2854·7 | 431·12 | 430·70 | 431·137 |
| | 2869·7 | 430·13 | 430·00 | 430·190 |
| | *a* | 428·96 | 428·90 | ---- |

| Kirchhoff. | D. | Angstrom. | v. d. Willigen. |
|---|---|---|---|
| A | 427·32 | 427·15 | 427·477 |
| $\gamma$ | 426·11 | 426·00 | 426·002 |
| $s$ | 425·41 | 425·05 | ---- |
| $\delta$ | 424·98 | 424·95 | ---- |
| $\varepsilon\ \omega$ | 423·69 | 423·55 | ---- |
| B | 422·68 | 422·65 | 422·876 |
| $\varsigma$ | 421·80 | 421·50 | ---- |
| $\theta$ | 420·13 | 419·81 | ---- |
| $\iota$ | 418·92 | 418·70 | ---- |
| $\chi$ | 417·36 | 417·20 | ---- |
| $\mu$ | 415·70 | 415·40 | ---- |
| $\nu$ | 414·43 | 414·30 | 414·544 |
| $\Gamma$ | 413·37 | 413·20 | 413·444 |
| E | 410·22 | 410·01 | 410·402 |
| $o$ | 408·21 | 407·70 | 407·979 |
| $\pi$ | 407·75 | 407·10 | ---- |
| $\sigma$ | 406·31 | 406·30 | ---- |
| Z | 404·52 | 404·50 | 404·772 |
| $\tau$ | 403·38 | 402·95 | 403·615 |
| $\phi$ | 400·63 | 400·45 | ---- |
| H | 396·89 | 396.80 | 397·146 |
| H′ | 393·53 | 393·30 | 393·872 |

W. G.

2. *On the spectroscopic observation of the rotation of the sun.*—Zöllner and Vogel have succeeded in applying the spectroscope to the measurement of the velocity of the sun's rotation. The first successful observations were made on the 2d of June last under unfavorable circumstances. The subject was resumed on the 9th of June and subsequent days by Vogel and Lohse with complete success, the instrument employed being the reversion-spectroscope of Zöllner attached to the large refractor of the observatory at Bothkamp near Kiel. The slit of the spectroscope was first directed by the aid of the clock-work to the receding edge of the sun, and the coincidence of the D lines in the two superposed spectra effected with the utmost precision. The clock-work was then stopped, and the moment of the disappearance of the second border of the sun observed. The non-coincidence of the D lines at the second border was distinctly seen in all the observations. On June 10th the observations were repeated with a highly dispersive spectroscope by Schröder, consisting of five direct-vision prisms and five other prisms arranged in a circle, and made of very heavy glass. The line selected was the fine line ($\lambda$=485·917), rather more refrangible than F. The non-coincidence of the image of this line with a fixed steel point was distinctly observed when the light came from the second border of the sun, the coincidence for the first border having been established. By measuring the amount of the displacement, Vogel found for the motion of a point on the sun's equator a velocity of 0·42 (German) miles per second in one series of observations, and 0·35 miles in a second series. These velocities are greater than those at present admitted, and Vogel considers the observations at present as simply demonstrating the fact of the sun's rotation.—*Pogg. Ann.*, cxliv, p. 449.

W. G.

3. *Researches on the ammoniacal compounds of Cobalt.*—F. Rose has published in pamphlet form an extended paper upon the ammonia-cobalt bases, containing, besides an elaborate history of the subject, some interesting new facts. By the action of the air upon solutions of cobaltous chloride in ammonia, besides the chlorides already well known, a dark- and a light-green salt are formed. The dark-green salt dissolves readily in water, at first with a greenish-blue color, which quickly passes to pure blue, and after some time to violet. Chlorhydric acid, with the aid of heat, decomposes this body with formation of chloride of purpureo-cobalt. The author calls this body chloride of dichro-cobalt, in

consequence of its well-marked dichroism. Its formula is, in the old notation employed by Rose, $Co_2Cl_3 . 3NH_3+2HO$, which may be written $\text{Є}o_2Cl_6 . 6NH_3+2\Theta H_2$, so that it is probably the chloride of cobalt-hexamin. Erdmann has described a corresponding nitrite and Künzel a sulphite; both these salts probably belong to the same series. Rose does not state whether the chloride unites with metallic chlorides to form salts. The light-green salt formed at the same time is identical with the salt discovered by Genth and Gibbs, and called by them praseo-cobalt. The existence of this body was denied by Braun. The salt forms beautiful bright-green crystals, which dissolve in water with a pure green color, which, however, soon passes to rose-red. Strong chlorhydric acid precipitates chloride of purpureo-cobalt from the solution. The formula of this salt is $Co_2Cl_3 . 4NH_3+2HO$ or $\text{Є}o_2Cl_6 . 8NH_3+2\Theta H_2$. It appears to be the chloride of the tetramin (octamin) series, the hyposulphate of which was discovered by Künzel and has the formula, $Co_2O_3 . 4NH_3 . 2S_2O_5$ or $\text{Є}o_2 . 8NH_3 . S_2\Theta_{13}$. Rose does not state whether the chloride combines or not with metallic chlorides, nor whether it yields other salts by double decomposition.—*Untersuchungen ueber ammoniakalische Kobalt-Verbindungen von Dr. F. Rose.* Heidelberg, 1871. W. G.

4. *On some new salts of roseo-cobalt and luteo-cobalt.*—KROK has studied a number of interesting salts of roseo-cobalt and luteo-cobalt in the laboratory of Blomstrand. The iodosulphate of luteo-cobalt, a yellow salt slightly soluble in hot and nearly insoluble in cold water, has the formula $\text{Є}o_2(NH_3)_{12}I_2(S\Theta_4)_2$. By evaporation with chlorhydric or nitric acid it yields the chloride or nitrate of luteo-cobalt. The corresponding chlorosulphate, $\text{Є}o_2(NH_3)_{12}Cl_2(S\Theta_4)_2+6$ aq, forms beautiful quadratic prisms, rarely octahedrons. Other salts of the same base have respectively the formulas,

$$\overset{vi}{\text{Є}}o_2(NH_3)_{12}\left\{\begin{matrix}(Cl_2 . 2HgCl_2)\\(S\Theta_4)_2\end{matrix}\right. \qquad \text{Є}o_2(NH_3)_{12}\left\{\begin{matrix}Cl_2 . PtCl_2\\(S\Theta_4)_2\end{matrix}\right.$$

$$\text{Є}o_2(NH_3)_{12}\left\{\begin{matrix}Cl_2 . 2HgCl_2\\Cl_4\end{matrix}\right. \qquad \text{Є}o_2(NH_3)_{12}\left\{\begin{matrix}I_4\Theta_{11}+2\text{ aq}\\Cl_4\end{matrix}\right.$$

The salts of roseo-cobalt obtained were:

$$\overset{vi}{\text{Є}}o_2(NH_3)_{10}I_2(S\Theta_4)_2+2\text{ aq}$$
$$\text{Є}o_2(NH_3)_{10}B\ _2(S\Theta_4)_2+2\text{ aq}$$
$$\text{Є}o_2(NH_3)_{10}Cl_6+2\text{ aq}$$
$$\text{Є}o_2(NH_3)_{10}(N\Theta_3)_6+2\text{ aq}$$
$$\text{Є}o_2(NH_3)_{10}Cl . S\Theta_4 . (S\Theta_4NH_4)'_3$$
$$\text{Є}o_2(NH_3)_{10}\begin{matrix}Cl_2 . 2HgCl_2\\(S\Theta_4)_2\end{matrix}+6\text{aq}$$
$$\text{Є}o_2(NH_3)_{10}\begin{matrix}(PtCl_4)''_2\\(N\Theta_3)_2\end{matrix}$$
$$\text{Є}o_2(NH_3)_{10}\begin{matrix}Cl_3 . 3HgCl_2\\(N\Theta_3)_3\end{matrix}$$
$$\text{Є}o_2(NH_3)_{10}Cl . (N\Theta_2)_5+3\text{ aq.}$$

They are not described in the letter from which this abstract is taken; the chloride and nitrate have long been known. The only salts of purpureo-cobalt mentioned are the well-known chloride and a chloroxalate, with the formula, $Co_2(NH_3)_{10}Cl_2(C_2O_4)_2$. This last salt was obtained by precipitating the chloride by ammonic oxalate.—*Berichte der Deutschen Chemischen Gesellschaft, Jahrgang* iv, p. 749. W. G.

5. *On the transformation of glucosides into monatomic and hexatomic alcohols.*—BOUCHARDAT has studied the action of an amalgam of sodium—in other words, of nascent hydrogen—upon glucose and milk-sugar. By the action of an amalgam, containing about 3% of sodium, upon glucose, the author obtained, together with a considerable quantity of mannite, an oily liquid containing common alcohol, $C_2H_6O$, isopropylic alcohol, $C_3H_8O$, and hexylic alcohol, $C_6H_{14}O$. This last is identical with the alcohol obtained by Erlenmeyer and Wanklyn from the iodide formed by distilling mannite or dulcite with iodhydric acid. The same volatile products were obtained from milk-sugar, but in place of mannite, dulcite was formed. By the hydrogenation of inverted milk-sugar, a mixture of dulcite and mannite was obtained.—*Comptes Rendus*, lxxiii, p. 1008. W. G.

## II. GEOLOGY AND NATURAL HISTORY.

1. *Notice of a new species of Hadrosaurus;* by O. C. MARSH.—Among the Reptilian remains obtained by the Yale College party during the past summer was the greater part of a skeleton of a small *Hadrosaurus*, discovered by the writer in the blue Cretaceous shale near the Smoky Hill River, in Western Kansas. This species was somewhat smaller than *H. minor* Marsh, from New Jersey, and hardly more than one-third the bulk of *H. Foulkei* of Leidy. It was of more slender proportions, with the tail much elongated. The cervical vertebra are proportionally shorter than in *H. Foulkei*, and the caudals appear more compressed. Some of the distal caudals have a longitudinal ridge on the lateral surface. The sacrum, which is composed of six confluent vertebræ, is 414·mm· in length. The first caudal vertebra is 62·mm· in length. The feet are nearly entire, and are proportionally more slender than the known remains of the other species would indicate. The third metatarsal is 235·mm· in length, and 77·mm· in transverse diameter at its distal end. This species, which may be called *Hadrosaurus agilis*, will be fully described in this Journal at an early day.

Yale College, New Haven, March 19th, 1872.

2. *Corundum of North Carolina.*—Corundum has long been known to occur in Franklin, Macon Co., N. C., in large loose masses. Through the energy and labors of Col. C. W. JENKS, the masses have been traced up to their source, near by, in veins in the Blue Ridge, about 2500 feet above the sea level. Col. Jenks informs us that the main vein is four feet wide, and has a northeast course. It is made up of crystalline masses and crystals of the corundum, of

fine blue, grayish white and red colors, along with crystallized chlorite, and has a considerable thickness of the chlorite either side. The chlorite is supposed to be the *corundophilite* of Shepard, as the mineral to which this name was given came from masses of the corundum. There are six other veins, according to Col. Jenks: one of them is pure corundum; in others, it is associated with chlorite, or tourmaline, or feldspar, or mica. One chloritic vein has the chlorite packed with zircons; while another contains a greenish black variety of spinel, partly in disseminated grains, and partly in octahedral crystals, often grayish externally. In the mountain there are talcose or talcoid schists with some serpentine and several other minerals. The crystals of corundum are of all sizes from those of quite small size that are red and blue sapphires with good terminations, to others of gigantic dimensions, one prism weighing 300 pounds. These large masses are often fine in their red and blue colors.*

3. *Tusk of an Elephant or Mastodon found in Colorado.*—According to Capt. BERTHOUD, at the Patch or Hill diggings in the valley of Clear Creek five miles above Golden, and about one mile east of Guy gulch, he has recently discovered a portion of an elephant or mammoth tusk two feet eight inches long and eight inches in diameter, which in the ground sluicing of that placer was freed from its ten or fifteen feet of superincumbent gold-bearing gravel. This fragment of tusk lay some 25 feet above the bed of Clear Creek, and seems to have been brought to the position where found by glacial drift from a northwest course.

4. *United States Geological Surveys.*—A bill has passed the House in Illinois making liberal appropriations for the publication of the 5th volume of the Geological Report of the State, and it is confidently expected that the Senate will concur in it.

Dr. Newberry has asked from the Legislature for $10,000 to finish the Survey of Ohio and the Reports. The Legislature has not yet acted on the question, but a favorable result is expected. The good of the State and country will be promoted by the passage of the bill. The survey has been well carried forward under its able head, Prof. J. S. Newberry, and the Reports will be a highly valuable contribution to science.

A large appropriation is looked for from the Legislature of California for the continuation of the Survey of the State under Prof. J. D. Whitney and the printing of its Reports.

5. *Second Report of the Geological Survey of Indiana*, made during the year 1870, by E. T. COX, State Geologist, assisted by Prof. JOHN COLLETT and Dr. G. M. LEVETTE. 304 pp. 8vo, with plates, maps and sections. Indianapolis, 1871.—This second Report of Prof. Cox is occupied mainly with details respecting the coal beds and the associated rocks especially of Sullivan, Davies and Martin counties, with notes also on some of the counties adjoining. There are also brief observations on the Quaternary and the various economical products of the counties, numer

* The veins are being opened by the American Corundum Co. of St. Louis, of which Col. Jenks is the "business manager."

ous analyses of coal by Dr. Levette, and general observations on the subdivisions of the coal formation of the State.

The chapter on Sullivan Co. is contributed by Prof. Collett. Speaking of the Quaternary of this county, he observes that the drift consists, in descending order, of blue and gray clays irregularly mixed with coarse and fine gravel; below these, the same clays with coarse gravel and boulders of granite, gneiss, quartzite, porphyry, with a very small quantity of gold, copper, lead ore, magnetic iron ore and red garnets; and at bottom, blue and white plastic clay two to five feet thick. The stratified material called "loess," stated to be next in time, contains at Fort Azatlan near Merom, a number of land shells, all of which are identical with existing species now living in the State, excepting *Helix occulta*, which has not been found living north of Arkansas.

Prof. Cox states that he is unable to find any ground for subdividing the coal formation into parts corresponding to separate epochs. He observes that there are two well defined zones of coal in the State, an eastern and a western. The area of the eastern is about 450 square miles; and the coals are of the free-burning or non-caking variety. The number of coal seams is eight; of these four are of good workable thickness over a portion of the field, making together fifteen feet. Adding six feet for the others it gives in all twenty-one feet of coal. Supposing one half this thickness to exist over the 450 square miles of area, it makes, as Prof. Cox says, the whole contents of coal to exceed five and a quarter millions of tons. The coal from this zone has received the name of *Block-Coal* on account of readily coming out in large blocks when mined. It breaks into thin sheets parallel with the bedding, but with difficulty in the opposite direction. The coal is remarkably free from sulphur and phosphorus, and is coming rapidly into use for the manufacture of Bessemer steel.

The western zone covers full 6,000 square miles, and contains three or more thick beds of good coal, which are in general caking-coals.

The Report closes with a list of the Plants of the State, by A. H. Young.

6. *Mines, Mills and Furnaces of the Pacific States and Territories;* by Rossiter W. Raymond, Ph.D., United States Commissioner of Mining Statistics. 8vo, pp. 556. New York: J. B. Ford and Company. 1871.—This volume forms the report of the Commissioner for the year 1870, and is issued by the publishers in advance of the congressional edition, which has only recently been ordered. It is the fifth report, in the series commenced in 1866, upon the condition and progress of mining industry in the Rocky Mountains and westward to the Pacific. In addition to the usual chapters of statistics of the production of the precious metals, this volume, like those which have preceded it, gives a great amount of valuable information upon the condition, resources and methods of the mining and metallurgical industry in California, Nevada, Montana, Arizona, and other important mining regions. We find, also, chapters upon metallurgical processes,

narrow gauge railways, mining law, the geographical distribution of metals and ores, the origin of gold dust and gold nuggets, etc., etc.

Incidentally to the descriptions of mining districts, a very considerable amount of information respecting the topography and the geology is given. This is true especially of the chapters upon the Territory of Arizona, which was visited by Dr. Raymond's assistant, Mr. Tilers. We find, for example, p. 230, the best description of the nature and extent of the great basaltic bed along the Gila river that has yet been given.

In the five chapters devoted to metallurgical processes, there is one upon the treatment of auriferous ores in Colorado, which includes a description in detail of the stamp batteries, and the arrangements for concentration. It is thorough and scientific, and is a valuable contribution to the literature of the mechanical treatment of ores. The only regret experienced in reading it is, that the same critical care and labor could not have been bestowed upon the superior mills and working in California. The chapter contains an elaborate discussion of the capacity, the wear and the product of stamps. The cost of gold extraction at steam mills is deduced as $3.74 per ton, including the interest on capital and the loss of quicksilver. Mr. Hague, in the volume upon Mining Industry, p. 555, makes the cost, exclusive of interest on capital, $3.69 per ton.

The total production of bullion gold and silver for 1870 is estimated at $66,000,000, of which California is supposed to have produced $25,000,000, and Nevada $16,000,000. Of quicksilver, the production was 29,546 flasks, being about 4000 flasks less than in 1869, and the price had advanced from 60 to 90 cents.

The volume, throughout, gives evidence of great labor and care in its preparation, and is a most acceptable addition to our knowledge of the mineral resources of the western portion of the country.

7. *Geology of Oxford and the Valley of the Thames;* by John Phillips, M.A., F.R.S., etc., Prof. Geol. in the University of Oxford.—Professor Phillips, one of the best geologists of Great Britain, has done a great service to general geology in the preparation of this work on Oxford geology. The rocks of nearly the whole geological series exist within the region described, or upon its borders, and the work consequently has nearly the comprehensive character of a general treatise on the science. Moreover, it is written in an attractive style, and illustrated with a very large number of cuts of fossils and sections, besides a colored geological map. The Malvern Hills, forming part of the boundary of the district, are claimed to be the oldest rocks of England—as old as any in Scotland—and the representatives, therefore, of the Laurentian of North America. The next rocks described are the Cambrian (now proved to be Primordial) and the rest of the Lower Silurian, which occur in the Malvern region. The larger part of the volume is taken up with the lias and oölite, and in this

part especially the work contains the results of much original investigation. The great Ceteosaurus is described in detail, and with many new facts and figures; and the other British reptiles of the period are well illustrated. The volume should be in the hands of every teacher of geology, and of all who have special interest in the science. Moreover it is a model for a treatise of the kind.

8. *Papers on the Eastern and Northern Extension of the Gulf Stream.*—From the German of Dr. A. PETERMANN, Dr. W. VON FREEDEN and Dr. A. MUHNY. Translated, in the United States Hydrographic office, in charge of Captain R. H. Wyman, U. S. N., by E. R. Knorr. 388 pp. 4to. Washington, 1871.—The Bureau of Navigation in this translation has made accessible to English readers several valuable memoirs by European geographers and explorers. The subjects of the Gulf Stream, the circumpolar currents, and the temperature of the Arctic are treated at length, with a full presentation of facts from all sources. The volume contains two colored maps, one giving the course of the Gulf Stream and the oceanic temperature north of latitude 35° in July, and the other the same in January, with also the temperature lines over Europe and part of Asia.

9. *Corals and Coral Islands;* by JAMES D. DANA. 398 pp. large 8vo. with several maps and numerous illustrations. New York, 1872. (Dodd & Mead, 762 Broadway).—This work is a general treatise on coral animals, and on the structure and origin of coral reefs and islands. It is based on the report on Zoöphytes published by the author in connection with the Wilkes Exploring Expedition, and a chapter of one hundred and fifty pages on Coral Reefs and Islands in the author's Geological Report of the same Expedition. Over one hundred pages are devoted to the subject of polyps and coral animals, their structure, habits, coral secretions, their classification, geographical distribution, etc., and many figures of corals, some of them of living corals, are given. The frontispiece contains colored figures of species of Actiniæ or Sea-Anemones, from the author's Report on Zoöphytes.

The following two hundred and fifty pages are occupied with a description of the structure of reefs and islands, a discussion of the origin of their peculiar forms and conditions and the rate of growth of reefs, an account of the completed atoll, notes on the geographical distribution of reefs, a survey of the proofs of elevation and subsidence over the Pacific derived from coral reefs and islands, and a chapter of geological conclusions from the facts of the volume. In an appendix the accepted names of all the species figured in the author's Report on Zoöphytes are given in a table prepared by Prof. Verrill.

The volume is printed in an unusually handsome style. The illustrations add much to its beauty.

10. *Report of the Geological Survey of the State of New Hampshire,* showing its progress during the year, 1870, by C. H. HITCHCOCK, Ph.D., State Geologist, Prof. Geol. and Min. in Dartmouth

College. 82 pp. 8vo. 1871.—This report contains brief notes on some of the rocks of the State, but is occupied mainly with the meteorological observations and other records made during the "Mount Washington Expedition" in the winter of 1870–1871.

11. *Report of the Geological Survey of Wisconsin;* by JOHN MURRISH, Commissioner of the Survey of the Lead District. Addressed to the Governor of the State, and submitted with the Governor's message, Jan. 11, 1872. This report is evidently the work of no regular State geologist. It is a trashy document, miserable in the most of its science, and often bad grammatically.

12. *Annual Report of the State Geologist of New Jersey for the year* 1871. 46 pp. 8vo.—Prof. G. H. COOK, State Geologist, here presents briefly facts connected with the economical geology of the State.

13. *Das Elbthalgebirge in Sachsen* von Dr. HANNS BRUNO GEINITZ. Erster Theil. Der untere Quader. III. Seeigel, Seesterne und Haarsterne des unteren Quaders und unteren Pläners. Mit tafeln 14–23. This continuation of Prof. Geinitz's fine work on the Elbe valley geology, contains descriptions, as the title page mentions, of the fossil Echinoids, Asterioids and Comatulids with, ten plates of excellent crowded figures.

14. *Scheutz, Prodromus Monographiæ Georum.* (Ann. Act. Upsal, 1870.) pp. 69, 4to.—Fischer and Meyer, and later C. A. Meyer himself, have attempted to put the genus *Geum* in order, and it is now the subject of a very careful monograph by a young botanist of the Upsal school, working under the eye of the veteran Fries. The genus is here received in the widest sense, as including both *Stylipus* and *Sieversia.* The North American species admitted are:

*G. Virginianum* L. and *G. album* Gmelin, characterized as we now understand them, but with more absoluteness than is found to prevail here where they grow. To the latter Scheutz inclines to refer Walter's *G. Carolinianum.* From the character there is hardly a doubt of it, and Walter's name is much older than Gmelin's.

*G. Oregonense* Scheutz is a new "sub-species" under *G. urbanum* (otherwise recognized only from the Old World): it is described from a specimen in the Stockholm herbarium collected by Wærngren; nothing of the sort from Oregon has fallen under our notice.

*G. strictum* Ait. Its extension into Corea and Japan is not referred to. The Scandinavian *G. hispidum* of Fries, admitted as a distinct species, seems too like *G. strictum.*

*G. Japonicum* Thunberg. To this, on the authority of Thunberg's specimens, *G. macrophyllum* Willd, is referred. Our two Japanese specimens (Oldham's, and one from the Leyden herbarium) have neither radical leaves nor mature fruit; they accord with Thunberg's character, and their rounder, scarcely lobed cauline leaves, and soft close pubescence or tomentum of the peduncles and upper part of the stems (quite at variance with "tota planta hirsutissima"), leave one dissatisfied with the identification.

*G. agrimonioides* (Pursh ?) C. A. Meyer. As to Pursh's plant, Scheutz has overlooked the positive affirmation in Torr. and Gray Flora, that it is *Potentilla arguta*, as was long before suspected by Torrey. Scheutz has no authentic materials of this, but describes from a specimen cultivated in the Upsal Garden, which accords with Meyer's description. The latter describes a specimen received from New York, in flower only, of which the petals are said to be "alba, vel ochroleuca, certe non aurea," three lines long and two wide, oval, and rather shorter than the calyx. We have no white flowered species with densely pubescent receptacle, which is the special character of *G. strictum*, and none of the latter with petals oval instead of orbicular, and rather shorter than the calyx. Meyer's plant lies between *G. strictum* and *G album* or *Virginianum*. It is to be noted that there is a Geum in Pennsylvania, Ohio, &c., with greenish-yellow or yellow petals, but with the receptacle and mainly the other characters of *G. album*. This we have once referred to *G. urbanum* L., and the question is whether *G. album* altogether should not be so referred, as is intimated in the last edition of the Manual.

*G. rivale* L. and *G. geniculatum* Michx., our only *Caryophyllata*. The latter, we still presume, was not found in Canada.

*G. glaciale* Adams, *G. triflorum* Pursh (to which his *G. ciliatum* is also referred), and *G. anemonides* Willd. (the first and last barely reaching our northwestern shores), are the *Sieversiæ* with plumose styles.

*G. radiatum* Michx. and *G. Peckii* Pursh (regarded as distinct, but surely without grounds), of the east; and *G. rotundifolium* Langsd. and *G. calthifolium* Menzies (probably not distinct), of the northwest coast, are our round-leaved *Sieversiæ* with styles naked above.

*G. Rossii* Seringe has styles wholly naked, and the pinnate foliage of *G. triflorum*.

*G. vernum* Torr. and Gray, the *Stylipus vernus* Raf., our author is much disposed to rehabilitate as a genus. A. G.

14. *Baillon, Histoire des Plantes* (Hachette & Cie, Paris).—The parts which have appeared during the year 1871 are numerous and important, and show a disposition to push on this work rapidly. Besides those noticed in our December number, we have now before us the monograph of *Papaveraceæ* and *Capparidaceæ*.

Following his extreme bent for combination, Baillon not only ranks the *Fumariaceæ* as a mere tribe of *Papaveraceæ*, but combines *Hunnemannia* with *Eschscholtzia* (yet, singularly enough, he keeps *Adlumia* distinct from *Dicentra*), reduces all Cleomeous genera to *Cleome* and *Wislizenia*, in place of nine genera admitted by Bentham and Hooker, and finally, though somewhat dubiously, appends *Moringa* to the order.

In the next monograph, that of *Cruciferæ*, we were curious to know what course would be followed in a strictly monotypical order, rather expecting that the 170 genera which Hooker and Bentham admitted might be reduced to a moiety; but he has cut short only ten, and, in fact, has followed his predecessors somewhat literally.

In the monograph of *Resedaceæ* there is no novelty to report. In *Crassulaceæ* only seven genera are left, *Penthorum* being transferred to *Saxifragaceæ*, *Tillæa* as well as *Rochea* to *Crassula*, and *Diamorpha* reunited to *Sedum*.

*Saxifragaceæ* are more remarkably treated. The order,—widened beyond all former limits by Bentham and Hooker, who included the *Francoeæ*, *Brexieæ*, the *Grossularieæ* and *Cephalotus*,—is now to comprehend, 1. *Penthorum*, to which no particular objection need be made; 2. *Pterostemon*, with seeds at length determined to be copiously abuminous; 3. the *Pittosporeæ;* 4. the *Bruniaceæ;* 5. the *Hamamelideæ;* 6. *Liquidambar* and its allied *Bucklandia;* 7. *Platanus;* 8. *Myosurandra* and another genus, trees of Madagascar, of which we know nothing; and, 9, with a saving mark of doubt, the *Datisceæ*. As to number of genera there is not much reduction. How such a family group is to be characterized, or why the author stops where he does, is not for us to say.

*Piperaceæ* constitute the next monograph, and are made bodily to include, not only the *Saurureæ*, but the *Chloranthеæ*, and *Ceratophyllum* as an appendage; the genera nearly as in a recent volume of the Prodromus. In *Urticaceæ*, the order is taken in the strict sense, and Weddell is quite implicitly followed. A. G.

## III. Astronomy.

1. *On the Eclipse of the Sun on September 29th*, 1875; by Robert Treat Paine.* (Communicated to this Journal.)—In the remainder of this century there will be, in that large part of the United States north of North Carolina and east of the Mississippi, only one central eclipse of the sun, viz., the one which will be annular, in part of the State of New York and of four of the New England States, soon after sunrise on Wednesday, September 29th, 1875.

In the list of all the eclipses of the sun, visible at Boston, from 1824 to 1901, computed in 1823, by the solar and lunar tables then used, and published in the American Almanac for 1831, this eclipse is thus mentioned:

| | | | | | |
|---|---|---|---|---|---|
| 1875 Sept. 29th, | Sun rises three-fifths eclipsed | $5^h$ | $56^m$ | $30^s$ | mean time. |
| | Formation of the ring, | 6 | 20 | 21 | " |
| | Rupture of the ring, | 6 | 22 | 52 | " |
| | End of the eclipse, | 7 | 30 | 43 | " |

With the aid of the English Nautical Almanac for 1875 (in which the places of the sun and moon are given according to the recent and more accurate tables of Le Verrier and Hansen), this eclipse has been lately recomputed for lat. 42° 22′ 48″, long. 71° 7′ 40″, and will take place as follows:

* Mr. Paine states in a note to the editors:—My list of *all* the solar eclipses at Boston between 1824 and 1901, was computed in 1823 (the year after leaving college) when in my 19th year. It contains 30 eclipses, of which 20 have taken place, all of which but two, I think, I have observed; four of them (Feb. 1831; Sept., 1838; May, 1854, and Oct., 1865); *annular*, at Chatham, C. C.; Washington; Middlebury, Vt.; and Charleston, S. C. and two *total*: (Nov. 30th, 1834 and August 7th, 1869), at Beaufort, S. C.; and Boonesboro, Iowa; and I have begun to hope it is not impossible that I may observe here. the annular one of Sept., 1875, and at *Denver*, Colorado, the total one on July 29th, 1878.

| | | | | |
|---|---|---|---|---|
| Formation of the ring, | $6^h$ | $21^m$ | $22^s{\cdot}7$ | A. M. |
| Least distance of centers of ☉ and ☽, | 6 | 22 | 37 ·0 | " |
| Rupture of the ring, | 6 | 23 | 51 ·5 | " |
| End of the eclipse, | 7 | 32 | 35· 4 | " |

Least apparent distance of centers 29″·64, difference of semi-diameters 45″·78, do. of apparent latitudes, moon north, 29″·35.

The *central* eclipse will begin on the earth at sunrise, in lat. 43¼°, long. 77°, or near *Oswego*, in New York, and taking an E. by S. direction will reach the ocean at $6^h\ 24^m\ 2{\cdot}5^s$ *local* or at $11^h\ 7^m\ 22{\cdot}8^s$ Greenwich time, in *Salisbury*, in the northeastern extremity of Massachusetts, in lat. 42° 52 57″, long. 70° 50′ 5″; it thence passes in an E.S.E. course across the Atlantic, reaching Africa in lat. 17° N. long. 16° W. near Cape Verd, and leaving the earth at sunset, having occupied $3^h\ 41\frac{1}{2}^m$ in crossing it, in lat. 15° south, long. 46° east, in the island of Madagascar. The duration of the ring where longest will be $3^m\ 39^s$, but in *Salisbury*, Mass., and the adjacent town of *Seabrook*, N. H., $3^m\ 17{\cdot}2^s$.

The distance between the northern and southern limits of the annular eclipse in New York and New England will be about 110 miles, and a line drawn on a map, from Watertown, N. Y. about five miles south of Middlebury, Vt., and three south of Portland, Me., will represent very nearly the *northern* limit, and another drawn five miles north of Ithaca and of Hudson, N. Y., over Hadley, Franklin, Duxbury and Truro, Mass., the *southern*. Between these lines are included a large part of central New York east of Cayuga county, three quarters of Massachusetts, the southern half of Vermont and New Hampshire, and the southwestern extremity of York and part of Cumberland counties, Maine; also *five* astronomical observatories, viz: those of Hamilton College near Utica, and at Albany, in New York, at Harvard University and Amherst College, Mass., and at Dartmouth College, New Hampshire; but the eclipse will not be annular at Vassar College, Poughkeepsie, in any part of Connecticut or Rhode Island, at Springfield, Fall River or New Bedford, Mass., Middlebury, Vt., or Portland, Maine; at the last city, however, in lat. 43° 39′ 54″, long. 70° 14′ 34″, the least distance of the centers, 47″·62, will exceed the difference of the semi-diameters 45″·61, by two seconds only.

Since the magnificent total eclipse of five minutes duration, at Boston and Albany, near noon of June 16th, 1806, there have been in New England only two central eclipses, both annular in Massachusetts, viz., on February 12th, 1831, in Nantucket and Barnstable counties, and the second on May 26th, 1854, in a large part of New York, and of the same New England States as the one above described, and which at its next return on the 6th of June next will be annular at the city of Madras, etc., in India. When another central eclipse will occur in the northeastern part of the United States, has not, it is believed, yet been ascertained. But in more distant parts of our extensive territory or its vicinity, there will take place, according to the list computed in 1823, before mentioned, the following central eclipses within the next 29 years:

1876, March 25th, a central eclipse near noon, in part of Vancouver's Island and of British Columbia, probably total there a very few seconds, but generally annular, where the altitude of the moon will be less.

1878, July 29th, the great eclipse of June 16th, 1806, will return for the fourth time, and the shadow of the moon will pass over British Columbia, Montana, Colorado, Texas, Cuba, the city of Havana, etc. At *Denver*, Colorado, at about $3\frac{1}{2}$ P. M., the eclipse will be total nearly three minutes, so that for careful observations on this eclipse Denver appears to be very favorably situated.

1885, March 16th, the eclipse of Feb. 12th, 1831, will return the third time, and be annular in the northern part of California and in Montana.

1900, May 28th, a total eclipse of the sun in the southern States, and the shadow of the moon, coming from the southwest, will reach the ocean in North Carolina, a little south of Norfolk, but the duration of totality will not exceed a minute at any place in the United States, where the eclipse is central.

Boston, February, 1872.

2. *Solar eclipse of Dec.* 12. *Observations made at Bekul by* J. P. MACLEAR, dated S. S. Indus, Jan. 6, 1872.—* * * The morning dawned bright and clear, only a few small clouds to be seen near the western horizon, a light breeze from the N.E. All were early at their stations watching anxiously the appearance of the sun, which rose over the distant hills about half-an-hour before the commencement of the eclipse. But now I shall speak only of my own observations; Mr. Lockyer has already given the account of those made by himself.

The instrument I used was a double equatorial of two 6-inch refractors mounted on the same base, one at either end of the declination axis. To one was attached a 6-prism spectroscope from Kew, lent by Mr. Spottiswoode, of great dispersive power. To the other was fixed a spindle bar, carrying an erecting eye-piece, and a 7-prism direct vision spectroscope, either of which could be swung at pleasure into the focus of the object glass; the two tubes had been carefully made parallel, so that the same object was viewed in both telescopes. The 6-prism was worked nearly the whole of the time by myself, and the direct vision by Mr. Pringle, who had practised with it constantly during the last few days. I add the observations made by him. At the commencement of the eclipse the slit of the 6-prism was placed tangential to the point of contact, that of the direct vision radial, width such that the absorption lines were very distinct, but not too fine. No change was observed from the ordinary solar spectrum. Keeping the slit for the next quarter of an hour tangential to the northern cusp, C was very bright the whole length; F bright, but thin. The slit was then placed radial to the cusp, and four bright lines near C (besides C itself) became visible, one on the direct side within 10 units Kirchhoff, and three on the red side within 20 units, the length of all five varying, but not together, the average being about one-eighth the height the visible spectrum.

At 6h. 51m. M. T., twenty-five minutes after contact, on a large prominence, C lengthened to half height of spectrum; nine minutes afterwards cusp was at another prominence; the positions of these must have been about N. 13°, and nearly north.

At 7h. 8m. M.T. I watched with the direct vision radial, and, besides the hydrogen and "near D" lines, observed another bright line a little more refrangible than the air band between *b* and F. At 1830 Kirchhoff it was very faint, and soon disappeared; soon after this I saw F line double about the same height as usual, one-eighth spectrum.

At 7h. 23m. M. T., having returned to the 6-prism radial to the cusp, I observed the hydrogen D, E and *b* very plain; several lines then began to come into view, as near as I could judge all the iron lines from halfway between D and E to beyond *b*. These kept on brightening and more lines coming in. I called Mr. Lockyer to look at the phenomenon, and we watched it together for two or three minutes until it became time to take position to observe totality. During these two or three minutes the cusp must have passed from about N. 38° E. to N. 70° E. or farther, and the lines were not lost sight of till I moved the telescope and placed the slit tangential to the point where the light would disappear, keeping it there with R.A. movement. On looking through the spectroscope the field was full of bright lines, the light just enough to let me distinguish the positions from the well-known solar lines.

As totality came on the light decreased, and the lines increased exceedingly rapidly in number and brightness, until it seemed as if every line in the solar spectrum was reversed; then they vanished, not instantly, but so quickly that I could not make out the order of their going, except that the hydrogen D, *b*, and some others between D and *b*, remained last. Then they vanished, and all was darkness. I then unclamped, and swept out right and left, but saw nothing; then went to the direct vision, but saw nothing; placed the telescope on the moon's limb by the eye-piece, then put in the spectroscope, but the light was not sufficient to show any spectrum; pointed the telescope carefully, first on the dark moon, and then on a bright part of the corona, but no spectrum. I then looked at the corona with the naked eye, saw a bright glory around the moon, stellar form, six-pointed, something like the nimbus painted round a saint's head, extending to a diameter and a half. Looked through the finder, and saw the same form, but very much reduced in size and brilliancy; then examined with the 6in. and eye-piece, and saw nothing but a bright glow round the moon, not much more than the height of the big prominence plainly visible in the S.E. quarter. The last thirty seconds had now arrived, and, as previously arranged, Mr. Lockyer took my place at the 6in., while I again looked through the 6-prism spectroscope to record anything that might be visible, but I saw nothing. As the spectroscope was not on the sun's limb at the re-appearance of the light, I cannot state what took place.

During the remainder of the partial eclipse I watched the northern cusp as the moon uncovered the sun, and several times I saw distinctly the four bright lines near C; but saw nothing else worth recording.

The color of the corona appeared to me a light pinkish white, very brilliant. I saw no streamers. The rest of the sky and everything around had a bluish tinge. * * *—*Nature, Jan.* 18.

3. *The Solar Eclipse of Dec.* 12. *Observations made at Poodocottah;* by L. RESPIGHI.—The spectral observations of recent total eclipses of the sun had plainly demonstrated the existence of an incandescent gaseous stratum or atmosphere, surmounting the chromosphere or stratum of hydrogen which envelops the body of the sun, but they had not sufficed to determine its true conformation and extent. This question, therefore, constituted one of the principal problems remaining to be solved by observations of the eclipse of the 12th of December, 1871.

The slit-spectroscope applied to large telescopes doubtless affords the best means of verifying the existence, in the circumsolar regions, of this gaseous stratum, which may be termed the superior chromosphere, and of determining the materials of which it is composed; but from the shortness of the time available in an eclipse, the spectroscope can furnish only partial and local results, insufficient, therefore, to reveal the true structure, form, and dimensions of this upper chromosphere.

Preceding observations having shown that the light of the solar corona is composed for the most part of a small number of elementary rays differing considerably in refrangibility, it appeared to me that the form and dimensions of the higher chromosphere might be much more conveniently studied by means of a large prism fixed in front of the object-glass of the telescope, whereby the several chromatic images of the corona would be distinctly formed in the focal plane. If the prism has but little dispersive power, and the eye-piece does not magnify too much, all the chromatic images of the corona may in this manner be observed simultaneously in the same field, and their form and dimensions directly investigated.

Towards the end of the year 1868, a small flint-glass prism was made for me by Signor Merz, of Monaco, to be fitted to the object-glass of the equatorial belonging to the Observatory of Campodoglio, for observations on the spectra of the stars; and this apparatus, in consequence of the dispersion of the prism, and the goodness of this prism and of the object-glass, was found to be admirably adapted for observing the eclipse in the manner just described.

The dispersion of the prism from the lines C to H of Fraunhofer is about 32′; the free aperture of the object-glass is $4\frac{1}{3}$ French inches; the field of the telescope is about 1°, with a magnifying power of 40.

My conviction of the great advantages which would be afforded by this instrument in the observation of the approaching eclipse, induced me to carry it to India for that purpose; and I was glad to learn that Mr. Lockyer, the chief of the expedition, had in like manner resolved to observe the corona by means of a spectroscope without a slit, being persuaded that this would be the most con venient method of solving the questions relating to the corona itself. With this instrument, then, I prepared to observe the eclipse, proposing to myself the following problems:—

1. To ascertain whether, just before the beginning, and at the end of totality, the solar spectral lines are reversed—a phenomenon observed by Prof. Young in the eclipse of 1870.

2. Amidst the several chromatic images of the prominences, to observe especially whether the image given by the yellow line $D_3$ coincides with that of the lines of hydrogen gas.

3. To define the form and dimensions of the chromatic images of the corona. * * *

To verify the phenomenon of the reversal of the spectral lines at the extreme edge of the sun, I had arranged the plane of dispersion at right angles to the edge at the point of second contact.

At thirty seconds before totality, the spectral image of the luminous crescent was already sufficiently weakened to allow of its observation by the naked eye without a dark glass; and it was then that the principal dark lines of the solar spectrum came out distinct, and even more strongly marked than before, and curved parallel to the bright edge of the sun; but a few seconds before totality these lines disappeared completely, and the spectrum became continuous, without however exhibiting, just before totality, the reversal of the lines, although I was watching most intently for this phenomenon. I would not, however, be understood as denying altogether the reversal of the lines, for it is not impossible that a thin film of mist, or the bright atmospheric light at that time diffused over the spectrum of the solar limb, may have concealed the bright lines.

At the very instant of totality, the field of the telescope exhibited a most astonishing spectacle. The chromosphere at the edge, which was the last to be eclipsed—surmounted for a space of about 50° by two groups of prominences, one on the right, the other on the left, of the point of contact—was reproduced in the four spectral lines, C, $D^3$, F and G, with extraordinary intensity of light and the most surprising contrast of the brightest colors, so that the four spectral images could be directly compared and their minutest differences easily made out.

In consequence of the achromatism of the object-glass, all these images were well defined, and projected in certain colored zones, with the tints of the chromatic images of the corona. My attention was mainly directed to the comparison of the forms of the prominences on the four spectral lines; and I was able to determine that the fundamental form, the skeleton or trunk, and the principal branches, were faithfully reproduced or indicated in the images, their extent being, however, greatest in the red, and diminishing successively in the other colors down to the line G, on which the trunk alone was reproduced. In none of the prominences thus compared was I able to distinguish, in the yellow image $D^3$, parts or branches not contained in the red image C.

Meanwhile the colored zones of the corona became continually more strongly marked, one in the red corresponding with the line C, another in the green, probably coinciding with the line

1474 of Kirchhoff's scale, and a third in the blue, perhaps coinciding with F.

The green zone surrounding the disc of the moon was the brightest, the most uniform, and the best defined. The red zone was also very distinct and well defined, while the blue zone was faint and indistinct. The green zone was well defined at the summit, though less bright than at the base; its form was sensibly circular and its height about 6′ or 7′. The red zone exhibited the same form and approximately the same height as the green, but its light was weaker and less uniform. The height of the green zone was estimated by comparison with the moon's diameter, and from the observed distance of the spectral lines of the prominences.

These colored zones shone out upon a faintly illuminated ground, without any marked trace of color. If the corona contained rays of any other kind, their intensity must have been so feeble that they were merged in the general illumination of the field.

Soon after the middle of the total eclipse, there appeared on the eastern limb, at about 110° from the north point, a fine group of prominences formed of jets rather low but very bright, some rectilinear, others curved round the sun's limb, and exhibiting the intricate deviations and all the characters of prominences in the neighborhood of solar spots. The brightness and color of these jets were so vivid as to give them the appearance of fire-works.

The spaces between some of these jets were perfectly dark, so that the red zone of the corona appeared to be entirely wanting there. Perhaps, however, this was only an effect of contrast due to the extraordinary brightness of the neighboring jets. I have thought it right to refer to this peculiarity, because the appearance of interstices, or dark spaces, between prominences of considerable brightness, is often observed by means of the spectroscope, independently of total eclipses.

The want of an assistant to note the time, and to write down the observations as they were made, occasioned me some loss of time, and the end of the total eclipse was already at hand before I was aware of it.

The green and red zones were well developed at the western as at the eastern limb, while the blue remained faint and ill-defined.

Soon after the appearance of the chromosphere at the western edge, there was suddenly projected on the spectrum of the sun's limb, which then appeared beyond that of the moon, a stratum of bright lines, separated by dark spaces; but I could not determine whether they were due to a general or partial reversal of the spectral solar lines, or to a simple discontinuity in the spectrum, since they were too soon immersed in a flood of light, which put an end to the totality of the eclipse. * * *—*Nature, Jan.* 25.

4. *Prof. Young on the results of the Eclipse observations.*—In an article in the Boston Journal of Chemistry, Prof. Young thus speaks of the results of the observations on the recent solar eclipse, in establishing his interesting discovery in 1870, of the reversal of the Fraunhofer lines in a stratum close to the sun:

"The reversal of the Fraunhofer lines seems to have been satisfactorily observed by Captain Maclear at Bekul, Colonel Tennant at Dodabetta, and Captain Fyers at Jaffna. It was partially seen by Pringle at Bekul, and Respighi at Poodocottah, and probably by Pogson at Avenashi. How it was with Janssen I do not know. His instrument, however, on account of the small size of the sun's image, was not very well adapted for this observation.

Mosely, at Trincomalee, did not see it. Mr. Lockyer missed it by an accidental derangement of the telescope. He says further, 'At the last contact Mr. Pringle watched for it and saw no lines.' How the mistake occurred I do not understand, but Mr. Pringle's own words are, 'At the end of totality a considerable number of lines flashed in; what proportion of the whole I cannot say, perhaps one-third.'

Captain Maclear writes, 'As totality came on the light decreased, and the lines increased exceedingly rapidly in number and brightness, until it seemed as if every line in the solar spectrum was reversed; then they vanished, not instantly, but so rapidly that I could not make out the order of their going.'

This description applies exactly to what I saw in 1870, except that the lines then made their appearance more suddenly—they flashed out like the stars from a rocket head; but the discrepancy is easily enough accounted for by supposing that the portion of the sun's limb last covered by the moon was then more quiet than at the time of Captain Maclear's observations."

## IV. Miscellaneous Scientific Intelligence.

1. *Correspondence relating to the Dismissal of the late Botanist to the Department of Agriculture.* Reprinted from the American Naturalist for January, 1872. 8 pages, 8vo.—In the pages of the Naturalist, and in this pamphlet, this case has been so far made known that we can well enough refer to it without reprinting the correspondence, although this indeed is not long. That the botanists of the country should have felt aggrieved by the treatment accorded to one of their number is natural, and some expression of their indignation might not have been out of place. But in the published correspondence they have confined themselves first to a respectful request to the Commissioner of Agriculture that he "would take into consideration the propriety of re-appointing Dr. Parry to the position of Botanist in the Department of Agriculture;" then, on receiving an unfavorable reply, to which the Commissioner gratuitously appended the intimation that were it not for his desire to spare Dr. Parry in the estimation of his friends, he could say something to Dr. Parry's disparagement, one of their number claimed to be informed as to the nature of the delinquency insinuated, and was accordingly "put in possession of the whole subject," in a reply from the Commissioner, and thereupon (permission asked and granted), the correspondence is printed, that it may speak for itself. Leaving the case to make its own impression upon the Commissioner's own showing, no comment was made beyond the following preface.

"Dr. Parry was thought to have performed the duties of Botanist to the Department of Agriculture to the entire satisfaction of the previous Commissioner. His extraordinary abrupt dismissal upon the incoming of the present Commissioner, following a course of vexatious treatment to which, he states, he was subjected by his Chief Clerk, does not seem calculated to win the confidence of scientific men in the present administration of a department in which they naturally feel much interest."

The tenure of any appointment in a government office, with present usages, is precarious enough under ordinary circumstances; but here a scientific man is dismissed with far less notice and consideration than is due to a household servant. The Commissioner, just established in his office, writes to Dr. Parry, Sept. 27—"Sir: Your services as botanist of this department will not be required after this date;" and this letter is delivered at the close of the day.

Now, apart from the recognized official usages, there is one reason which might have suggested less precipitation in this instance. The Herbarium which Dr. Parry was in charge of, and was putting for the first time in order under instructions of the previous Commissioner, does not belong to the Agricultural Department, but is a part of the National Museum, of which the Smithsonian Institution is the legal, and was the actual custodian. The custody was transferred to the Agricultural Bureau under an arrangement between the Secretary of that Institution, and the late estimable and enlightened head of the Bureau (Gen. Capron)—who seems not to have thought an herbarium and an "herbarium botanist" "practically unimportant." And we understand that the Secretary of the Smithsonian Institution stipulated that the herbarium should be in the charge of some botanist acceptable to him, and should be put into proper order; and that Dr. Parry was appointed under his recommendation. It might have been expected, therefore, that if the Commissioner desired to make a change, or even thought a change necessary, he would have conferred with the Secretary of the Institution; while the delay of a week or two needful for doing so, would have allowed the incumbent he was superseding no more than the customary notice which the lowest clerk in a government office may expect to receive.

Evidently, this precipitate dismissal of his subordinate by the Commissioner, as it would seem to be justifiable only on the ground of gross misconduct of the former, so it would of itself seem to imply misconduct. And the Commissioner makes the implication explicit at the next stage of the proceedings, namely, in his reply to the memorial of the botanists who solicited a reconsideration, and that gratuitously, as the memorial does not ask for the reasons. When informed that they were of a nature "disagreeable to utter and likely to disparage Dr. Parry in the estimation of his friends," they were of course immediately asked for. The claim for them was responded to; and it only remains to considerwhat the reasons turn out to be.

First, the Commissioner, on taking possession of his office, "found that nothing at all had been done by Dr. Parry beyond his attention to the preservation of the herbarium." Without stopping to enquire what more the Commissioner might have found if he had waited until more familiar with the work and duties which Dr. Parry had fulfilled under General Capron, it may be remarked that the "preservation" of the herbarium in this case means the whole arrangement, and in a good degree the formation of it, out of an accumulation of collections, in part unnamed, requiring long labor and much study; that this was obviously the first thing to be done, and Dr. Parry was specially appointed to do it; and that the herbarium was in the midst of removal to new quarters prepared for it when the work was thus summarily arrested.

Next, as to the investigations which the Commissioner would desire the botanist to undertake, "the principles of vegetable physiology, their relations to climate, soils, and the food of plants, and the diseases of plants, which are principally of fungoid origin," and the throwing of "some light upon the origin and condition of growth of the lower orders of cryptogamic botany;" it is clear that Dr. Parry could not yet have had much time for them: it is not said that he had been asked to undertake, or had shown any disposition to evade them; all that the Commissioner charges is, that "this is a domain into which I could not discover that Dr. Parry had ever entered, so far as his practical work here gave any indication." Thus far there is nothing to explain the urgent action resorted to.

The next charge is that there were letters written by Dr. Parry which the Commissioner "deemed objectionable because of his mode of expression, wanting in perspicuity and not creditable to the department." That is a matter somewhat of taste and opinion. We have read Dr. Parry's published reports and articles without noticing any deficiency in this regard. We have also read, with a sense of wonder and bewilderment, some published reports of the present Commissioner, one or two extracts from which are appended to the correspondence we are noticing. Such things it would hardly be worth while to notice, except by way of a demur to the Commissioner's judgment. If the want of perspicuity and good grammar is as urgently felt in the Agricultural Bureau, as it is practically illustrated, let these accomplishments be supplied at all hazards.*

The Commissioner's remaining specifications, detailed at some length, from all that we can learn, amount to this. While arranging the herbarium, Dr. Parry was in the habit of transmitting by mail occasional specimens to be examined by other botanists. Specimens were also sent to him for naming. The new Commissioner and his clerk appear to have suspected something wrong or irregular in this, and required that all notes accompanying such

* Yet it is hard to insist upon them, since, when sought at "any of the literary colleges," they are to be acquired at such fearful risk. The Commissioner declares —in one of the choice excerpts referred to—that "our experience teaches us, that a farmer's son, graduated in such an institution, finds no place, ever after, in the domestic circle of his family; *he is actually driven by his education* into the necessity of resorting to some neighboring town, in pursuit of a learned profession, *where he soon forms habits of idleness and intemperance.*"

enclosures, however trivial, should be strictly copied, and should receive the Commissioner's own signature. This was novel to the botanist, who could not at once see the sense of it in such little matters; it appears to have led to some bickering with the clerk, and this to a request for definite instructions on the point from the Commissioner himself. That the botanist should ask for "definite written instructions" was not unnatural when a new practice was thus pressed upon him, which he thought could hardly be meant to apply to such particulars; but he asks them in order that he may be enabled to comply strictly with the regulations of the department, and his letter appears to us respectful and proper, both in form and substance. That our rèaders may judge, we append a copy of it.

DEPARTMENT OF AGRICULTURE,
*Washington, D. C., September* 27, 1871.

Hon. F. WATTS, *Commissioner of Agriculture.*

SIR:—In order to enable me to comply strictly with the regulations of this Department in regard to ordinary correspondence in connection with my official duties as botanist, I respectfully ask to be furnished with written instructions on the following points. 1st. Should letters addressed to me personally, as botanist of the department, imparting or requesting information on botanical subjects, be answered and signed by me personally as botanist. or in the name of the Commissioner? 2d. In sending botanical specimens to be named, or in returning such as have been sent to me to name, should the accompanying letter be signed by myself as botanist or by the Commissioner?

Having heretofore exercised my own discretion in this matter, with due regard to the scientific interests of the department and to facilitate the business of my division, I desire to avoid any future misunderstanding by receiving definite written instructions on these points for my guidance.

Respectfully yours,
C. C. PARRY, *Botanist Agr. Dpt.*

In the Commissioner's account of the matter he states: "I did not think that he [Dr. Parry] was in want of the information he asked for, and my answer to his note was that the Department did not longer require his services." The letter of dismissal, which, as an English scientific journal remarks, "may well stand as a model of epistolary curtness," we have already cited in full.

Here is the upshot of this petty and truly pitiful business. It is not pleasant to call attention to it. But if such be the treatment to which scientific men may be exposed upon entering the service of the Government, the more widely it is known, the sooner it may perhaps be amended. EDITORS.

2. *Spectrum Analysis in its application to Terrestrial Substances and the Physical Constitution of the Heavenly Bodies*, familiarly explained by Dr. H. SCHELLEN, Director der Realschule, I. O. Cologne, etc. Translated from the second enlarged and revised German edition by JANE and CAROLINE LASSELL. Edited, with notes, by WM. HUGGINS, LL.D., F.R.S. 662 pp. 8vo., with numerous woodcuts, colored plates, and Angström's and Kirchhoff's maps. London, 1872. (Longmans, Green & Co.)—Schellen's work on Spectrum Analysis has a high European reputation. It is excellent in all respects, in its paper and typography, its clear and thorough treatment of the subject, and its admirable illustrations, which are

numerous and include many colored spectra of the elements, others uncolored of the sun's spots, corona, etc., several of comets and stars, and many beautiful colored views of the protuberances of the sun. It contains also descriptions and figures of instruments and an account of the methods of observations, together with a list of the memoirs and works hitherto published on the subject.

3. *Kansas Academy of Science.*—This Academy is a State Society, and has no special location in the State. A list of the papers presented at the annual meetings in 1869 (the second), 1870 and 1871, is contained in the Eleventh Annual Report of the Department of Public Instruction of the State of Kansas, 1871. The papers on the plants of Kansas by J. H. Carruth mention 600 species, and one on the birds by F. H. Snow describes 164 species. Among the titles are those of geological papers by Prof. B. F. Mudge and J. D. Parker.

4. *Hunt's Green Mountain Series.*—In my notice of the address of Prof. Hunt, on page 93 of this volume, I speak of the Green Mountain series as including with small exceptions the Metamorphic rocks between the Connecticut River and Mesozoic on the east and the Green Mountain (Stockbridge and Eolian) limestone on the west. A correspondent observes that the exceptions are larger than is implied in the above expression. In order to give the facts correctly, I cite here the paragraphs from the Address bearing on the subject, although they do not affect the argument in my paper. Mr. Hunt says: "The rocks of the second [Green Mountain] series are traceable from southwestern Connecticut northward to the Green Mountains in Vermont; and the micaceous schists and gneisses of the third or White Mountain series are found both to the east and the west of the Mesozoic valley in Connecticut and Massachusetts. They also occupy a considerable area in eastern Vermont, where they are separated from the White Mountain range by an outcrop of rocks of the second series" He also says that certain gneisses in western Connecticut, defined by Percival (his K1 and K2), may prove to be Laurentian. The address contains nothing more definite on the subject. In his article on the Geology of New England, in this Journal, II, l, 83, he says with regard to the occurrence of the White Mountain series in Vermont: "I believe that much of the calcareous mica slate of Eastern Vermont will be found to belong to the Terranovan [White Mountain, as now designated by him] series." J. D. D.

## OBITUARY.

DR. WM. BAIRD, of the British Museum, died on the 27th of January last. The *Standard* writes of him:—"In losing Dr. Baird, the British Museum has lost one of the most valuable members of its staff. Dr. Baird, who was born in Scotland in 1803, was educated at Edinburgh, Dublin, and Paris, for the medical profession, and served for some years as a surgeon in the naval service of the late East India Company. His voyages in this capacity gave him emple opportunities for the study of his favorite pursuit—zoology. In 1841 he accepted an appointment in the Zoological

Department of the British Museum, and this he retained up to the time of his death. His writings are chiefly to be found in periodicals; but his most important work was a 'Natural History of the British Entomostraca,' which was published under the auspices of the Ray Society in 1850. Subsequently Dr. Baird was elected a Fellow of the Royal Society. In private life he was greatly beloved, on account of the unvarying amiability of his disposition and the kindness of his manners." A writer, Mr. H. Lee, in *Land and Water*, for Feb. 3, adds, "Most heartily do we confirm the last preceding sentence. His store of knowledge, though freely at the service of all who desired to profit by it, was hidden under the quiet modesty of his demeanor; but the amiability of his disposition and the kindness of his manners were instantly apparent, even to a stranger who had the honor of an introduction to him. On those days when the Museum is closed to all but students, he was usually to be seen in the conchological gallery, bending over one or other of the table-cases, patiently and carefully arranging and examining specimens of shells; and so closely is he associated in our mind with the scene of his duties, that when in future we enter the gallery on such days, it will be long ere we cease to look instinctively, as of old, for the familiar blue skull-cap, and the gentle, placid face beneath it, and the kind, genial smile, and the cordial greeting of Dr. Baird. They can never more gladden and encourage us, but they will take and retain a place in the treasury of our pleasant recollections of good men whom it has been our privilege to know and appreciate."

W. Harper Pease died recently at Honolulu, where he had lived since 1853, collecting and studying the mollusca of the Hawaian seas and of Polynesia generally. During the Mexican war he made a large collection of birds, which were deposited with the Academy of Natural Sciences at Philadelphia, and among them were some new species, which were afterward described by Mr. Cassin.—X. in *Harper's Weekly*, Feb. 10.

Rev. Canon Moseley, F.R.S., author of papers on the freezing of ice and the movement of glaciers, died on the 20th of January last in his 71st year.

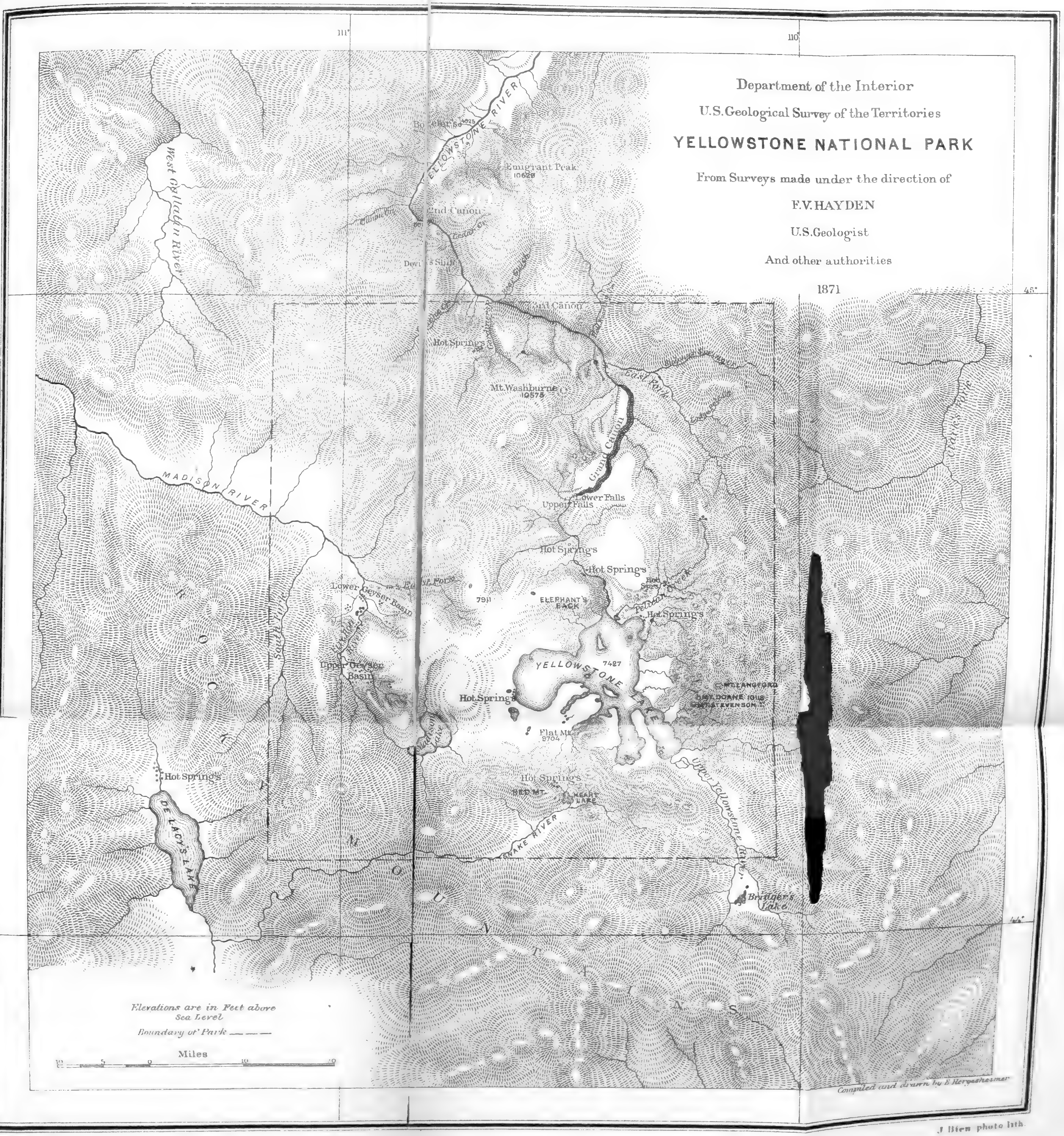
Dr. Adolph Strecker, the able Professor of Chemistry at Würzburg, has recently died.

Appendix to the Fifth edition of Dana's Mineralogy, by Prof. George J. Brush. 24 pp. 8vo. 1872. New York. (John Wiley & Son, Astor Place). Contains descriptions of eighty-seven minerals announced as new during the four years since the publication of the Mineralogy.

Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. V. The immature state of the Odonata, Part I. Sub-family Gomphina; by Lewis Cabot. 18 pp., with three plates. No. VI. Supplement to the Ophiuridæ and Astrophytidæ; by Theodore Lyman. 18 pp., with two plates.

Catalogue of the Principal Minerals of Colorado, with Annotations on the local peculiarities of several species; by J. Alden Smith. 16 pp. 8vo. Central City, Colorado, 1870.

Contributions to the Fauna of the New York Croton Water. Microscopical observations during the years 1870–71; by Charles F. Gissler. 22 pp., 8vo., with four plates. New York, 1872.

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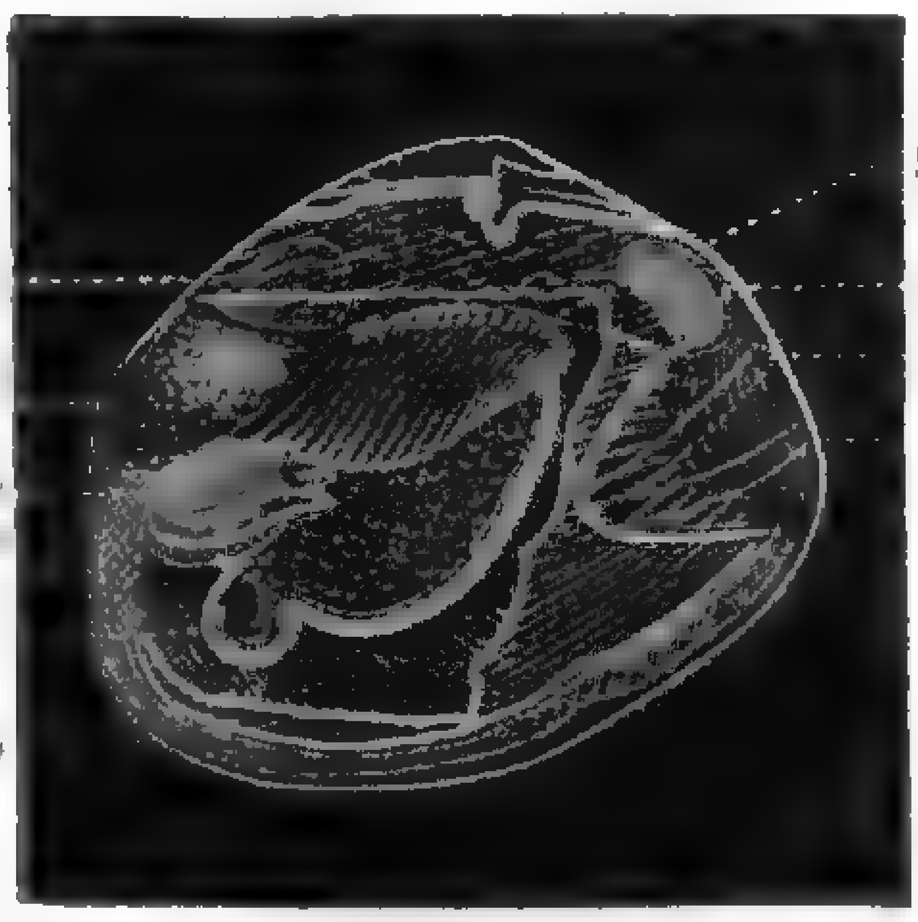

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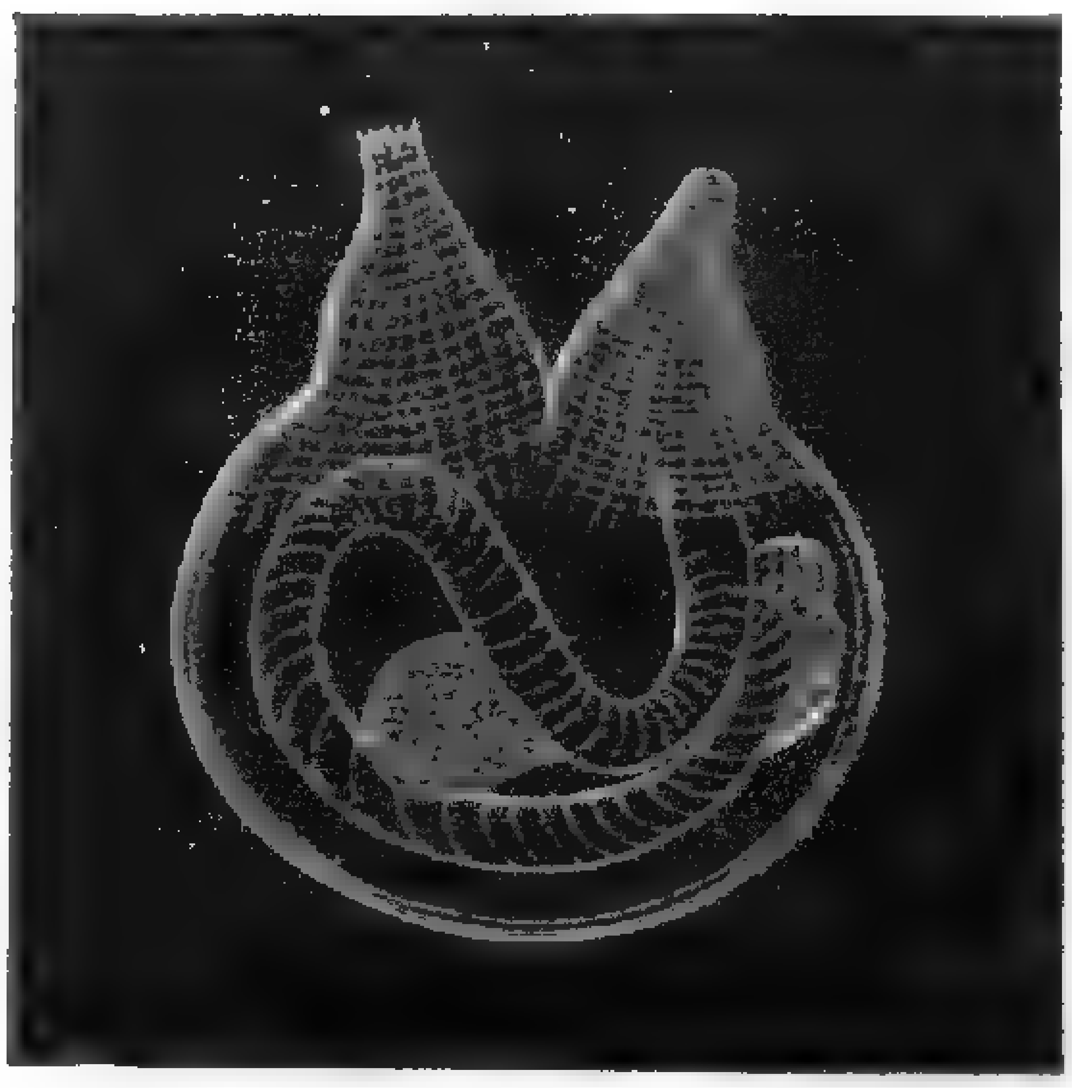

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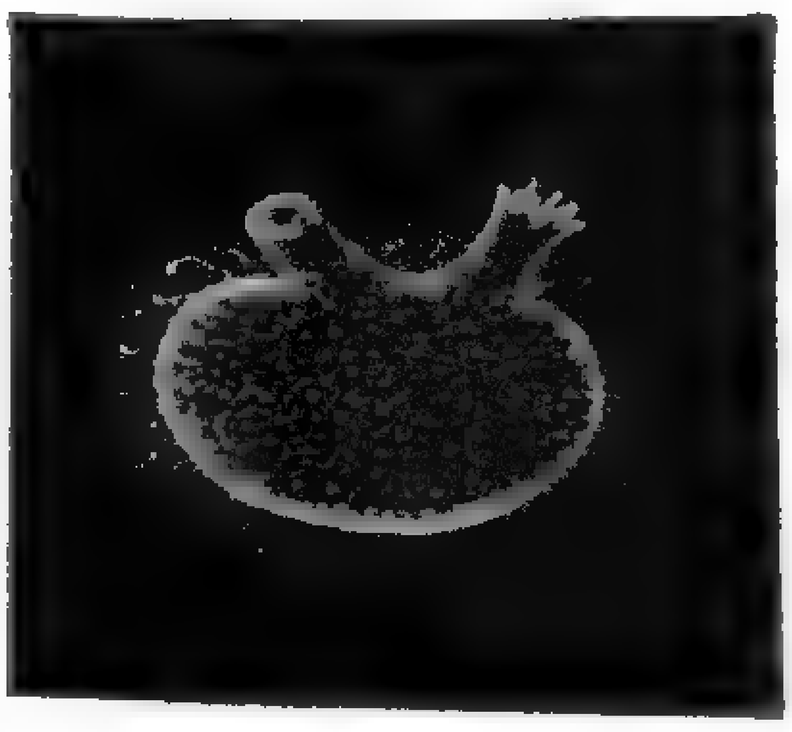

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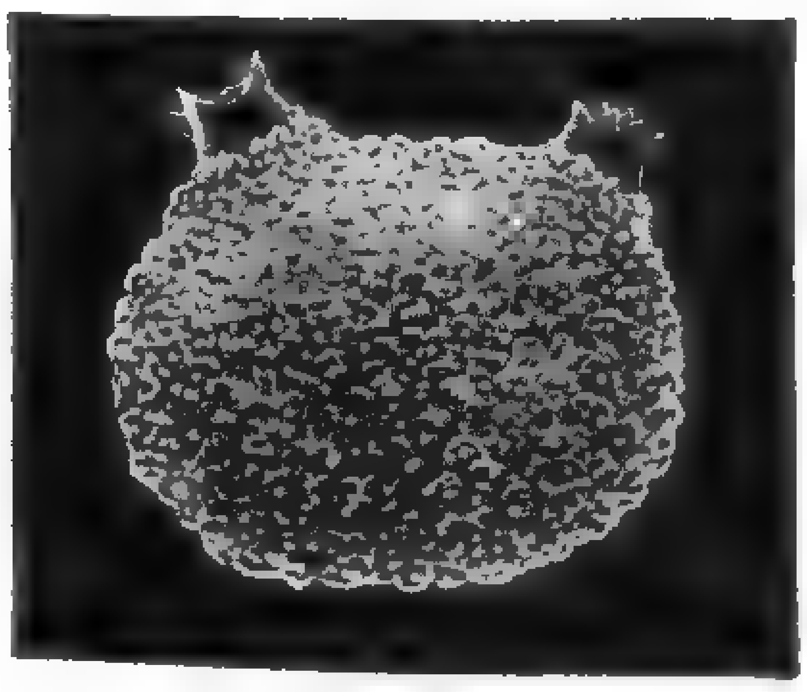

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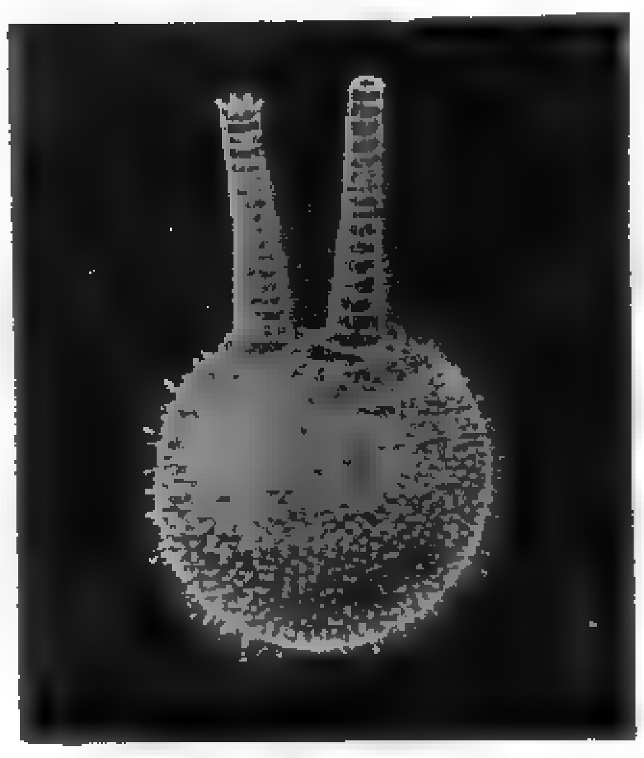

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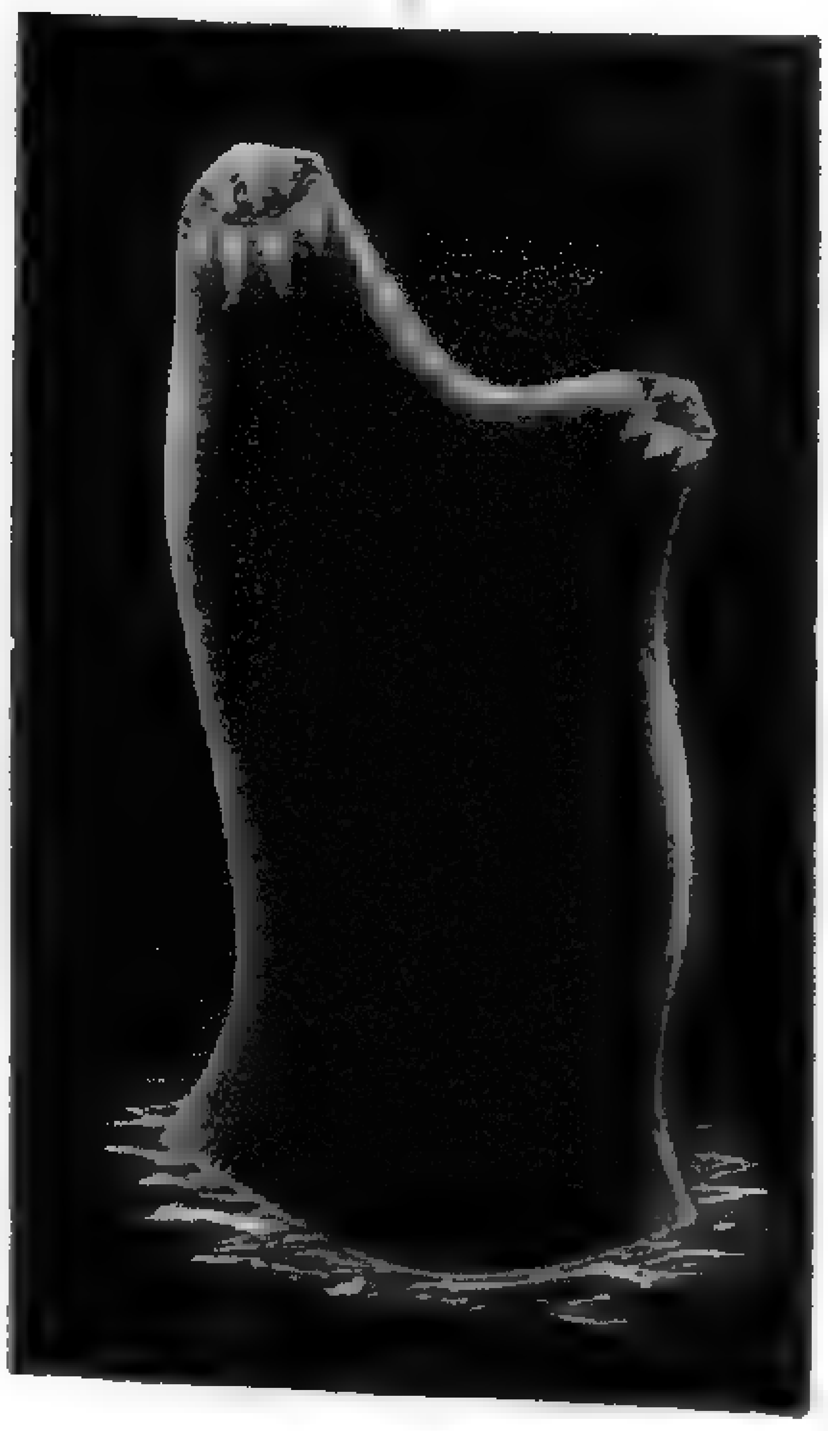

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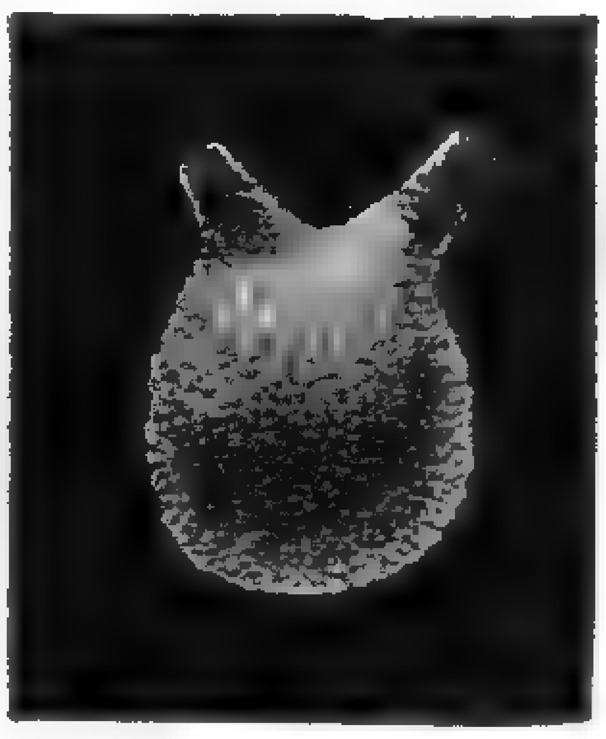

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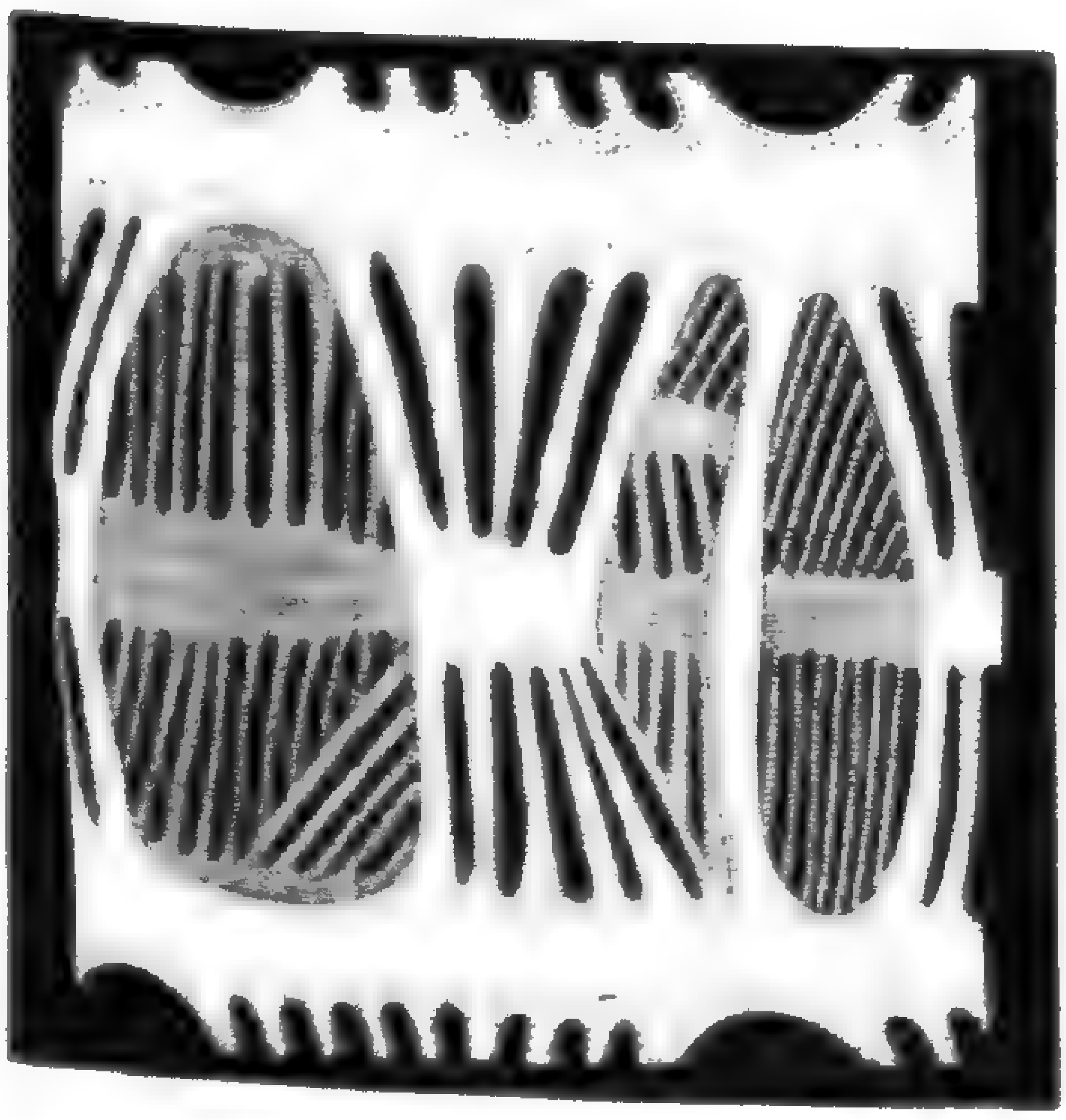

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A. E. V., from nature.

THE

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# JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

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## ART. XLII.—*Recent Geographical work in the United States.*

### A. REPORT OF THE CORPS OF ENGINEERS, U. S. ARMY.

THE report of the Chief of Engineers of the United States Army, Gen. A. A. Humphreys, presented to Congress in December last, enables the public to observe the valuable contributions which this corps is making to an accurate knowledge of the structure of the country. The chief work of this scientific body, in time of peace, is to superintend the construction and repair of the national fortifications, to devise and carry forward the improvements which commerce requires in the harbors, rivers and lakes of the country. Full details in regard to their work are given in the report referred to, but attention may here be called to some of the inquiries and examinations which have a general geographical importance.

(*a*) *The U. S. Lake Survey.*—The survey of the Great Interior Lakes, now under the direction of Major C. B. Comstock, U. S. Eng., has been in progress during the past year in Lakes Superior, Michigan, St. Clair and Champlain, and on the St. Lawrence river.

"In Lake Superior the survey of the Apostle Islands has been completed; the primary triangulation has been carried from Porcupine Mountains to Duluth, a distance of one hundred and twenty miles; the base line at Minnesota Point has been measured; the longitude of Duluth and St. Paul determined by telegraphic connection with Detroit; and longitude, latitude, and azimuth observations have been made at several primary stations in the west end of the lake.

In Lake Michigan the shore-line topography and hydrography have been carried on the east shore from Little Point Sable to New Buffalo, a distance of one hundred and forty miles, and on the west shore from Manitowoc to Oak Creek, south of Milwaukee, a distance of eighty-five miles, leaving but one hundred and twenty miles of shore-line to finish the lake. The off-shore hydrography has nearly kept up with the shore-line work.

A reconnaissance has been made, and stations erected for a triangulation, to connect Green Bay with Milwaukee, over a distance of one hundred and twenty miles, and a part of the angles measured.

Lines determined by azimuth and latitude are in progress down the two shores of the lake. The triangulation, hydrography and topography of Lake St. Clair have been completed.

A reconnaissance has been made, and nearly all the stations erected for a triangulation, reaching from the forty-fifth parallel (the northern boundary of New York) to the east end of Lake Ontario, and a part of the angles have been measured. The topography and hydrography have been carried from the forty-fifth parallel to ten miles above (south-west) Ogdensburgh.

In Lake Champlain surveys of Plattsburgh and Burlington Bays have been made, and the narrows have been surveyed for a distance of thirty miles from the south end of the lake.

In the office, besides the ordinary computation and plotting of the field-work, final chart No. 2 of Lake Superior, and a chart of Isle Royale, have been prepared for the engraver, and preliminary chart No. 3 of Lake Superior has been engraved on stone and published. Final charts Nos. 1 and 3 of Lake Superior, and final chart of St. Clair are now in progress.

The expansions of the 15-foot brass bar, and of the two base-tubes, have been determined; observations for difference of longitude have been made with Duluth, Minnesota; Washington, D.C.; Austin and Battle Mountain, Nevada; and Fort Leavenworth, Kansas. The Washington work has been reduced.

The meteorological work of the survey has been continued."

The preliminary report of Prof. S. I. Smith of New Haven, on the zoölogical results of the dredging which was carried on in August and September, 1871, is appended to Major Comstock's report.

The longitude of Detroit (site of the present Lake Survey observatory) has been determined as west of Washington $24^m\ 00^s.12 \pm 0^s.02$. The longitude between Detroit and Duluth, and between Duluth and St. Paul, has also been determined by telegraphic connection, but the result is not published. A map is given showing the progress of the survey, indicating how far the shores are triangulated, how far carefully surveyed, and how far the maps are ready for publication.

(*b*) *Wheeler's Survey in Nevada and Arizona.*—The exploration of the territory south of the Central Pacific R. R., embracing parts of Eastern Nevada and Arizona, which was begun in 1869 by Lieutenant Wheeler, Corps of Eng., has been in progress during the past year. An outline of the results was printed in this volume, p. 232.

(*c*) *Raymond's Survey of the River Yukon, Alaska.*—Capt. C. W. Raymond, Corps of Engineers, has made a reconnaissance of the river Yukon in Alaska, with especial reference to a determination of the exact position of Fort Yukon.

His report, with a map of the river, has been separately printed by Congress.

(*d*) *King's Survey of the 40th Parallel.*—The survey of the Fortieth Parallel, to which frequent reference has been made in these pages, is still in progress. A succinct account of all the work begun by this survey from March 22, 1867, to Oct. 3, 1871, by Mr. King, is printed in the report.

We cite the latter half of his Report on "the methods of work, the character of the problems investigated, and what I consider the chief results."

"The foundation of our explorations has been a continuous system of triangulation, carried from mountain-top to mountain-top, over the whole extent of our work, by theodolite observations upon stone monuments. These triangles have been located geographically, and their distances computed from a base and check-base, and a system of astronomical stations. Within the primary triangles a large number of secondary triangles were located, by a large theodolite, from the primary points, and from these, working always inwardly, a thorough system of minor triangles has been measured with the gradienter, and the topography filled in by compass and gradienter, basing the system upon 300-foot grade-curves, located approximately by the barometer. In connection with this, the altitude of all prominent mountain-peaks and localities upon the plains have been determined.

In the department of geology careful and actual sections have been made over the whole area; the superposition of the immense variety of irruptive rocks has been, in almost all cases, accurately determined; the dynamical questions, such as the build of mountains, the upheaval of chains, and the formation of mining districts and of mineral-bearing lodes, have received our careful attention.

An extensive series of observations was also made upon the present climatic conditions of the Great Basin, as regards its isothermal lines, annual and monthly averages of temperature, relative evaporation, and the outlines of storms and rainfall.

In the department of botany a very large collection has been made, resulting in the discovery of somewhat over a hundred species of plants new to science, in a complete knowledge of the distribution of timber, and the leading families of the Desert flora.

In zoölogy, the collection has been equally careful, and the results, according to Professor S. F. Baird, in whose hands they now are, are of interest and value.

The work embraces a very complete scientific examination of a section of country which traverses, from west to east, nearly the entire Cordillera system. The rocks at our eastern terminus are already those of the Atlantic formations, and are being extensively studied by a number of geologists.

In the department of mining industry our labors have been completely worked up, and the volume and accompanying atlas, embracing the elaborated results of our three years' study, is already printed, and being bound at the Congressional establishment [since published]. Also, the topographical maps of the fortieth parallel belt are plotted on a scale of two miles to the inch, and have been photographically reduced to a scale of four miles to the inch, resulting in three maps, about 30 or 40 inches each. These maps, assembled in grade-curves, are now being drawn in *hachure*, preparatory to lithographing them upon stone.

The volume of botany is completed, transmitted, and in process of printing. That of geology is also completed, and has been transmitted, and awaits the action of the Congressional printer, who is unable to keep up with our rate of furnishing material.

To complete the series, I propose two more volumes: one descriptive geology, and one embodying general results. That on descriptive geology is now in active preparation, and the geological maps accompanying it are already in the hands of the engraver.

These volumes, making thus far four, will be brought out as quickly as the printer can execute them. For the first, or general volume, I am unable at present to fix a definite time; its scope being somewhat unique, forbids a definite estimate.

When finished, the series is designed to embody, first, a groundwork topographical map, upon which shall appear all the features of the country surveyed; second, a series of geological maps, illustrating the formations of rocks, soils, alkaline deposits, and the distribution of arable land; third, a general report, which, in a synthetical manner, shall describe the history of the formations of that portion of the Cordillera, its original deposition in the primeval ocean, the evolution of continental features and mountains, the minute lithological structure of each family of rocks, and chapters upon the volcanic and glacial ages; and an attempt to explain the present physical conditions, and an account of a considerable climatic change now going on.

As appendices to this, the second, third, fourth, and fifth volumes will treat of technical geology, zoölogy, and mining industry.

(*e*) *Surveys and Reconnaissances of Western Rivers.*—Among the great variety of enterprises of this character with which the Engineer Corps are charged, the following, which were in progress during the year 1870–71, seem to us as of most general interest.

1. A survey of the Cumberland river under the direction of Major G. Weitzel, Corps of Engineers, which was made by Mr. S. T. Abert and a party of twenty-one men. The reconnaissance

extended from Nashville first to the river's mouth; afterwards from Nashville to the falls of the Cumberland.

The length of the river from the falls to the mouth is 595 miles. The following altitudes are of interest:

| | | |
|---|---|---|
| Foot of Falls, | 770·70 | above mean tide at Mobile. |
| Laurel River, | 685·70 | |
| Smith's Shoals— | | |
| (Head), | 651·70 | |
| (Foot), | 597·00 | |
| Point Burnside, | 597 | |
| State Line, | 502·50 | |
| Nashville, | 365 | |
| River Mouth, | 286 | |

A minute report of the character of the river, and of the resources of the region, is given.

2. A preliminary survey, under the same officer of Engineers, has been made of the *Wabash river*, from Wabash to its mouth, by Mr. F. Stien of Tipton, Ind.

3. An examination has also been made of the *French Broad river*, by Lieut. M. B. Adams, U. S. Eng.

4. A route has been surveyed for a ship-canal between Hennepin on the Illinois river, and Rock Island on the Mississippi, via Geneseo, showing a length for such a canal of 65 miles, with a navigable feeder from Dixon of 38 miles. The estimated cost of a ship-canal 160 feet wide and 7 feet deep is $12,500,000; and for a commercial canal 60 feet wide and 6 feet deep $3,900,000.

5. A series of examinations carried on under the direction of Lieut. Col. W. F. Raynolds, U. S. Eng., having reference to the improvement of the Mississippi river and its tributaries,—among them a survey of the Mississippi from Alton, Ill., to the mouth of the Maramec river, examinations of the Ouachita (Washita) and the little Missouri, one of its tributaries; and of the White, Black, Red and other rivers in Arkansas. These reports of surveys largely relate to the removal of obstacles to navigation; but they also contain much other information respecting the water courses and the adjacent territory. There is also a very interesting report on the vicinity of Vicksburg, "the key of the Mississippi Valley," called out by the apprehension, "too well founded," that the river will there seek a new channel, leaving Vicksburg an inland town.

6. On the Pacific Coast, river surveys more or less in detail have been made in various regions; including the Willamette, above Oregon City, by Maj. R. S. Williamson and Lieut. W. H. Heuer; the Umpqua; and portions of the Sacramento.

### B. The Yellowstone Geysers.

The remarkable geysers which have been found in the valley of the Upper Yellowstone; the proposition which has been adopted in Congress to reserve a considerable portion of the valley most interesting for its natural characteristics as a public park, belonging to the nation; and the possibility that the Yellowstone Valley will be adopted by the Northern Pacific Railroad as their route for approaching the Rocky Mountains divide,—have recently attracted very general attention.

The most valuable sources of information which have come under our notice are as follows:

1. A picturesque description of the Geyser region, based upon the observations of the Washburne-Langford party, which was printed in Scribner's Monthly in 1871.

An account by Walter Trumbull of the Washburn Yellowstone expedition, was printed in the Overland Monthly for May, 1871.

2. The Reports of Dr. Hayden's visit in 1871, printed in this volume, pp. 161 and 294, with two illustrative maps, which are also prepared for publication on a larger scale.

3. The narrative of a reconnaissance by Capt. John W. Barlow of the Corps of Engineers, U. S. A., likewise made in the summer of 1871, published, by permission of Gen. Sheriden, in several of the daily newspapers of January and February, 1872.

4. The report of a railroad reconnaissance of the valley by Gen. Wm. Milnor Roberts, Chief Engineer of the Northern Pacific R. R., made in the summer of 1871,—a report which has been printed, but is not yet published, by the corporation just named.

### C. Route of the Northern Pacific Railroad.

The prosecution of a second railroad route across the continent, by way of the Upper Missouri and the Columbia Valley, has added much to our knowledge of that country. This is the region which was first made known by the journey of Lewis and Clark in 1804–5 and 6; was surveyed by Gen. I. I. Stevens in 1853–4–5 (whose report was published as vol. xii, pt. 1, of the U. S. Pacific Railroad Report), and was again carefully examined by Capt. John Mullan, U. S. A., who constructed, from 1858 to 1862, a military road from Fort Walla Walla on the Columbia river to Fort Benton on the Missouri. The report of Capt. Mullan was printed by the Government in 1863.

1. The Northern Pacific Railroad published last year the report of a reconnaissance of the route made in 1869, by Gen. W. Milnor Roberts. The same engineer has been engaged during the summer of 1871 in an examination of the Rocky Mountain Divide, between Lewis and Clark's Pass on the north

and Deer Lodge Pass on the south, a distance of nearly 100 miles, covering all the passes of the main chain available for the Northern Pacific Road. He subsequently went down the Yellowstone, as mentioned before.

2. At the same time, Gen. Thos. L. Rosser has made a survey of a route between the Missouri at Fort Rice and the Yellowstone.

3. Mr. Frank Wilkeson also made last summer an examination of the geology of the region between Cadotte's Pass and Deer Lodge Pass, with reference to the occurrence of coal and iron.

4. Mr. Charles A. White has been across the Great Plain of the Columbia and through the Grand Coulée.

(These four reports have been printed, but are not yet published.)

### D. Map of Transportation Routes in Minnesota and Dakota.

A map of transportation routes in Minnesota and Dakota, including railroads, mail and express routes, has just been prepared by Gen. S. R. Holabird, Chief Quartermaster of the Department of Dakota, and published on a scale of ten miles to one inch. The water courses, lakes, and routes of transit are carefully indicated, and the sites of settlements and villages; the heights of land are of course less accurately delineated. This vast region is now attracting so much attention and is so rapidly developing, that this preliminary map, prepared under circumstances of very considerable difficulty, is of special interest. The lakes which are so characteristic of Minnesota and Eastern Dakota, the line of the divide between the waters running to the Gulf of Mexico and those running to Hudson's Bay, the outlines of the Coteau des Prairies and of the Coteau du Missouri, and the line of the Northern Pacific Railroad, are among the interesting features which the map exhibits.

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## Art. XLIII.—*On Molecular and Cosmical Physics;* by Prof. W. A. Norton.

A recent review of a portion of the ground theoretically surveyed in my papers on Molecular and Cosmical Physics, published at intervals during the last eight years, has led to new results, which I now propose succinctly to present: and at the same time, for the proper understanding and appreciation of these, to sketch the outline of the general theory, and give a connected view of the results obtained. The theoretical deductions obtained in the papers alluded to have received many striking confirmations, which will first be briefly noticed.

One of the most conspicuous of the theoretical positions reached, was that of the incessant operation of a repulsive force, exerted at all distances beyond the minute sphere of molecular attraction, upon individual molecules. Evidence of the operation of such a force at small distances, in the contact of bodies whether by pressure or impact, has often been recognized, and it has generally been conceived to be the physical cause of the elastic outward pressure of gases;* but in both cometary and solar physics we have striking evidence of the operation of a force of repulsion upon the atoms of highly attenuated gases, at great distances. It is at present the general belief among astronomers that the tails of comets are composed of attenuated matter urged away to indefinite distances from the sun, by an energetic solar repulsion.† I think I may justly claim that my own researches, with reference to Donati's comet, have served materially to strengthen this conviction, long since entertained by such eminent astronomers as Olbers and Bessel.

The outstreaming of luminous vapors from the sun's photosphere, recognized by spectroscopists in the solar protuberances, and in the indefinite extension of the solar corona,‡ give intimation of a highly energetic repulsion of subtile vapors from the sun's luminous surface.

Another position taken was that the contiguous molecules of a liquid mutually repel each other; the equilibrium being maintained by a compressive force exerted inward at the surface—that to which the phenomena of capillarity are ascribed. Several striking experimental discoveries have recently been made, which furnish a strong support to this view. These are,

* Many eminent physicists, it is true, attribute the elastic pressure of a gas to the impact of its molecules, supposed to have a rapid motion in right lines, instead of a repulsive action exerted by them in a state of rest; but I shall endeavor to show in the sequel, that this fundamental principle in the kinetic theory of gases, has its essential counterpart in the impulsive waves of heat incessantly proceeding from the molecules. Besides, the advocates of this theory are constrained to admit the existence of a gaseous molecular repulsion, to account for the elastic reaction of the molecules in their mutual collisions.

† See Herschel's Outlines of Astronomy, eleventh edit., pp. 382–3; Loomis's Astronomy, pp. 262–3; and Norton's Astronomy, pp. 237–244.

‡ Prof. Young, in his article on the Solar Corona (this Jour., May, 1871), has this paragraph: "How extensive then is this leucosphere? Perhaps the question can hardly be answered definitely as yet; but it seems likely that it will be found to be at least from 8′ to 10′ thick on the average, with occasional prolongations of double that extent; not impossibly it may turn out to have no upper limit whatever, but to extend outward indefinitely into space." He asks how its enormous extent can be reconciled with the known smallness of the pressure at its base, and remarks in reply that "it may consist of some new kind of matter whose density is far below even that of hydrogen, or of matter whose specific gravity is diminished, annihilated, or even rendered negative by some such solar repulsion as appears to be operative in the formation of a comet's tail." The latter view is that which I have long advocated. (See this Jour., Jan., 1871; and June, 1871, p. 406).

1st, the discovery made by M. Tresca, that solids may be made to flow through orifices, like liquids, by subjecting them, when placed within a strong enclosure, to a great pressure; 2d, the discovery that if water be confined in a strong vessel, so that its tendency to expansion is restrained, the freezing point may be lowered 23° F.; 3d, that of Dr. Andrews, of the continuity of the gaseous and liquid states of matter, under certain experimental conditions.

The theoretical notion formed of a solid was also peculiar, and has been sustained by the results of my own experiments on the deflection of pine sticks, of various dimensions, under a transverse stress.* These served to reveal the inaccuracy of the ordinary formula for deflection, and to show the necessity of introducing a new term, which proved to be in accordance with the conception adopted of the mechanical condition of a solid, and at variance with that generally entertained. The same notion of the solid state, also led to the apparent detection of the actual play and mode of propagation of the molecular forces called into effective action by the bending force. The importance of these new views and results is fully recognized by Prof. De Volson Wood, in his recent treatise on the Resistance of Materials.

The special theory given of electro-magnetic and electro-dynamic phenomena, has derived support from the results of recent ingenious and delicate experiments made by Professor Alfred M. Mayer.†

It may be added that the fundamental hypothesis of a general mutual repulsion of atoms of matter, is in essential accordance with what a distinguished physicist terms the "modern idea that matter consists of a force of resistance from a center."

These statements have been made in the hope that they would serve to secure from the candid reader a closer and more interested attention to the brief exposition that is to follow.

I. Matter exists certainly under two, and probably under three varieties; viz., *ordinary* or *gross matter*, directly recognized by our senses; *universal* or *luminiferous ether*, filling all space, and pervading the interstitial spaces of all bodies of ordinary matter, the existence of which is inferred from optical pheno-

* See Proceedings of the American Association for the Advancement of Science, eighteenth meeting, pp. 47 to 63.

† Prof. Mayer, in his paper on the electro-tonic state, makes the following remarks: "It has always, however, appeared to me that the explanation of dynamic induction given by Prof. W. A. Norton (in this Jour., Jan., 1866) in his paper on Molecular Physics, affords a simpler and more satisfactory explanation of these phenomena than any heretofore framed."

mena; and *electric ether*, associated with all bodies of ordinary matter, whose existence is inferred from electrical phenomena.

These varieties of material substance may possibly not differ in their essential nature. It is at least conceivable that the atoms, so called, of ordinary matter, and of electric ether, are condensed groups of atoms of the universal ether; and hence that there is, essentially, but one form of matter in existence, viz., that which, as made up of single atoms homogeneously aggregated, forms the ether of space.

It may be that the electric ether, the supposed agent of electrical phenomena, may ultimately be shown to be identical with the luminiferous ether; but in the present state of physical science, they cannot be so regarded.

It is supposed by some physicists that electrical phenomena may consist in some mode or modes of motion of the atoms of ordinary matter, and that the forces of electric attraction and repulsion may originate in such motions. But this notion cannot be regarded as anything more than a conjecture: since no conception has hitherto been formed of possible atomic movements capable of originating the electric forces, and producing even the simplest of the electrical phenomena.

The existence of an electric ether has not been as conclusively established as that of the luminiferous, but all the phenomena give decided intimations of the operation of such an agent, and thus serve to confer upon the hypothesis of an electric ether a high probability.

Now that the ethereal is known to be one of the forms in which matter exists, and as we perceive that ordinary matter presents a great variety of substances differing in density, and other conditions, we may certainly just as reasonably refer electric phenomena to a special ethereal agent, as to hypothetical atomic movements of ordinary bodies of matter. The comparative availability of the two hypotheses in adequately representing the entire series of electrical phenomena, both formally and in their precise laws, is the only proper ground upon which we can decide to which the preference should be given.

II. All atoms of matter, when within a certain range of distance, attract or repel each other, either actually or virtually. In the normal condition of things, in the instance of each distinct body of matter, each of its constituent atoms is in a state of equilibrium, relatively to the rest, under the operation of all the forces, attractive or repulsive, exerted upon it by all other atoms within the range of sensible action. This is true of the universal ether, each atom of which is conceived to be at rest, so far as the natural action of other ethereal atoms upon it is concerned; and this action is supposed to consist in a force of repulsion. It is also true of bodies of ordinary matter; but each integrant atom is under the operation of attractive as well as repulsive forces, exerted by other contiguous atoms—or at least of forces which tend to urge it from or toward the atoms acting on it. It is by virtue of this statical condition, and the change in the intensities of the effective forces when the relative distance of the atoms is altered, that all existing collections of matter are *media*, through which extraneous forces applied to them at any point are propagated to other points.

III. All atomic forces, whether operating at small or great distances, are of the nature of *incessant forces;* that is, are made up of impulses which are renewed every instant. In the case, certainly, of the forces propagated in the waves of radiant heat and light, and taking effect upon the atoms of bodies, the number of impulses received per second is not infinitely great, but capable of determination though enormously great. It is conceivable that all the other incessant forces in operation (gravitation, molecular forces, electric forces) are of the same essential character; that is, consist of, or result from *actual recurring impulses* propagated in ethereal waves. Upon this hypothesis these forces should conform to the law of inverse squares, like the radiations of heat and light; as they in fact do, in every instance in which the law of variation of intensity with the distance has been determined. The *effective* molecular forces may furnish an exception, but we have no reason to suppose that the law does not hold good for the actual attractive and repulsive forces from the antagonistic operation of which these effective forces result.

IV. In the light of these fundamental principles we may assume as the basis of an entire scheme of Nature, the hypothesis that all matter has but the one fundamental property of repulsion: and that the three great varieties of matter, and all the various substances known to us, differ essentially only in the mass, size, or perhaps in certain cases also the specific intensity of repulsion, of their atoms. We may reach a still deeper, underlying principle, by conceiving that all the atoms, so called, of ordinary matter, and of electric ether, consist of groups of atoms of the one primary universal ether, condensed by reason of a diminished repulsive action of their constituent atoms. This conception brings us to the simplest possible basis upon which a physical theory of inanimate Nature can be erected; viz., that of the existence of but one primordial form of matter and but one primary form of force.

The general inquiry now before us is whether the diverse physical forces in operation, in their varieties of character and their established laws, the physical constitution and properties of bodies, and the different classes of physical phenomena, can be shown to be legitimately deducible from it. Certain topics comprised in this general inquiry will now be briefly discussed; in as far as this may be deemed necessary, to supplement the discussions given in former papers.

V. *Universal Gravitation.*—Let *m*, fig. 1, represent a single atom of ordinary matter, posited at any point in the sea of ether, and *cmd* a slightly divergent cone, extending from it in any direction; and let us consider the force that should take effect upon *m* resulting from the propagation of repulsive impulses from all the ethereal atoms lying within this cone. These propagated impulses may be regarded as superadded to the force of repulsion, which gives to the ether the essentially statical condition by virtue of which waves are propagated—though it does not appear to be absolutely essential that this latter force should be strictly a statical repulsion. Let *ab* and *cd* be portions of spherical surfaces, lying within the cone. Every atom in *ab* and *cd* will originate impulses of equal intensity; and hence the entire amount of force propagated to *m* from *ab* will be equal to that transmitted from *cd*. The same will be true for every other such spherical layer of atoms comprised within the cone. The entire wave-force conveyed to *m* will be the sum of the individual impulses proceeding from all the indefinitely thin layers of ethereal atoms, *ab*, *cd*, etc., of which the conical mass *cmd* is made up. The result is the same as if each layer *cd* was replaced by another of the extent *ab*, posited at the distance *ma;* and thus one immeasurably dense force-radiating mass obtained, at a certain assumed distance *ma*. The entire wave-force propagated to *m* should then be enormously great, even if the impulses emanating from the individual ethereal atoms be very feeble.

1.


Now, for every wave transmitted to *m*, a certain minute fraction of the impulsive force conveyed in it, in the extent of the atom *m*, will take effect as an impulse against this atom. The equal reaction to this will originate a reflected ethereal wave, that will be propagated backward in all directions. If the cone *cmd* be extended indefinitely in the opposite direction, it will be seen that an equal impulsive force will take effect on *m*, from the waves transmitted from the ether lying within *c′md′*. These equal impulsive actions upon opposite sides of the atom will neutralize each other, and no motion can ensue. Every atom, *m*, then receives a certain impulsive action from the ethereal

2.


waves that fall upon it, from any side; and in so doing *intercepts* a minute fraction of the wave-force, which passes back into the ethereal medium as a reflected wave.

Let us now take two atoms $m$ and $n$, Fig. 2, and let $c'nd'$ be a conical surface circumscribing $n$. It is plain, from what has just been stated, that a certain portion of the impulsive wave-force propagated to $n$, from the ether included within this conical surface, will be intercepted by $n$, and thus prevented from passing on to $m$. The impulsive action upon $m$ received from the ether within the cone $cmd$, will then be in excess over that received from the ether posited within the cone $c'md'$, by the amount thus intercepted by $n$. The atom $m$ should then gravitate toward $n$, by this differential force. Let $a$ denote the amount of wave-force that falls upon $m$, from the cone $cmd$; $a'$ the amount that falls upon $n$, from the conical frustum $c'nd'$; $\frac{a}{r}$ the amount of impulsive action on $m$ due to the wave-force $a$; $\frac{a'}{r}$ that which takes effect on $n$, from the wave-force $a'$. The impulsive forces, $\frac{a}{r}$ and $\frac{a'}{r}$, will be intercepted by $m$ and $n$, respectively. Let $\frac{a'}{r}=b$; and the wave-force from $c'md'$ that is propagated to $m$ will be represented by $a-b$, and the impulsive action it exerts on $m$, by $\frac{a-b}{r}$. Then $\frac{a}{r}-\frac{a-b}{r}$, or $\frac{b}{r}$, will be the effective force by which $m$ will gravitate toward $n$; for the entire gravitating force will be due to the conical portions of ether considered, provided all the points of $m$ are taken into account. It is obvious that $n$ will gravitate toward $m$ with an equal force, if the two atoms are exact counterparts of each other.

It may be imagined that the deficiency, $\frac{b}{r}$, in the impulsive action received from $c'md'$, may be made up by the wave-force reflected back from $n$ toward $m$, but this initial wave-force is diffused over the whole extent of the outspreading wave, and proportionally weakened at any one point, as $m$, which it reaches; and hence the portion that falls on $m$ is but a minute fraction of the initial impulse, $\frac{a-b}{r}$, reflected at $n$ toward $m$, and it is only the $\frac{1}{r}$ part of this minute fraction that can take effect impulsively on $m$. Suppose $\frac{1}{n}$ of $\frac{a-b}{r}$ is propagated to $m$, then the impulse on $m$, from the reflected wave $\frac{a-b}{r}$, will be $\frac{a-b}{nr^2}$, whereas the gravitating force of $m$ toward $n$ is $\frac{b}{r}$, or $\frac{a'}{r^2}$; or, owing to the indefinite extent of the conical frustrum, $c'nd'$, not sensibly different from $\frac{a}{r^2}$ (for all the points of $m$). It is to be observed that $\frac{1}{n}$ will always be an exceedingly minute fraction, and therefore $\frac{a-b}{nr^2}$ excessively small, as compared with $\frac{a}{r^2}$.

It will be evident, on considering the varying size of the cones *cmd*, *c'md'*, as the distance $m\ n$ is supposed to vary, that the effective force of gravity, $\frac{b}{r}$, will conform to the law of inverse squares. It may also be shown, by means of the fundamental ideas just presented, that if we regard every atom of ordinary matter as made up of ethereal or other atoms of equal size (in accordance with our fundamental conception, p. 331), the entire force of gravitation of one body of matter toward another, will be proportional to the product of the masses of the two bodies, and inversely proportional to the square of the distance between their centers.* If we adopt the other possible conception, that an atom of ordinary matter is one continuous homogeneous mass, impenetrable at all points to the ethereal wave-force, then the force of gravitation of one atom, $m$, toward another, $n$, will be proportional to the surface of each; instead of the quantity of matter, or number of equal atoms in each. Upon this idea the atomic weights of substances would represent the comparative superficial dimensions of the atoms.

Let us now inquire what considerations can be urged in favor of adopting the theory thus briefly set forth of the possible origin of universal gravitation.

1. It is deduced from the simplest possible conception that can be formed of the essential elements of the material universe, viz., that they consist of one primary form of matter—the ethereal, and one form of force—repulsion; the actual existence of each of which is a well established fact. It is not, however, at variance with the notion that the atoms of ordinary matter are not made up of ethereal atoms; as we have just seen.

2. The hypothesis that the ethereal repulsion from which the force of gravity is derived is made up of definite impulses, leads to the law of inverse squares, as the law of propagation of the wave-force originated by it.

* See this Journal, Jan., 1870.

3. The effective force theoretically deduced, conforms to the established laws of universal gravitation.

4. The high improbability that the force of gravitation can take effect on cosmical bodies, and be transmitted through them without being in any sensible degree diminished, or intercepted, cannot be urged as an objection to the present view, since it is the very interception of a portion of the wave-force that gives rise to the effective gravitating tendency.

5. The conclusion reached by Laplace, that the velocity of the gravitating fluid, if such there be, must be immeasurably greater than the velocity of light, does not militate against the present theory. For when we consider that the gravitation waves are supposed to proceed from all the atoms of the sea of ether to an indefinite distance, it will be seen that the number of impulses that take effect on any atom, $m$, of ordinary matter, must be regarded as infinitely great in any finite time; and hence, that if we represent the action of these waves in any line of direction, by the progressive motion of a line of atoms impinging upon $m$, the velocity of this motion must be conceived to be infinite. The velocities of the earth and moon in their orbits must be wholly insensible in comparison with this representative velocity of an impinging fluid; and no augmentation of ethereal impulses can result from these velocities, that will be any sensible fraction of the entire impulsive action, or indeed of the differential action that constitutes the effective force of gravity.

6. If these be legitimate conclusions, then it would appear that the necessity does not exist of supposing the medium of gravitation to be a distinct ether, immeasureably more subtile than the luminiferous ether. It may be imagined, however, that the ready transmission of the force of gravitation through bodies necessitates this supposition. But, when we reflect that there are certain substances through which the waves of heat pass with facility, and that when absorption of any of the solar radiations occurs it is chiefly by reason of certain accordant rates of vibratory movement induced within the absorbing medium, it does not seem unreasonable to suppose that the mechanical conditions required for a similar absorption of the gravitation-waves may be wholly wanting in all substances. The only intercepting action would then be that already considered, from which the gravitating tendency results.

Let it not be supposed, however, that there is any theoretical objection to the notion of a separate gravitation-ether; farther than that we have no independent evidence of the existence of an ether more subtile than the luminiferous, and that the arbitrary hypothesis of such a medium does not seem to be demanded by the phenomena. If the hypothesis were adopted, the hypothetical ether would simply play the part here assigned to the luminiferous ether.

VI. *Physical Constitution of a Primitive Molecule.*—A primitive molecule is here regarded as the physical equivalent of a "chemical atom," or simple "integrant atom," as these terms are ordinarily understood. The prevalent notion has been that a simple atom is inherently endued with the property of attraction or repulsion, which it manifests under different circumstances; but against this hypothesis rests the objection that it is highly improbable that a homogeneous atom can, of its own nature, exert a force of repulsion at one distance and of attraction at another. This fact, together with a careful study of physical phenomena, has led certain able physicists to regard an atom, so called, as made up of dissimilar parts. Now we are conducted to a notion of the physical constitution of an atom (primitive molecule) that accords with this idea, if we follow out the consequences of a universal force of repulsion. The impulsive "waves of translation" that are propagated to any atom of ordinary matter, from the universal sea of ether, should condense the surrounding ether upon its surface, and thus form a permanent ethereal atmosphere around it. This theoretical result, it should be observed, is in accordance with one of the inductions of Physical Optics.

Again, the electric ether, the supposed agent in electrical phenomena, cannot be very much less subtile than the luminiferous; if so, a portion of it posited in the vicinity of an ordinary atom, should be condensed around it by the ethereal waves, and form an *electric envelope*, immersed in the ethereal atmosphere, as roughly indicated in fig. 3. The electric ether, in this movement, should be borne forward, in a good degree, as if it were a portion of the ethereal medium of the wave propagation, but partly also by a gravitating tendency toward the atom, originated in the same way as that of one atom of ordinary matter toward another.

3.


Now it is to be observed that both the ethereal atmosphere and electric envelope of the atom are in a condition of dynamic equilibrium. The forces urging the atoms of the envelope toward the central atom are made up of actual recurring impulses; and the same is true of those condensing the ethereal atmosphere. Every such momentary condensation of this atmosphere must originate increased repulsive impulses exerted by this atmosphere upon the portion of the envelope exterior to it. Also, by our fundamental hypothesis, the ethereal atmosphere and the central atom must act directly by recurring impulses upon the electric envelope. Every atom of this envelope must then be incessantly urged inward by one set of impulses, which virtually constitute an *attractive force* exerted by the central atom; and incessantly urged outward by another set of impulses which constitute a *repulsive force* exerted by the ethereal atmosphere and the central atom.

The center of the virtual attraction of the atom for its envelope is at the center of the atom. But, with respect to the action on any radial line, as *rs*, fig. 3, the center of the repulsion exerted by the ethereal atmosphere upon the envelope is not coincident with the center of the atom, but lies at some different point *o*, on the side considered. This results from the fact that the atom intercepts a part of the repulsive force propagated from the portion of this atmosphere posited on the opposite side of it. It follows from this relative position of the two centers of action, that the envelope can have no definite outer limit, but must extend with diminishing density indefinitely outward. Still, from most points of view, a virtual limit may be said to exist.

This is the state of the case for a single isolated molecule. If we consider two contiguous primitive molecules of a solid, or liquid, their actions on the electric ether in the interstitial space between them, do not in general neutralize each other, and determine an electric vacuum there; for their oblique actions on the ether lying on either side of the line of their centers will obviously tend to condense it upon this line. At the surface of every body there must also be more or less of condensing action that will occasion a certain density of the electric ether, at those special interstitial points of the body at which the attractive actions of surrounding molecules upon the ether neutralize each other.

VII. *Molecular Forces.*—The impulses of the virtual attractive force which, we have just seen, will be exerted by an atom upon its envelope, must originate at every point of the envelope a series of *attractive* waves that will be propagated indefinitely outward, by the interstitial electric ether, to surrounding atoms of the body. The resultant wave-system that may be taken to represent the entire system of waves thus originating on any one radial line, *rs*, fig. 3, will obviously proceed from a point lying much nearer the inner than the outer surface of the envelope; as at *n*. The action of these attractive impulses upon the envelope will also be attended by momentary condensations of the ethereal atmosphere below it; and therefore will originate waves in this atmosphere that will be propagated indefinitely outward by the interstitial luminiferous ether. These waves will be repulsive in their character.

The force thus originating I designate as the molecular force of *heat-repulsion;* but it should not be confounded with the heat energy in the body, derived from extraneous sources, or from work of condensation previously expended in the interior of the body. Again, the repulsive impulses exerted, as we have seen, by the ethereal atmosphere upon the envelope, must take effect upon every point of it, and the outward pressures thus originating at the various points of any radial line, *rs*, will combine to produce a greater and greater outward condensing action at points more and more remote from the lower surface of the envelope, within a certain limit. From each of these points of varying condensation will proceed indefinitely outward, through the interstitial electric ether, a series of repulsive waves. These may be represented by a resultant wave-system, which must obviously be regarded as proceeding from a center nearer the outer then the inner surface of the envelope, as at $m$, fig. 3. This resultant system of repulsive waves, as it originates in the electric envelope, and is propagated by the interstitial electric ether, is termed the molecular force of *electric repulsion.*

The result then is, that *the molecular forces consist of one attraction and two repulsions;* all originating in the primary force of repulsion. They are made up of impulses propagated in waves; and hence must observe the law of the inverse ratio of the square of the distance.

From these fundamental results I have deduced in my former paper on Molecular Physics, the following general analytical expression for the intensity of the effective action of one primitive molecule on another, in terms of the distance, $x$, between the envelopes of the two molecules;

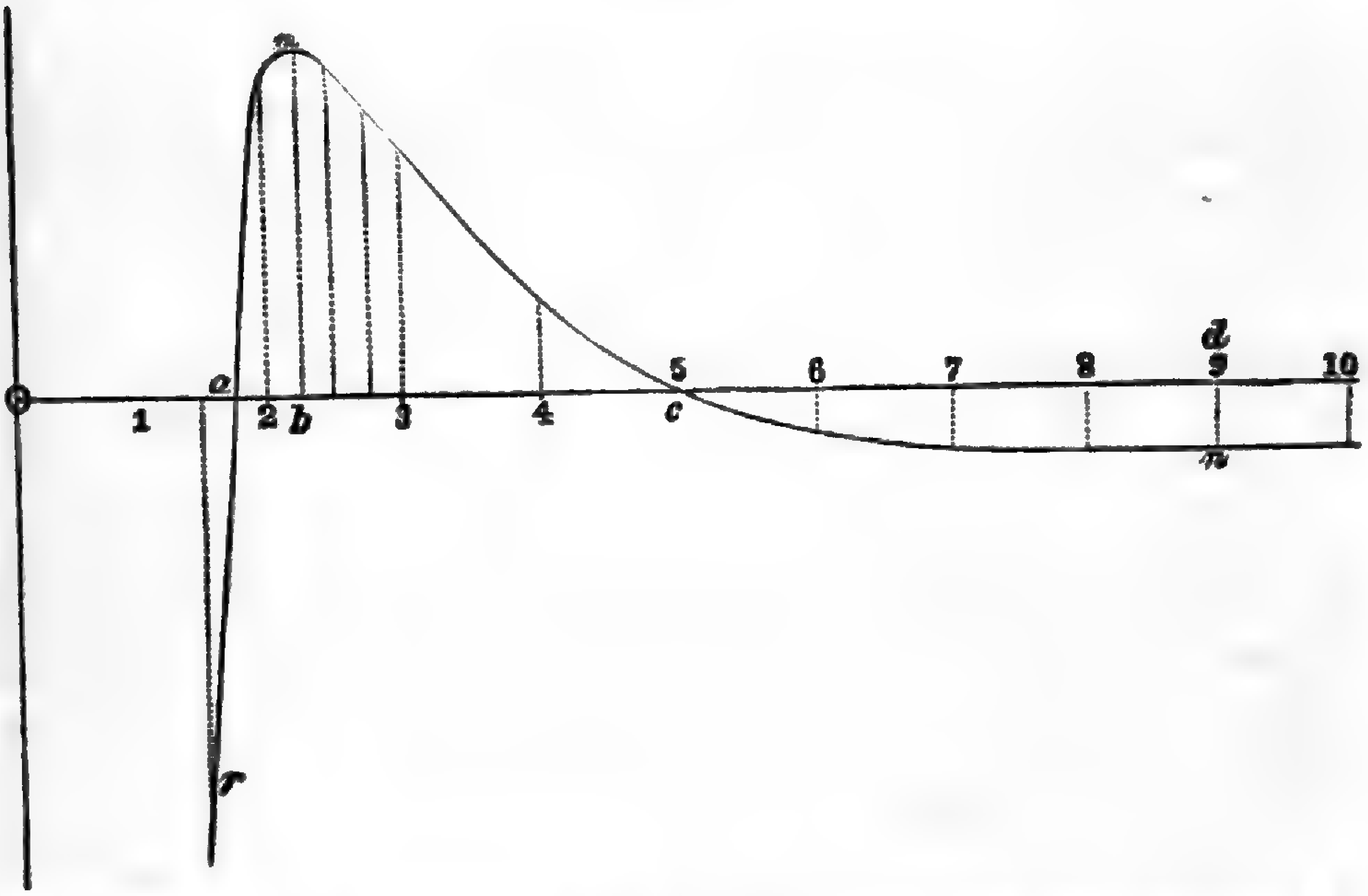
$$f=\frac{n(3r^2+2rx)}{(r+x)^2(2r+x)^2}-\frac{m}{x^2}$$

In this expression $n$ denotes the coefficient of the attractive force, and also of that termed the heat-repulsion, $m$ the coefficient of the electric repulsion, and $r$ the distance between the two centers from which the resultant systems of waves proceed (fig. 3). The molecules of different substances may differ in respect to the values of $m$ and $r$, and of the ratio $\frac{n}{m}$. Various supposed values of $\frac{n}{m}$ were taken, and the effective molecular action calculated in terms of $\frac{m}{r^2}$. The general character of the results was graphically represented by a *curve of effective molecular action* (fig. 4).

VIII. *Special Results.*—The following are some of the most important *results of the discussion;* a few of which have been obtained since the publication of my former paper.

1. There are two alternations in the nature of the effective molecular action, viz., one from a repulsion at the most minute

4.




distances to an attraction at greater distances, and another to a repulsion beginning at the outer limit of the attraction, and extending to an indefinite distance. This is shown in the figure, in which the distances laid off from $O$ represent the assumed values of the distance, $x$, between the theoretical envelopes, in terms of $r$, and the ordinates the effective action; $a$ and $c$ are the points at which the alternations occur. At the distance $Ob$ the maximum attractive action occurs, and at $Od$ the maximum repulsive action. $a$ is the position of stable equilibrium; that is, $Oa$ is the distance between the molecular envelopes when the two molecules are in equilibrium under their natural action.

2. For some distance above and below $a$ the curve is very nearly a right line, showing that the effective actions are for small displacements very nearly proportional to the distance from the point of rest. It is to be observed that $r$, the thickness of the theoretical envelope, is doubtless very small in comparison with the radius of the outer surface of this envelope, and hence that any displacement $a^2$ is a much smaller fraction of the distance between the centers of the molecules than of the distance $Oa$ between the envelopes.

3. The calculations were made for various values of $\frac{n}{m}$, from 4·938 to 12·410. The former value gives a curve lying entirely below the axis of $x$, and touching it at the distance

2·85 $r$. For this and every less value of $\frac{n}{m}$ the effective action is repulsive at all distances between the molecules. In proportion as the value of $\frac{n}{m}$ is greater than 4·938, the maximum attraction, $bm$, is greater, the range $ac$ of attractive action greater, the distance $Oa$ smaller, and the distance $Od$ greater. $Oa$ ranges from $2·85r$ to $0·5r$; $ac$ from 0 to $19·5r$, and $Od$ from $7r$ to $30r$. The value of $ab$ is nearly $0·5r$, for all the values of $\frac{n}{m}$ considered, excepting those differing but little from 4·938. The value of the maximum attractive ordinate, $bm$, varies from 0 to $0·73\frac{m}{r^2}$; and that of the maximum repulsive ordinate, $dn$, from $0·0042\frac{m}{r^2}$ to $0·00032\frac{m}{r^2}$; the latter value of $dn$ answering to the greatest assumed value of $\frac{n}{m}$. At the distance $80r$ the repulsion becomes very nearly the same for all the assumed values of $\frac{n}{m}$; viz, $0·00013\frac{m}{r^2}$.

(To be concluded.)

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## ART. XLIV.—*A New Sensitive Singing Flame;* by W. E. GEYER, of the Stevens Institute of Technology.

PHILIP BARRY has recently described* a very sensitive flame produced by placing a piece of ordinary wire-gauze on the ring of a retort stand, about four inches above a Sugg's steatite pin-hole burner, and lighting the gas above the gauze. "The flame is a slender cone about four inches high, the upper portion giving a bright yellow light, the base being a non-luminous blue flame. At the least noise this flame roars, sinking down to the surface of the gauze, becoming at the same time almost invisible. It is very active in its responses, and being rather a noisy flame, its sympathy is apparent to the ear as well as to the eye."

A simple addition to this apparatus has given me a flame, which, by slight regulation, may be made either: (1) a sensitive flame merely; that is, a flame which is depressed and rendered non-luminous by external noises, but which does not sing; (2) a continuously singing flame, not disturbed by outward

* Nature, v, 30, Nov. 2, 1871. [This form of apparatus would seem not to be original with Mr. Barry, since identically the same thing, apparently, was described months earlier by Professor Govi, of Turin, and noticed in the September number of the *Moniteur Scientifique.*—EDS.]

noises; (3) a sensitive flame, which only sounds while disturbed; or (4) a flame that sings continuously except when agitated by external sounds. The last two results, so far as known to me, are novel.

To produce them it is only necessary to cover Barry's flame with a moderately large tube, resting it loosely on the gauze. A luminous flame six to eight inches long is thus obtained, which is very sensitive, especially to high and sharp sounds. If now the gauze and tube be raised, the flame gradually shortens and appears less luminous, until at last it becomes violently agitated, and sings with a loud uniform tone, which may be maintained for any length of time. Under these conditions, external sounds have no effect upon it. The sensitive musical flame is produced by lowering the gauze, until the singing just ceases. It is in this position that the flame is most remarkable. At the slightest sharp sound, it instantly sings, continuing to do so as long as the disturbing cause exists, but stopping at once with it. So quick are the responses, that by rapping the time of a tune, or whistling or playing it, provided the tones are high enough, the flame faithfully sounds at every note. By slightly raising or lowering the jet, the flame can be made less or more sensitive, so that a hiss in any part of the room, the rattling of keys, even in the pocket, turning on the water at the hydrant, folding up a piece of paper, or even moving the hand over the table, will excite the sound. On pronouncing the word "sensitive," it sings twice; and in general, it will interrupt the speaker at almost every "s" or other hissing sound.

The several parts of the apparatus need not be particularly refined. By the kindness of Pres. Morton, I have used several sensitive jets of the ordinary kind made of brass; they all give excellent results. Glass tubes, however, drawn out until the internal diameter is between one sixteenth and one thirty-second of an inch, will do almost equally well. For producing merely the singing flame, even the inner jet of a good Bunsen burner will answer. The kind of gauze too is not important: I have generally used a piece which had been rounded for heating flasks; it contained about 28 meshes to the inch.

The tube chiefly determines the pitch of the note, shorter or longer ones producing, of course, higher or lower tones respectively. I have most frequently used either a glass tube twelve inches long and one and a quarter inches in diameter, or a brass one of the same dimensions. Out of several rough pieces of common gas-pipe, no one failed to give a more or less agreeable sound. Among these gas-pipes was one as short as seven inches, with a diameter of one inch; while another was two feet long, and one and a quarter inches in diameter. A third gas-pipe, fifteen inches long and three quarters of an inch in diameter, gave, when set for a continuous sound, quite a low and mellow tone. If the jet be moved slightly aside, so that the flame just grazes the side of the tube, a note somewhat lower than the fundamental one of the tube is produced. This sound is stopped by external noises, but it goes on again when left undisturbed. All these experiments can be made under the ordinary pressure of street gas, three-fourths of an inch of water being sufficient.

Hoboken, March 18, 1872.

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ART. XLV.—*Contributions from the Physical Laboratory of Harvard College.*—I. *On the Electro-motive action of Liquids separated by Membranes;* by JOHN TROWBRIDGE.

IT is well known that two liquids, of a dissimilar chemical composition, separated by a porous partition, give rise to a galvanic current. This fact has an important bearing upon the subject of animal electricity. Desiring to prove certain theories in regard to muscular currents, I undertook the following line of investigation.

The apparatus which I used was identical with that described by DuBois Reymond in his researches upon the muscular currents (Untersuchungen über Thierische Elektricität, Bd. I, p. 213, et seq. Beschreibung, &c.) It consists essentially of the following parts: a sensitive galvanometer with mirror and scale; two vessels filled with a saturated solution of sulphate of zinc, in which the amalgamated zinc terminals of the galvanometer are immersed; and connecting pads formed of many layers of fine filtering paper, which are laid over the edges of the vessels, forming the cushions upon which the muscle or nerve rests.

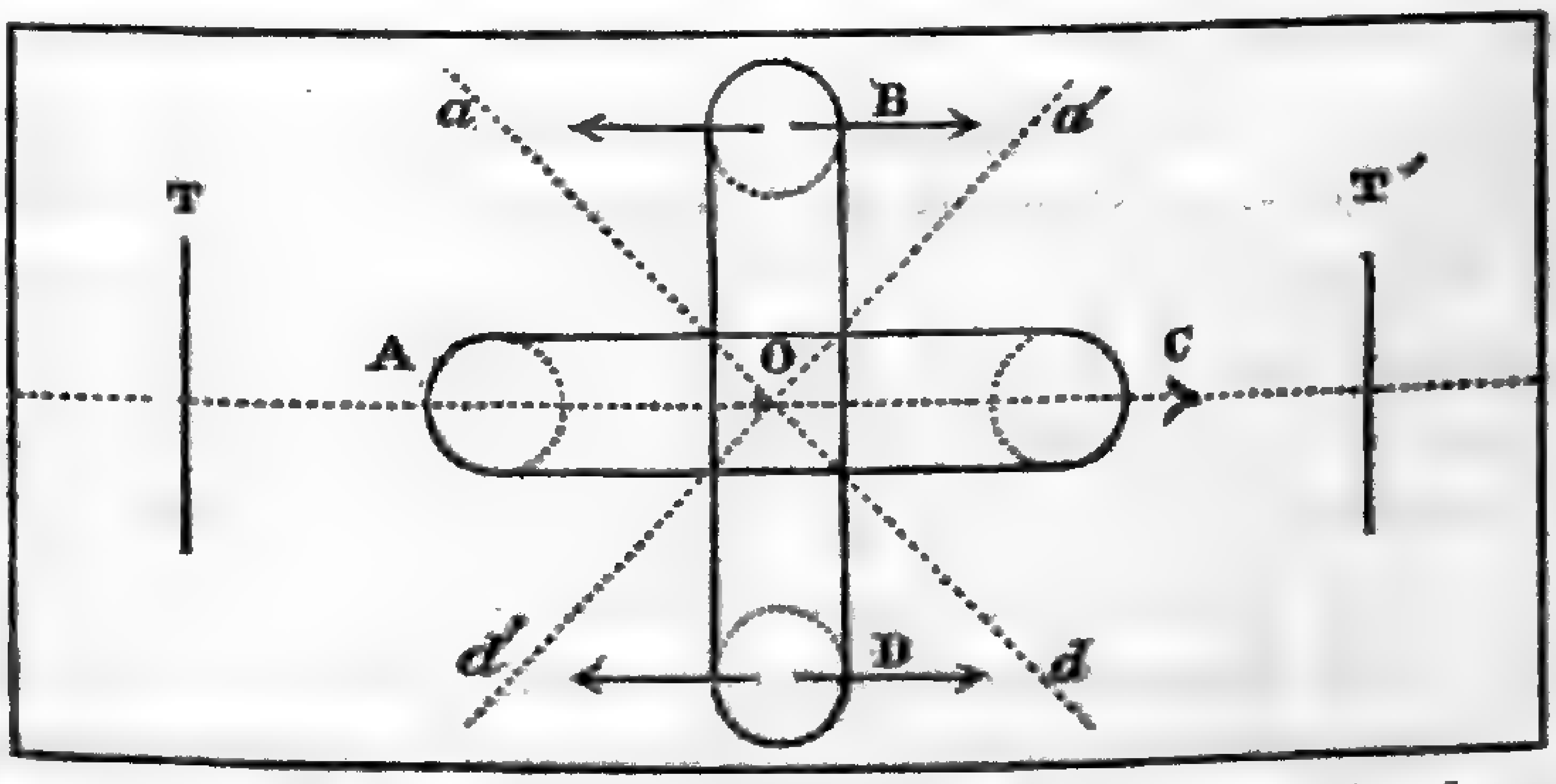
This apparatus obviates the difficulties arising from the unequal chemical composition of the two electrodes which essentially vitiates conclusions drawn from the currents obtained by touching the muscle or nerve with the bare terminals of the galvanometer.

The muscle or nerve is further protected from the saline solution in which the filtering paper is saturated by clay guards or by pieces of bladder soaked in the white of an egg.

In place of the muscle, I made use of a series of artificial muscles, consisting of glass tubes with the openings protected by porous partitions, and filled with the following liquids: undistilled water; weak solution of salt in distilled water; solution of various salts of iron; blood; acidulated water. Having carefully placed the artificial muscle in position with the proper openings placed upon the protecting guards, I found that each liquid produced a deflection of the needle of the galvanometer. The currents undoubtedly arose from the action of the liquids in the tubes upon the saline solutions with which the cushions and the protecting guards were saturated; for upon filling the artificial muscle with distilled water, no appreciable deflection was produced, whereas when it was filled with a solution of ordinary salt, or with the other liquids mentioned above, a decided swing of the needle resulted, throwing in many cases the spot of light reflected from the mirror of the galvanometer off the scale. The same precautions must be adopted as are advised by the electro-physiologists in obtaining the muscular currents. It will be seen that when we experiment with the muscle itself, we have a vessel containing fresh blood, with all its chemical properties active, separated by the sheath of the muscle from the clay guards placed upon the cushions of the galvanometer. An action must take place between the fluids of the muscle and the saline solutions of the connecting apparatus, which is extremly difficult to distinguish from the muscular current, when we consider that the fluids in their natural state in the muscle must exert a more definite chemical action than when they are removed and put in an artificial test muscle.

When membranes are used instead of clay partitions, endosmotic action may arise. Graham has shown, however, that the membrane must be chemically affected by the separated liquids in order that an appreciable action may take place. This source of error can be shunned by using unbaked sculptor's clay kneaded in sulphate of zinc. We cannot affirm conclusively, however, even in this case, that the membranous sheath of the muscle is not acted upon by the blood and the sulphate of zinc in the clay partition.

1.



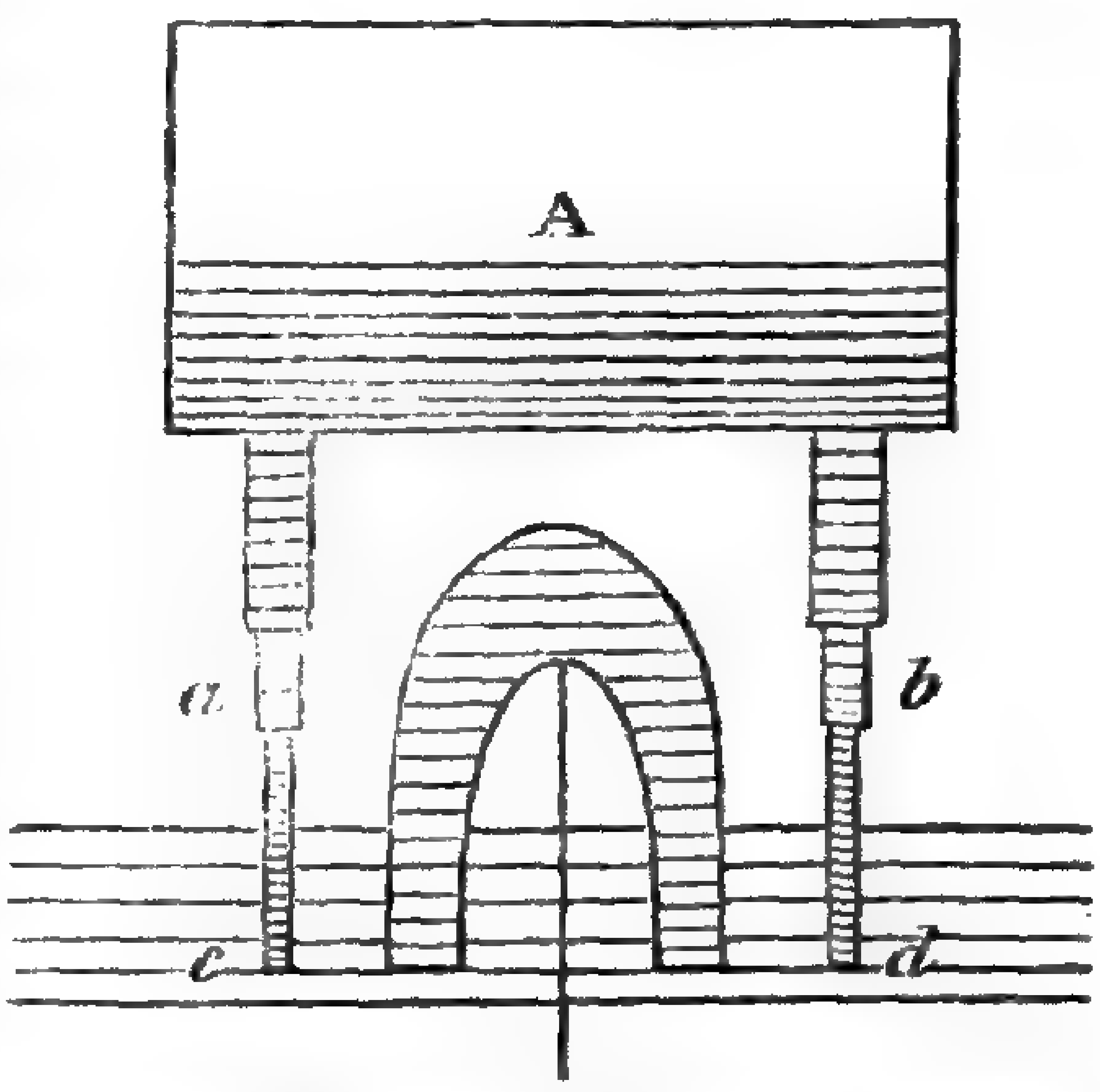

In the following experiments I placed the terminals of the galvanometer in an oblong vessel filled with sulphate of zinc; and filling a U tube with the liquid to be experimented with, I closed the ends with pieces of bladder prepared with the white of an egg, and dipped them in the bath of sulphate of zinc.

In fig. (1) T and T′ represent terminals of the galvanometer in plan. I found that when the extremities of the U tube were placed along the line A C, a current went from C to A through the U tube, arising probably from the resultant electromotive action at A and C, between the fluid enclosed in the tube and the sulphate of zinc in the connecting vessel. The current passed through the U tube, not, as it might be supposed, flowing merely from the point C to the point A along the surface of the bath. This was shown by contracting the bend of the tube; the deflection of the needle being greatly lessened thereby. Upon turning the U tube around a vertical axis passing through O into the position B D, the needle of the galvanometer returned to zero, and oscillated over a few degrees. This may be explained by supposing that the current divides at B into nearly equal portions, one part taking the direction to the right and the other to the left, and counteracting each other in their action upon the galvanometer. On turning the tube into the position a′ d′, the current is immediately reversed, the current which before passed in the direction O A through the galvanometer, now passing in the direction O C. The same phenomena are repeated at D, when the tube has been turned 270° from the point A; the current running again in the direction O A on a very slight movement of the tube from D toward A.

Care must be taken to eliminate the errors which arise from the mere disturbance of the bath of sulphate of zinc by the introduction of the tube. A rise of level of the bath is sufficient of itself to produce a current, owing probably to an immersion of a fresh portion of the surfaces of the zinc electrodes. This current, however, can be readily distinguished from that arising from the electromotive action between two fluids.

The experiments of Tomlinson on the cohesive figures produced by different liquids readily occurs to one in making these experiments. But there is not a close analogy between the two classes of phenomena; for, upon touching the surface of the bath with a drop of colored liquid, the needle in most cases is deflected before the colored fluid reaches the terminals. These experiments bear upon certain facts stated by writers on electro-physiology. DuBois Reymond having connected the vessels containing the terminals of the galvanometer by a siphon tube containing the same liquid as was contained in the separate vessels, the ends of the tube having been covered with a porous preparation, placed a fore-finger in each vessel near the opening of the connecting siphon tube. Upon contracting one arm violently, he found that the needle was deflected in one direction, and upon contracting the other, the direction was reversed. This action is attributed by DuBois Reymond to the electrical currents supposed to be circulating in the arms. By the contraction of one arm the muscular current becomes enfeebled, and the current of the other arm predominates. It occurred to me that experiments with the U tube might throw some light upon this celebrated experiment. I therefore arranged the vessels in the manner of Du Bois Reymond, but used instead of the human fingers, a vessel (fig. 2) with two limbs, which were connected with each other at the top. At $a$ and $b$ are pieces of flexible tubing, and the extremities $c$ and $d$ were covered with prepared membrane; A was filled with a weak solution of salt.

2.




The resistance of the circuit was nearly that of the human body from the forefinger of one hand to that of the next, and equal to seven or eight times that of the Atlantic cable. The extremities of the tube were then immersed in the liquid of the connecting vessels, the same precautions being observed as are advised by DuBois Reymond. Upon the first contact with the liquid, the spot of light from the galvanometer was deflected over 200 divisions of the scale, and upon the reversal of the limbs the direction of the deflection was also changed. By pinching the flexible tube of one of the limbs, this deflection could be greatly lessened.

When a slight chemical difference was made between the liquids in the two limbs of the tube, and one limb was tightly contracted, a deflection of the needle resulted in a contrary direction from its first indication. This experiment may perhaps be regarded as a mere exemplification of the manner in which the supposed electrical currents circulating in the arms act when the muscles of one arm are violently contracted.

The difficulty, however, in conceiving of a distinct electrical current existing in the arms, and coëxistent with the individual currents claimed by the electro-physiologists; and the further difficulty of conceiving how muscular contraction can effect this current, lead me to believe that the deflection of the needle resulting from the contraction of the muscle of the arms is produced either by the perspiration or by the change in the flow of the blood. It may be mentioned in this connection that the electromotive force between arterial and venous blood is 2.43, if we represent that of a Daniell's cell by 76·42.

(Scoutetten. *Experiences nouvelles pour constater l'electricite* *du sang et en mesurer la force electromotrice.* C. R., lvii, 791-795.)

It is well known that muscular contractions can alter the character of the blood; and we have shown that a very slight chemical difference between two fluids separated by a membrane of the same nature as the cutaneous covering of the fingers, will be shown by the galvanometer.

## II.—*Demagnetization of Electro-magnets;* by Robert W. Willson, Junior Class, Harv. Coll.

Wiedemann has shown Pogg. Ann. C. 235, Ann. de Min. (3), l, 189, that the intensity of the current necessary to demagnetize a steel magnet is much less than that of the current by which the bar was originally magnetized.

It has occurred to me to experiment, with a view to ascertaining how far this principle can be applied to electro-magnets.

The apparatus used consisted of a cylindrical bar of soft iron 8 c.m. in length and 1 c.m. in diameter, slightly rounded at the end. The armature was a piece of soft iron, of the same diameter and 2 c.m. in length.

Around this core were placed two concentric helices, wound in opposite directions, through each of which could be passed the current of a single Grove's cell.

The method of experimenting was as follows. A current was first passed through the inner helix, which, for convenience, I shall call A, and the weight supported by the bar was noted. This current being broken, the outer helix, B, was introduced into the circuit, and the corresponding weight noted. The current through B being then broken, and that through A closed, after a short time, the current was again passed through B and the weight noted. The following table shows the results.

Wt. supported by—

| | A | B | A diminished by B |
|---|---|---|---|
| | 490 grms. | 250 | 130 |
| | 470 | 240 | 130 |
| | 460 | 230 | 130 |
| | 460 | 220 | 120 |
| | 420 | 220 | 130 |
| | 410 | 200 | 110 |
| Mean | 452 | 227 | 125 |

Taking the mean result, we see that while the helix B can only develop sufficient magnetism in the bar to render it capable of sustaining 227 gr., yet, if it act in opposition to A, it can diminish the weight which the latter supports by 327 grms.; that is, its power to demagnetize is greater than its power to magnetize.

If then we suppose the coercive force of the steel bar used in Wiedemann's experiments to be represented by the helix A, and the demagnetizing current of feeble intensity to be represented by the helix B, of less magnetizing power, we have here an interesting confirmation of Wiedemann's results, while we may also extend the application of the principle to electro-magnets, and may assert, in general, that a current of given intensity, or a helix of given dimensions, traversed by a constant current, has greater power to demagnetize than to magnetize. It is evident that the case of demagnetizing an electro-magnet by a current is more difficult than the process of demagnetizing a steel bar; for whereas in a steel magnet the resistance is simply the coercive force of the steel, so that the bar when partially deprived of its magnetism has no tendency to return to its original state, even if the demagnetizing current be broken, in the case of electro-magnets the helix, by which the bar was originally magnetized, is still acting with its full power when the demagnetizing helix in introduced into the circuit.

A natural inquiry was this: if the bar were magnetized by the weaker helix B, and then demagnetized by the helix A, what additional amount of magnetism could A impart to the bar? It is evident that this case, though somewhat similar to the former, is not identical with it; here the helix B acts as resistance to the magnetization of the bar, while in the former case it acted to deprive the bar of a portion of the magnetism which it already possessed.

Accordingly the bar, being magnetized by B, was submitted to the action of A, and the weight supported being noted, the reverse operation was performed, and the weights supported compared as follows:

| A demagnetized by B. | B demagnetized by A. |
|---|---|
| 85 | 65 |
| 70 | 65 |
| 65 | 60 |
| 65 | 50 |

It will be noticed that the results in the left hand are larger than those in the right hand column, that is, when A is simply demagnetized by B, it can support a greater weight than when it is employed to magnetize the bar against the resistance of B.

In short, the result of my experiments has been to show that a given helix, traversed by a given current, has more power to demagnetize than to magnetize, while its power to prevent magnetization is greater than either.

## Art. XLVI.—*Canons of Systematic Nomenclature for the higher groups;* by Samuel H. Scudder.

Several years ago, the American Association for the Advancement of Science appointed a committee to reconsider the canons of biological nomenclature, and to report whether, with the growth of science, they required any additions or alterations. No report has yet been made, nor, so far as we are aware, is any likely to be presented, until the subject is again brought prominently forward and new instructions given. Professor A. E. Verrill has since republished * the Revised Rules of Zoölogical Nomenclature adopted by the British Association for the Advancement of Science in 1865, and has accompanied them by a few apt comments; in England, Mr. W. F. Kirby, in a paper read before the Linnean Society of London, has called attention to the extensive changes which a strict adherence to the laws of priority would cause in the generic nomenclature of butterflies; and quite recently has put the same into practice in his catalogue of these insects.

But hitherto very little has been said concerning the special application of definite rules to groups higher than genera, and it is to this division of the subject that we desire to call attention.

In attempting to legislate upon this branch of zoölogical nomenclature, two principles must be kept in view: *first,* so far as possible, the canons already in general acceptance for generic nomenclature should be applied to all the monomial groups. Unity of principle lies at the foundation of acceptable legislation; *second,* retrospective laws should be avoided.

One difficulty meets us at the outset,— what some are pleased to term the unstable nature of the higher groups, but which we should prefer to call the disagreement of naturalists as to the limits and value of these groups; yet as this diversity of view is a nearly equal hindrance to any code of rules, it needs only to be mentioned in passing.

Endeavoring to keep in mind the principles above enunciated, and as the simplest means of presenting our views, the following outline of a code is suggested for the consideration of zoölogists.

*Canons.*—I. The name originally given by the founder of a group should be permanently retained, to the exclusion of all subsequent synonyms.

This rule, recognizing the law of priority, which lies at the foundation of all systematic nomenclature, is the same as the

* This Journal, July, 1869.

first and prime rule of the code accepted by the British Association, with the exception of certain references made exclusively to species; and, since this canon meets universal acceptance, there is no need of discussing it, aside from the following limitations.

1. This law of priority should not extend to works published before 1758.

The same reasons for such a limitation do not exist in the present instance as in the case of specific nomenclature; but similar objections can be made to an earlier limitation. Only three reasonable courses are open to the naturalist: to accept (*a*) no limitation whatever, in which case "our zoölogical studies would be frittered away amid the refinements of classical learning; (*b*) the limitation here formulated, in which case all our systematic nomenclature takes its common origin in the tenth edition of Linné's Systema Naturæ;* or (*c*) to apply the laws of nomenclature to each kind of group (subfamily, family, class, etc.), from the time when such group was first brought into use—which would engender such confusion as speedily to bring all nomenclature into deserved disrepute.

2. Plural or collective substantives (or adjectives used as substantives) are alone admissible.

As the higher groups are all collective—in idea, if not in fact—it is essential that the names applied to them should be at least capable of a collective sense; and names which are not so formed should be dropped. The retrospective action of such a law would be very slight.

3. A name which has been previously proposed for some genus or higher group in zoölogy should be expunged.

This accords too well with accepted rules to require any discussion.

4. When two authors define and name (differently) the same group, both making it of the same or very nearly the same extent, the later name (or if synchronous, the least known name) should be cancelled, and never again brought into use.

With the exception of certain verbal modifications, this law is identical with the sixth section of the British Association rules, where it is applied to genera only.

5. In any subsequent alterations of the limits of a group, its name should never be cancelled; but should be retained either in a restricted or an enlarged sense.

The necessity for such a limitation is obvious; otherwise a different name would (or, could) be given by every author who

* The English—the strongest upholders of the plan of dating from the twelfth edition of the Systema Naturæ—are now, by degrees, accepting the earlier date of 1758 as the starting point for zoölogical nomenclature, and we may assume that, in this view, the whole scientific world will sooner or later concur.

differed from preceding ones in his ideas of the precise limitation of any group in question. This indeed has already been done, and, if continued, will create lamentable confusion; but this limitation should itself be subject to one exception, which may be formulated thus:

6. But any assemblage so defined by an author as harshly to violate the groupings of nature (as known to naturalists of his time), should be cancelled.

Such a rule would prevent the injury which might accrue to science by too close an application of the preceding law. The parenthetical limitation seems, however, to be necessary.

II. Changes in the name of one group should not affect the names of other groups.

This follows as a corollary of the first canon, but it has been not infrequently violated, and it is easy to perceive the cause. The nomenclature of higher groups, notably of families and subfamilies, has, to a considerable degree, been founded upon generic names, with the addition of special collective endings to the root (see recommendation 1). Now, when a generic name which has formed the basis of a family designation has been found to be pre-occupied, it has been thought necessary by some to recast the nomenclature of the higher group. But why? After a name has been long applied to a group, it ceases to have any intrinsic meaning, and is simply associated with the group itself, recalling it without reference to any particular member of the same. It certainly would be agreeable if we had a nomenclature in which each group should by the very association of ideas recall its members; but since that is utterly impossible, and we have to deal with a mass of synonyms already tangled and intricate, our problem is—how best to make our way out of the difficulty without a continual wrangling over names and entailing endless disputes upon future generations.

To this canon no exception whatever should be made; for it would be difficult to draw the line anywhere and gain general consent. Anyone who considers the subject, will see that one apparently reasonable exception will lead to another scarcely less desirable, until the whole value and force of the proposed canon is destroyed.

III. The mere enumeration of its members, when known, is a sufficient definition of the limits of a group, and gives it an unquestionable claim to recognition.

Although it is certainly *most* desirable that every name proposed for a group should, when first propounded (or shortly after), be accompanied by a full description of its essential characters, it is evident that no one acquainted with the subject of which an author treats can fail to understand his meaning if he defines his groups by mere enumeration of their members. If for instance, he designates the known genera to be embraced in a proposed family, he actually defines his group much better than he could do by a specification of its characters, since we have probably not yet been favored with any description of a natural family which gives everything which is characteristic and omits all that is not.

*Recommendations.*—1. "That assemblages of genera, termed families, should be uniformly named by adding the termination -idæ to the name of the earliest known or most typically characterized genus in them; and that their subdivision, termed subfamilies, should be similarly constructed with the termination -inæ."

This recommendation, formulated by the committee of the British Association, is deprived of a great part of its value by the disagreement of naturalists as to the nature of family and subfamily groups,—assemblages of very diverse natures having received this designation at the hands of different writers; indeed, up to the issue of Professor Agassiz's Essay on Classification, no one had ever attempted to give definite shape to current opinions upon the subject; and it will be long before we shall see a general concurrence in either the views put forward in that work, or in any modification of them. Such being the case, it is evident that this recommendation cannot have the force of a law, nor be allowed any retrospective action. Otherwise these rules, or any other reasonable ones (however generally they may be accepted), are powerless to assign to any higher natural group a fixed and unalterable name; but the group in question would receive a different name from different authors, according as they considered it a subfamily or an assemblage of still another nature.

2. All monomial collective names should be derived from the Greek, and have a plural form.

3. Only the surname of the author who first proposed a group need follow its name, whether the group be used in its original or in a modified sense; but when it is desirable to indicate at the same time its recognized, altered limits, the surname of the writer who first proposed the accepted circumscription may follow in a parenthesis.

In systematic nomenclature, the object is to register titles, not to gratify pride, and the names of authors are appended for convenience, not fame; the question of justice or injustice has no place here; and yet the above recommendation ought to be satisfactory to those who view this matter in a different light.

## Art. XLVII.—*On some new Species of Paleozoic Fossils;** by E. Billings, F.G.S.

### Genus Hyolithes *Eichwald.*

In the following description of new species of *Hyolithes*, I shall call the side of the fossil which is most flattened, or from which there is a projection in front of the aperture, "the ventral side." Directly opposite is the "dorsum." The lateral walls, whether consisting of two sloping planes, as in fig. 2, or rounded as in the other figures, I shall designate simply "the sides." The "width" of the aperture is the greatest distance between the two most projecting points of the sides. This is

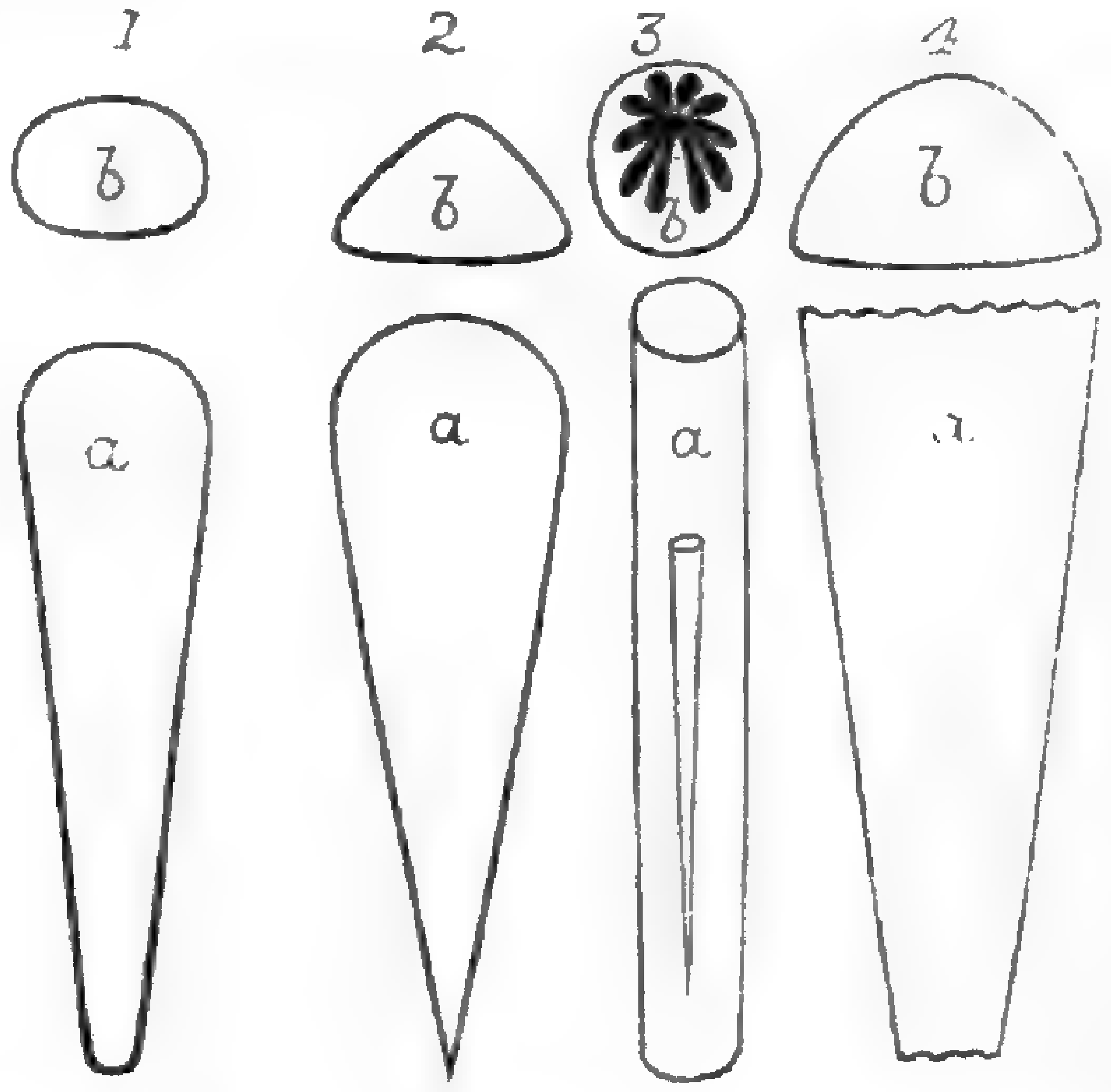



Fig. 1. *Hyolithes communis.* 2. *H. Americanus.* 3. *H.? micans.* 4. *H. princeps.* In these diagrams *a* represents the rate of tapering of the shell on the ventral side; *b*, the transverse section (except in 3 *b*, which is the inner surface of an operculum enlarged two diameters). The small figure in 3 *a* represents the apical portion of a specimen. N. B.—All these species vary slightly in the rate of tapering.

sometimes close to the ventral side, as in fig. 2. The "depth" is the distance between the median line of the ventral side and the dorsum, and is at right angles to the width. That part of the ventral side which projects beyond the aperture is the "lower lip." The "ventral limb" of the operculum is that side which is in contact with the lower lip, when the operculum is in place, in the aperture. The "dorsal limb" is the opposite side of the operculum, in contact with the dorsum. In some of the opercula there is a point around which the surface markings are arranged concentrically; this is the "nucleus."

The following species occur in the pebbles and boulders of a

* Extracted from the Canadian Naturalist of December, 1871.

conglomerate which constitutes an important formation on the south shore of the St. Lawrence, below Quebec. The age of the rock in which these pebbles are found, is not yet certainly determined, but it is, at all events, near that of the Potsdam.

*H. communis.*—This species attains a length of about eighteen lines, although the majority of the specimens are from ten to fifteen lines in length. The ventral side is flat (or only slightly convex) for about two-thirds the width, and then rounded up to the sides. The latter are uniformly convex. The dorsum, although depressed convex, is never distinctly flattened, as is the ventral side. The lower lip projects forward for a distance equal to about one-fourth or one-third the depth of the shell. In a specimen whose width is three lines, the depth is two lines and a half.

The operculum is nearly circular, gently but irregularly convex externally, and concave within. The ventral limb is seen on the outside as an obscurely triangular, slightly elevated space, the apex of the triangle being situated nearly in the center of the operculum. The base of the triangle forms the ventral margin. This limb occupies about one-third of the whole superficies of the external surface. The remainder, constituting the dorsal limb, is nearly flat, slightly elevated from the margin toward the center. On each side of the apex of the ventral limb there is a slight depression, running from the nucleus out to the edge. On the inside there is an obscure ridge, corresponding to each one of the external depressions. It is most prominent where it reaches the edge. These two ridges meet at the center, and divide the whole of the inner surface of the operculum into two nearly equal portions.

The surface of the operculum is concentrically striated. The shell itself in some of the specimens is covered with fine longitudinal striæ, from five to ten in the width of a line. The shell varies in thickness in different individuals. In some it is thin and composed of a single layer, but in others it is much thickened by concentric laminæ, and thus approaches the structure of a *Salterella.* There are also fine engirdling striæ, and sometimes obscure sub-imbricating rings of growth.

This species has been found at Bic and St. Simon.

Fig. 1 *b*, representing the transverse section, is not so distinctly flattened on the ventral side as it is in most specimens.

Collected by T. C. Weston.

*H. Americanus.*—Length from twelve to eighteen lines, tapering at the rate of about four lines to the inch. Section triangular, the three sides flat, slightly convex or slightly concave, the dorsal and lateral edges either quite sharp or acutely rounded. Lower lip rounded, projecting about two lines in full-grown individuals. Surface finely striated, the striæ curving forward on the ventral sides, and passing upward on the sides at nearly a right angle, curve slightly backward on the dorsum. In a specimen eighteen lines in length, the width of the aperture is about six lines and the depth about four, the proportions being slightly variable.

The operculum has a very well-defined conical ventral limb, the apex of which is situated above the center, or nearer the dorsal than the ventral side. The dorsal limb forms a flat margin, and is so situated that when the operculum is in place, the plane of this flat border must be nearly at right angles to the longitudinal axis of the shell. In an operculum six lines wide, the height of the lower limb to the apex of the cone is two and a half lines, and the width of the flat border, which constitutes the dorsal limb, about one line.

This species occurs at Bic and St. Simon; also at Troy, N. Y., where it has been found abundantly by Mr. S. W. Ford of that city. It is *Theca triangularis* of Hall, Pal. N. Y., vol. i, p. 213, 1847. As that name was preoccupied by a species previously described by Col. Portlock, Geol. Rep. on Londonderry, p. 375, pl. 28 A, figs. *3a*, *3b*, *3c*, 1843, it must be changed. It is a very abundant species, and varies a good deal.

The Canadian specimens were collected by T. C. Weston.

*H. micans.*—This is a long, slender, cylindrical species, with a nearly circular section. The rate of tapering is so small, that it amounts to scarcely half a line in length of eighteen lines, where the width of the tube is from one to two lines. The largest specimen collected is two and a half lines wide at the larger extremity, and if perfect would be four or five inches in length.

The operculum does not show distinctly a division into a dorsal and ventral limb. It is of an ovate form, depth somewhat greater than the width, the nucleus about one-third the depth from the dorsal margin. Externally it is gently concave in the ventral two-thirds of the surface; a space around the nucleus is convex, and finely striated concentrically. On the inner surface there is a small pit at the dorsal third of the depth, indicating the position of the nucleus. From this point radiate ten elongate ovate scars, arranged in the form of a star, the rays toward the ventral side being the longest. None of these scars quite reach the margin.

The shell and operculum are thin and of a finely lamellar structure, smooth and shining.

Occurs at Bic and St. Simon; also at Troy, N. Y.

Collectors, T. C. Weston and S. W. Ford.

Sometimes numerous small specimens, from half a line to three lines in length, are found with the operculum on the same slab.

This shell appears to me at present to constitute a new genus, differing from the majority of the species of *Hyolithes* in its circular section, the operculum not divided into dorsal and ventral limbs, and in the remarkable system of muscular impressions on the interior. Barrande has figured an operculum of the same type, differing from this in having only three instead of five pairs of impressions. They are, however, arranged on the same plan in both the Canadian and Bohemian species.* It is possible that our species may be a *Salterella*.

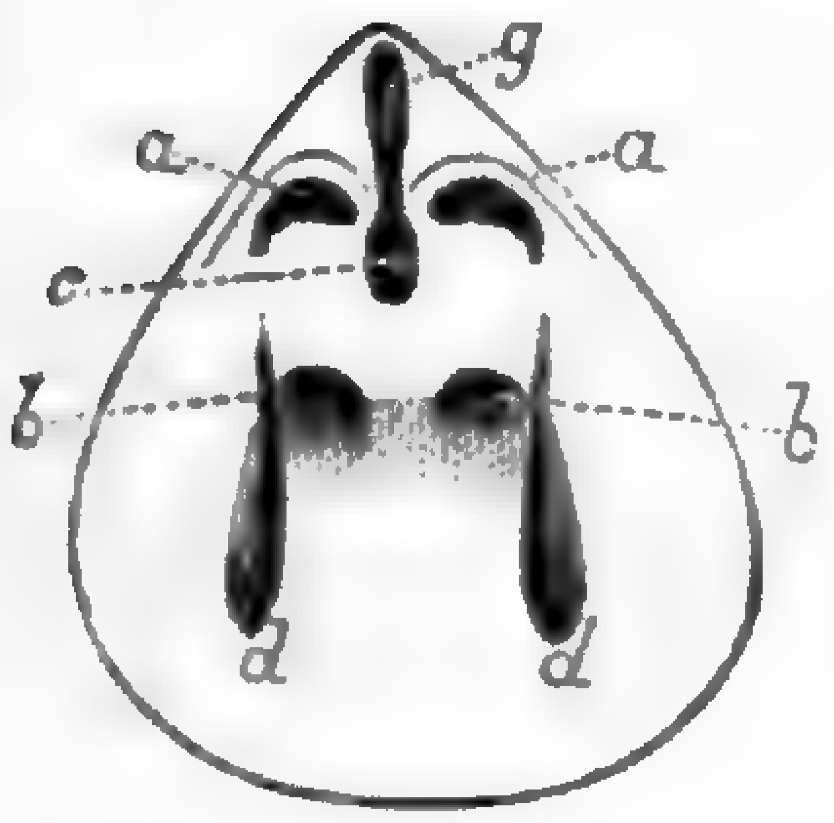
*H. princeps.*—Shell large, sometimes attaining a length of three or four inches, tapering at the rate of about three lines to the inch. In perfectly symmetrical specimens, the transverse section is nearly a semicircle, the ventral side being almost flat, usually with a slight convexity, and the sides and the dorsum uniformly rounded. In many of the individuals, however, one side is more abruptly rounded than the other, in consequence of which the median line of the dorsum is not directly over that of the ventral side, and the specimen seems distorted. This is not the result of pressure, but is the original form of the shell. Sometimes, also, there is a rounded groove along the median line of the dorsum. The latter is somewhat more narrowly rounded than the sides. Lower lip uniformly convex, and projecting about three lines in a large specimen. Surface with fine striæ and small sub-imbricating ridges of growth. These curve forward on the ventral side. In passing upward on the sides, they at first slope backward from the ventral edge, and then turn upward and pass over the dorsum at a right angle to the length.

When the width of the aperture is seven lines, the depth is about five. The operculum has not been identified.

Collected by T. C. Weston at Bic and St. Simon.

Genus Obolella *Billings.*

5

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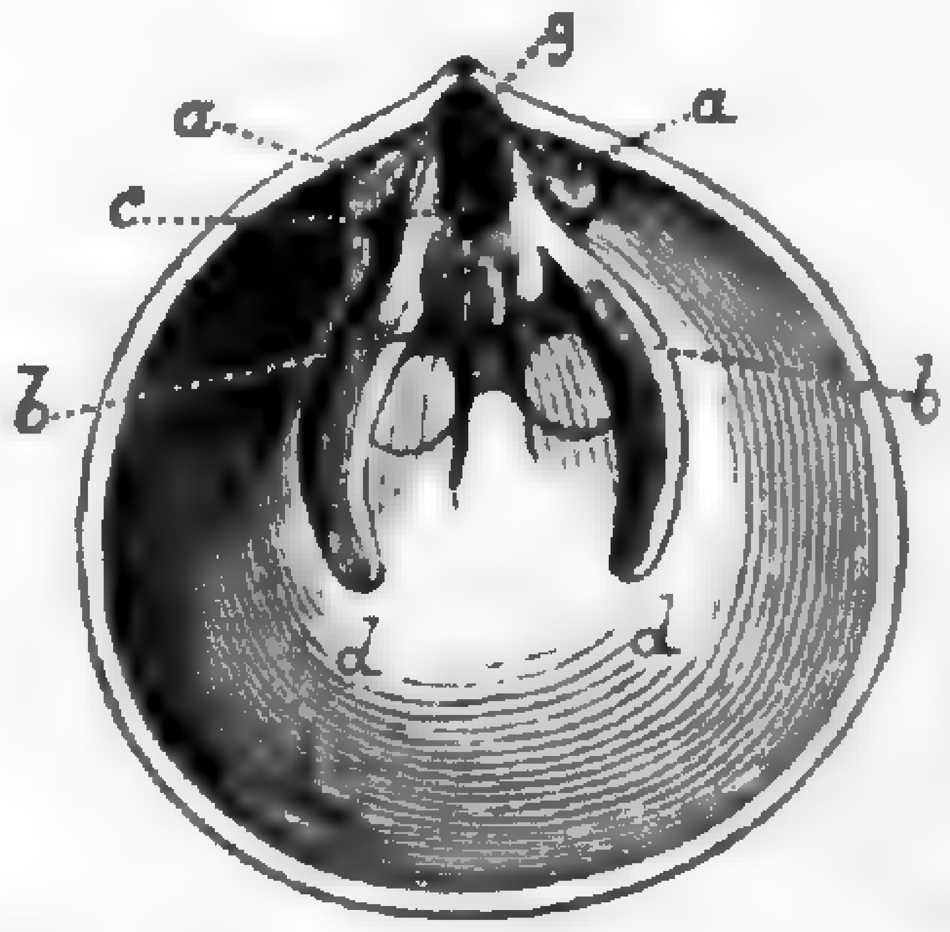


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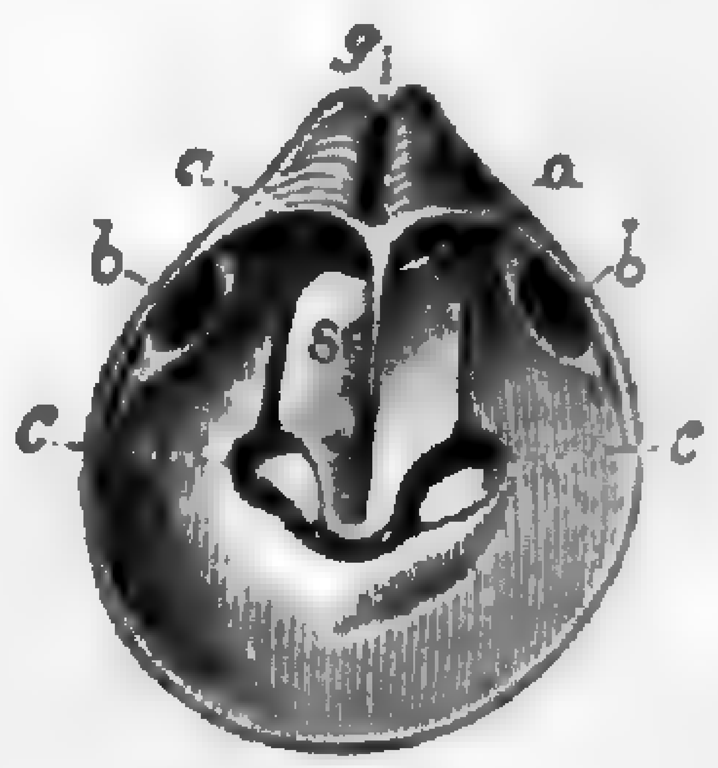


Fig. 5. Interior of the ventral valve of *O. gemma*, enlarged about five diameters. *aa*, the two small scars at the hinge; *bb*, the two central scars; *c*, the small pit near the hinge; *dd*, the two principal muscular scars; *g*, the groove in the area.

6. Interior of the ventral valve of *O. desquamata* Hall,† enlarged 2½ diameters.

7. Interior of the ventral valve of *Obolus Apollinis* Eichwald, copied from Davidson's "Introduction to the study of the fossil Brachiopoda."

* Systéme Silurian, &c., vol. iii, pl. 9, fig. 16 H, and fig. 17.

† Engraved from a figure kindly drawn for me by Thos. Davidson, Esq., F.R.S., of Brighton, England. The specimen is from the original locality of the species, Troy, N. Y. Collected by T. C. Weston.

*Generic Characters.*—Shell unarticulated, ovate or sub-orbicular, lenticular, smooth, concentrically or radiately striated, sometimes reticulated by both radiate and concentric striæ. Ventral valve with a solid beak and a small more or less distinctly grooved area. In the interior of the ventral valve there are two elongated sub-linear or petaloid muscular impressions, which extend from near the hinge line forward, sometimes to points in front of the mid-length of the shell. These are either straight or curved, parallel with each other or diverging toward the front. Between these, about the middle of the shell, is a pair of small impressions, and close to the hinge line a third pair, likewise small, and often indistinct. There is also, at least in some species, a small pit near the hinge line, into which the groove of the area seems to terminate. In the dorsal valve there are six impressions corresponding to those of the ventral valve, and sometimes an obscure rounded ridge along the median line.

If we compare the interior of the ventral valve of an *Obolella* with that of *Obolus Apollinis*, we see that there are six muscular impressions in each, but not arranged in the same manner. The two small scars *aa*, at the hinge line, are most probably the same in both genera. The two lateral scars *bb* of *Obolus* have no homologue in *Obolella*, unless they be represented by the two large ones *dd*. Should this be the case, however, the great difference in their position would no doubt be of generic value. I think it more probable that the large scars *dd* of *Obolella* represent the central pair *cc* of *Obolus*. Again, Eichwald says that in the interior of the ventral valve of *O. Apollinis* there is a longitudinal septum (shown in the above fig. 7 at *s*), which separates the two adductors *cc*, and extends to the cardinal groove (I suppose he means the groove *g* on the area).* No such septum occurs in any species of *Obolella*. I have not seen any description of the dorsal valve of the *O. Apollinis* sufficiently perfect to afford a means of comparison with that of *Obolella*, but the differences in the ventral valve alone are so great that the two genera can scarcely be identical. They are, however, closely related, and occur in nearly the same geological horizon.

In the rocks below Quebec and at the Straits of Belle Isle, we find the following species of *Obolella*:—

1. *O. desquamata* Hall, = *Avicula? desquamata*, Pal. N. Y., vol. i, p. 292, pl. 80, fig. 2. Occurs at Troy, N. Y.

2. *O. crassa* Hall, = *Orbicula? crassa*, op. cit. p. 299, pl. 79, fig. 8. Occurs at Troy.

* Speaking of the adductors, he says: "Une crête longitudinal occupe le milieu des dernières impressions et arrive jusqu'au sillon cardinal." (Lethea Rossica, vol. i, p. 925).

3. *O. cœlata* Hall, = *Orbicula cœlata*, op. cit. p. 290, pl. 79, fig. 9. Occurs at Troy.

4. *O. gemma*, n. sp.

5. *O. circe*, n. sp.

6. *O. chromatica* Billings; has been found as yet only at the Straits of Belle Isle.

The following are new species:

*O. gemma.*—Shell very small, about two or three lines in length, ovate, both valves moderately convex and nearly smooth. Ventral valve ovate, the anterior margin broadly rounded, with sometimes a portion in the middle nearly straight; greatest width at about one-third the length from the front, thence tapering with gently convex or nearly straight sides to the beak, which is acutely rounded. The area is about one-fifth or one-sixth the whole length of the shell, with a comparatively deep groove, which extends to the apex of the beak. The dorsal valve is nearly circular, obscurely angular at the beak, and rather more broadly rounded at the front margin than at the sides.

In the interior of the ventral valve there are two small muscular impressions of a lunate form, close to the cardinal margin, one on each side of the median line. A second pair consists of two elongate sub-linear scars, which extend from the posterior third of the length of the shell to points situated at about one-fourth the length from the front margin. These scars are nearly straight, parallel or slightly diverging forward, and divide the shell longitudinally into three nearly equal portions. Between them, about the middle of the shell, are two other small obscurely defined impressions. There is also a small pit close to the hinge line and in the median line of the shell. In the interior of the dorsal valve there is an obscure rounded ridge which runs from the beak along the median line almost to the front margin. Close to the hinge line there is a pair of small scars, one on each side of the ridge. The other impressions in this valve have not been made out.

The surface of both valves is in general nearly smooth, but when well preserved shows some obscure concentric striæ.

This species is closely allied to *O. chromatica*, the species on which the genus was founded, only differing from it, so far as the external characters are concerned, in being much smaller, and the beak of the ventral valve more extended.

Occurs at Bic and St. Simon. Collected by T. C. Weston.

*O. circe.*—Ovate, front and sides uniformly rounded, posterior extremity more narrowly rounded than the front, length and width about equal, greatest width at the mid-length, rather strongly and uniformly convex, surface nearly smooth, but with fine concentric striæ. Length seven lines, width a little less. The rostral portion of the shell is much thickened for about one-fifth the length, and in this part there is a deep and wide groove. In front of the thickened portion the muscular impressions are indistinctly seen, but appear to be formed on the same plan as those of the ventral valve of the genus.

The above description is drawn up on one exterior, and several interiors of the same valve, apparently the ventral valve. The exterior is very like that of *O. desquamata,* and is of the same size, but the interior shows it to be an entirely distinct species.

Length of the largest specimen seen, seven lines; width about the same, or slightly less.

Occurs at Trois Pistoles. Collected by T. C. Weston.

*Platyceras primævum.*—Shell minute, consisting of about two whorls, which as seen from above are ventricose, but most narrowly rounded at the suture: the inner whorl scarcely elevated above the outer. The under side is not seen in the specimen. Diameter, measured from the outer lip across to the opposite side, one line; width of last whorl at the aperture, about one-third of a line.

Collected at Bic by T. C. Weston.

*Proposed new genus of Brachiopoda.*

Genus MONOMERELLA, gen. nov.

*Generic characters.*—Shell unarticulated, ovate or orbicular; ventral valve with a large area and with muscular impressions like those of *Trimerella.* Dorsal valve with muscular impressions in the central and posterior portion of the shell, nearly like those of *Obolus.* In the ventral valve there is only a single septum, which extends from the cardinal line a greater or less distance forward. There are two cavities in the shell beneath the area. In the dorsal valve there are no cavities in the shell. The main difference between this genus and *Trimerella* are, thus, as follows:—

*Trimerella.*—Cavities in both valves.

*Monomerella.*—Cavities in the ventral valve, but none in the dorsal.

The above description is intended to be merely introductory. As Mr. Davidson will soon fully describe and illustrate the genus from both Canadian and Swedish specimens, no more need be said about it here.

This genus was discovered in the spring of 1871, at Hespelar, Ontario, in the Guelph limestone, by T. C. Weston. Before venturing to describe it, I sent a specimen to Mr. Davidson, and on returning it he stated that he considered it to be a new genus, "very closely allied to *Trimerella*" Lately I received a letter from him in which he states that he has obtained the same genus from Wisby, Island of Gothland, and he requested me to name it, as he was about to publish the Swedish species.

We have two distinct species, both occurring in the Guelph limestone. This formation I consider to be about the age of the Aymestry limestone of the English geologists. I shall characterize our species briefly as follows. Full descriptions and figures will be given hereafter.

*M. prisca.*—Ventral valve ovate, greatest width at about the anterior third of the length, thence tapering with gently convex sides to the narrowly rounded beak; front margin broadly rounded; septum about one-third the length of the shell. Dorsal valve about one-fourth shorter than the ventral, and more broadly rounded at the anterior extremity. On a side view the outline of the ventral valve would be, so far as we can judge from a cast of the interior, somewhat straight, or only gently arched from the beak to the front margin. The dorsal valve, on the other hand, is rather strongly convex, most prominent in the anterior half. It is evident that the general cavity of the shell of the dorsal valve extends a short distance under the area.

Length of ventral valve, eighteen lines; greatest width, thirteen or fourteen lines; length of dorsal valve about fourteen lines. There are some fragments in the collection which indicate a larger size.

Occurs in the Guelph limestone at Hespelar, Ontario. Collected by T. C. Weston.

*M. orbicularis.*—Broadly ovate, nearly circular, lenticular, both valves moderately convex; septum about one-third the length. The casts seem to show that a thin plate extends forward a short distance from the cardinal edge, supported by the septum. The length and width appear to be about twelve or fifteen lines.

Occurs with *M. prisca.* T. C. Weston, collector.

Both *Trimerella* and *Monomerella* are sub-genera of *Obolus.*

There is, beside the above, a third group which differs from the other two in having no cavities in either valve.* It includes the species I have called *Obolus Canadensis* and *O. Galtensis.* For this group I would propose the name OBOLELLINA. It differs from *Obolus Apollinis* in the form of the area of the ventral valve, and in having a small pair of muscular impressions in the dorsal valve, in front of the large central pair. In all

* Since the above was published in the Can. Nat., in Dec. last, I have ascertained that cavities may exist both in *Monomerella* and *Obolellina.* Where they do occur, however, in species of these genera, they are small or rudimentary as compared with their great size in *Trimerella.* They occur in some individuals of *O. Galtensis*, but not in others. When, therefore, they are only slightly developed, they are not even of specific value. But when very large, they may be of subgeneric importance.

three of these sub-genera there are species which have the large muscular impressions of the ventral valve obliquely striated or grooved. This seems to show that the muscles were not single, but composed of several bands. The three genera pass gradually into each other, and yet I think some sort of a subdivision is required. It seems almost absurd to place such shells as *T. grandis* and *O. Canadensis* in the same generic group.

*Proposed new genus of Pteropoda.*

Genus HYOLITHELLUS, gen. nov.

Since the sheet containing the description of *Hyolithes micans* was printed off, I have arrived at the conclusion that a new genus for its reception should be instituted. I propose to call it *Hyolithellus.* It differs from *Hyolithes*, in its long slender form and in the peculiar structure of its operculum.

Montreal, 23d March, 1872.

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ART. XLVIII.—*Preliminary Description of* HESPERORNIS REGALIS, *with Notices of four other new Species of Cretaceous Birds;* by O. C. MARSH.

THE few remains of birds hitherto described from the Cretaceous deposits of this country, although of much interest, all pertained to comparatively small species, and belonged, apparently, to families still existing.* It is fortunate, therefore, that the existence of a fossil bird, so large and remarkable as the one that forms the subject of the present description, should first be made known by the discovery of such important parts of a skeleton, as to afford ample material for the determination of its affinities. This interesting discovery has already been announced in this Journal, and the name, *Hesperornis regalis*, proposed by the writer for the species thus represented.† The present paper is preliminary to a full description, with illustrations, now in course of preparation. The other species briefly described in this article are likewise of interest, as they add some new forms to the limited avian fauna heretofore found in the Cretaceous beds of the Atlantic coast.

*Hesperornis regalis*, gen. et sp. nov.

The remains of this species at present known consist of portions of one skeleton, including the nearly entire posterior limbs, from the femur to the terminal phalanges, parts of the pelvis, several cervical and caudal vertebræ, and numerous ribs,

* This Journal, vol. xlix, p. 205, March, 1870. † Vol. iii, p. 56, Jan., 1872.

all in excellent preservation. Fragments of four other individuals were also found by the writer, which agree essentially with the corresponding parts of the more perfect skeleton. An examination of these various remains soon makes it evident that they represent a gigantic swimming bird, having its nearest living allies probably in the *Colymbidæ*, but differing widely in many respects from that group, and from all other known birds, recent and extinct.

The femur is unusually short and stout, much flattened antero-posteriorly, and the shaft curved forward. It somewhat resembles in form the femur of *Colymbus torquatus* Brün., but the great trochanter is proportionally much less developed in a fore-and-aft direction, and the shaft is much more flattened. The tibia, or *tibia-tarsus*, is straight and elongated. Its proximal end has a moderately developed cnemial process, with an obtuse apex. The epi-cnemial ridge is prominent, and continued distally about one-half the length of the shaft. The distal end of the tibia has on its anterior face no ossified supratendinal bridge, differing in this respect from all known aquatic birds. The fibula is well developed, and resembles that of the Divers.

The tarso-metatarsal bone is much compressed transversely, and resembles in its main features that of *Colymbus.* On its anterior face there is a deep groove between the third and fourth metatarsal elements, bounded on its outer margin by a prominent rounded ridge, which expands distally into the free articular end of the fourth metatarsal. This extremity projects far beyond the other two, and is double the size of either, thus showing a marked difference from any known recent or fossil birds. There is a shallow groove, also, between the second and third metatarsals, which taken in connection with the deeper one, made the specimen appear, while still in the rock, as if its main elements were separate. The second metatarsal is much shorter than the third or fourth, and its trochlear end resembles in shape and size that of the former. The existence of a hallux is indicated by an elongated oval indentation on the inner margin above the articular face of the second metatarsal. The free extremities of the metatarsals have the same oblique arrangement as in the *Colymbidæ*, to facilitate the forward stroke of the foot through the water. There are no canals or even grooves for tendons on the posterior face of the proximal end, as in the Divers and most other birds; but below this there is broad, shallow depression, extending rather more than half way to the distal extremity.

The phalanges of the large, external toe are very peculiar, although an approach to the same structure is seen in the genus *Podiceps.* On the outer, inferior margin they are all deeply excavated. The first, second and third have, at their distal ends, a single, oblique, articular face on the inner half of the extremity, and the outer portion is produced into an elongated, obtuse process, which fits into a corresponding cavity in the adjoining phalanx. This peculiar articulation prevents flexion except in one direction, and greatly increases the strength of the joints. The terminal phalanx of this toe was much compressed. The third, or middle, toe was greatly inferior to the fourth in size, and had slender, compressed phalanges, which correspond essentially in their main features with those of modern Divers. The phalanges of the first and second toes of the present specimen are wanting.

Portions of the pelvis, found with the posterior limbs in three of the specimens, indicate that the illia were separated from each other, and not very firmly ossified to the sacral vertebræ. The acetabulum was covered with a thick cushion of cartilage, as in *Apteryx*, and, at its upper margin, the anterior and posterior extensions of the illia, if both existed, were disconnected, or unossified at their union.

The cervical and caudal vertebræ preserved present no features deserving of special mention in this preliminary notice. The latter are numerous, but apparently not much in excess of those in some modern birds. Unfortunately, no portions of the skull were recovered. The femur and tibia have very thick, compact walls, and do not appear to have been pneumatic. The tarso-metatarsals and the phalanges were nearly or quite solid.

***Measurements.***

| | |
|---|---|
| Length of right femur, | 98· mm. |
| Transverse diameter of proximal end, | 53· |
| Diameter of articular head, | 18·5 |
| Transverse diameter of shaft, at middle, | 22· |
| Antero-posterior diameter, | 19·2 |
| Transverse diameter of distal end, | 53·5 |
| Length of right tibia, | 316· |
| Transverse diameter of proximal articulation, | 38· |
| Length of cnemial process, | 22· |
| Transverse diameter of shaft, at middle, | 29· |
| Transverse diameter of distal end, | 32· |
| Antero-posterior extent of outer condyle, | 32· |
| Antero-posterior extent of inner condyle, | 22· |
| Length of right tarso-metatarsal, | 137· |
| Length to distal end of third metatarsal, | 130· |
| Length to distal end of second metatarsal, | 116· |
| Transverse diameter of proximal articulation, | 36· |
| Least transverse diameter of shaft, | 15· |
| Transverse diameter of distal end of fourth metatarsal, | 16· |
| Transverse diameter of third metatarsal, | 8·5 |

| | |
|---|---|
| Transverse diameter of second metatarsal, | 8· mm. |
| Length of proximal phalanx of fourth toe, | 45· |
| Length of second phalanx, | 39·5 |
| Length of third phalanx, | 40· |
| Length of proximal phalanx of third toe, | 41· |

The various remains of the present species already discovered belonged to five individuals, which differed but little in size, or in any important particulars. Taking the great Northern Diver (*Colymbus torquatus* Brün.) as a standard of comparison for the portions that are wanting, the skeleton of *Hesperornis regalis* would measure about five feet and nine inches from the apex of the bill to the extremities of the toes.

The affinities of *Hesperornis* have already been mentioned. The characters given in the above description show plainly that, although a comprehensive type, it belongs in the Palmipedes; and while most nearly allied to the *Colymbidæ*, it still differs so widely from that group in the structure of the pelvis and posterior limbs as to demand a place in at least a separate family, which may be called *Hesperornidæ*.

All the remains of the species now known were found by the writer, last summer, in the gray shale of the upper Cretaceous, near the Smoky Hill River, in Western Kansas.

### *Graculavus velox*, gen. et sp. nov.

Among the vertebrate remains in the Yale Museum, from the Cretaceous green-sand of New Jersey, are fragments of the skeletons of two aquatic birds, which apparently belong to the same genus, although to quite distinct species. Both of these differ essentially from any recent birds, but are evidently most nearly allied to the Cormorants. The largest of these birds, to which the above specific name may be given, is mainly represented, at present, by the proximal half of a left humerus, in perfect preservation, and hence a very characteristic specimen. In its general features this humerus resembles that of the common Cormorant (*Graculus carbo* Linn.), although indicating a somewhat smaller species. The articular head is much more compressed transversely, its apex is more prominent, and its anconal margin is strongly deflected. The median ridge, on the anconal side below the head, is rounded instead of angular, and the ulnar crest is much less produced distally.

#### *Measurements.*

| | |
|---|---|
| Greatest diameter of proximal end of humerus, | 23·75 mm. |
| Vertical diameter of articular head, | 13· |
| Transverse diameter, | 6· |
| Proximal extension of head beyond ulnar crest, | 4·6 |
| Least diameter of shaft below proximal extremity, | 6· |

The specimens on which this species is based were found by John G. Meirs, Esq., at Hornerstown, New Jersey, in the green-sand of the upper Cretaceous, and by him presented to the Museum of Yale College.

*Graculavus pumilus*, sp. nov.

The present species, which is hardly more than one-third the size of the preceding, is likewise represented by the proximal end of a humerus, as well as by some other characteristic remains. The articular head in this specimen is equally compressed, and shows the same prominent apex, but is without the anconal deflection, which distinguishes the larger species. The lower half of the head is narrower transversely, and separated from the internal trochanter by a wider notch. The median ridge, moreover, on the anconal face is much more acute.

***Measurements.***

| | |
|---|---|
| Greatest diameter of proximal end of humerus, | 13·25 mm. |
| Vertical diameter of articular head, | 8· |
| Transverse diameter, | 4· |
| Least diameter of shaft below proximal end, | 3·1 |
| Greatest diameter of metacarpal, at distal end, | 5·5 |
| Least diameter, | 3·75 |

The known remains of this species are from the same locality and geological horizon as the preceding, and were also discovered by John G. Meirs, Esq.

*Graculavus anceps*, sp. nov.

The only fossil bird remains secured during the explorations of the Yale College party of 1870 in the Cretaceous beds of Kansas, although special search for them was made, was the distal extremity of a left metacarpal, which is so well preserved and so characteristic a part of the skeleton, that it indicates with considerable certainty the affinities of the bird to which it belonged. A careful comparison of this specimen with the corresponding bone in recent birds has made it apparent that the species was a near ally of the Cormorants, and it may therefore be referred provisionally to the genus *Graculavus*, until further discoveries determine its position more accurately. The specimen implies a species about the size of the Violet-green Cormorant (*Graculus violaceus* Gray) of the Pacific coast, and one somewhat larger than *Graculavus velox*, described above. From the metacarpal of the former it differs essentially in having the articular face for the external digit broader and nearly flat, the face for the small inner digit considerably smaller and oval in outline, and the intervening tubercle much more prominent.

*Measurements.*

| | |
|---|---|
| Greatest diameter of distal end, | 6·75 mm. |
| Least diameter of distal end, | 5· |
| Transverse diameter of outer articular face, | 5· |
| Vertical diameter, | 2·25 |

This specimen was found by the writer in the gray, upper Cretaceous shale, on the North Fork of the Smoky Hill River, in Western Kansas.

*Palæotringa vagans*, sp. nov.

The existence of a new wading bird in the Cretaceous green-sand of New Jersey is plainly shown by an interesting fossil recently presented to the Yale Museum. The specimen is the greater portion of the shaft and distal end of a left tibia, somewhat injured, but with its more characteristic portions still preserved. It indicates a bird somewhat smaller than *Palæotringa littoralis*, described by the writer from the same locality,* but is probably a closely allied form. From the tibia of that species, the present specimen may readily be distinguished by the proportionally more narrow and shallow tendinal canal, on the anterior face of the distal end, and by the more depressed supra-tendinal bridge. The trochlear surface, also, on the posterior side contracts more rapidly, and at its superior margin passes directly, and not abruptly, into the shaft.

*Measurements.*

| | |
|---|---|
| Length of portion preserved, | 62· mm. |
| Approximate width of condyles in front, | 8· |
| Width of bridge at center, | 2·15 |
| Transverse diameter of lower outlet, | 1·5 |
| Transverse diameter of shaft where broken, | 5· |
| Antero-posterior diameter, | 4· |

This unique specimen was discovered at Hornerstown, New Jersey, about ten feet below the surface of the marl, and was presented to the Yale Museum by John G. Meirs, Esq.

Yale College, New Haven, April 10th, 1872.

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ART. XLIX.—*On a proposed method of estimating Ethylic Alcohol when present in Methylic Alcohol;* by M. CAREY LEA, Philadelphia.

WHILE engaged in the study of some methyl compounds, I met with a method, which has recently been published in England, for effecting the above object with approximate correctness. As any simple means of accomplishing this result

* This Journal, vol. xlix, p. 208, March, 1870.

would be useful, I have made an examination of the proposed method, which is as follows:

Methylic oxalate is first to be prepared from the specimen of methylic alcohol to be examined, by distilling it with sulphuric and oxalic acids. After separating the methylic oxalate from the distillate, its melting point is to be determined, and this melting point is affirmed to fix approximately the quantity of ethylic alcohol present, the melting point being lower in proportion to the ethylic alcohol contained in the methylic.*

This was tested as follows:

1. Some good wood-spirit, which I had distilled over caustic soda, was heated with oxalic and sulphuric acids, and the crystals of methylic oxalate separated from the distillate. It was not stated whether the melting point of the crystals was to be taken while they were still wet, or after drying. Apparently the first was intended; I tried, however, in both ways.
2. The adhering liquid was squeezed out as completely as possible with a spatula, the mass was liquified by heat, and a thermometric bulb placed in it.
   Crystals first appeared at .................. 102° F.
   The liquid became thick with crystals at ... 100° F.
3. The crystals were next taken out and dried on blotting paper; as soon as dry were tried again. Result:
   Crystals first appeared at .................. 128° F.
   The liquid became thick with crystals at .... 127° F.
4. Nine volumes of the same wood-spirit were next mixed with one volume of 95 pr. ct (by vol.) alcohol, and the experiment repeated.
5. The crystals of methylic oxalate were freed from adhering liquid as far as could be done by pressure, the mass was liquified, and as it cooled,
   Crystals first appeared at .................. 98° F.
   The liquid became thick with crystals at ..... 97° F.
6. These crystals were dried as before, and then fused and cooled.
   Crystals began to form at .................. 128° F.
   " became thick " .................. 127° F.

It thus appears that the melting point of the crystals, if they have been dried on blotting paper, is precisely the same whether prepared from methylic alcohol nearly pure, or containing about ten per cent of ethylic alcohol. So that no inferences can be drawn from this.

When the crystals have been simply squeezed, the congealing point appears to be lower when ethylic alcohol has been

* A table has been given to show the relation:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Per cent | of | ethylic alcohol, | 0 | Methylic oxalate | solidifies | at or | about | 104° F. |
| " | " | " | 5 | " | " | " | " | 95° |
| " | " | " | 10 | " | " | " | " | 86° |
| " | " | " | 15 | " | " | " | " | 76° |

present, and when, consequently, the liquid which moistens the crystals contains ethylic oxalate. But it seems evident that the congealing point will depend quite as much on the amount of liquid which chances to be left with the crystals, as upon the purity of the wood-spirit, so that two operators working with the same materials would be apt to get quite different results.

Accordingly, the congealing point attained at (5) compared with the table would indicate the presence of 3–4 per cent of ethylic alcohol, whereas there was present about ten per cent. This conclusion is to be regretted, as the method, if reliable, would have been valuable.

March 2, 1872.

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ART. L.—*Discovery of a New Planet;* by Prof. JAMES C. WATSON. From a letter to one of the editors, dated Ann Arbor, April 4, 1872.

I DISCOVERED last night, in the constellation Virgo, a planet hitherto unknown, of which I have observed the following places:

| | Ann Arbor M. T. | $\alpha$ | $\delta$ |
|---|---|---|---|
| 1872. | April 3, $12^h$ $20^m$ $0^s$ | $13^h$ $23^m$ 43·13 | |
| | 3, 13 51 30 | 13 23 40·42 | $-9°$ 28′ 20″·1 |
| | 3. 15 13 43 | 13 23 37·59 | $-9$ 27 42 ·8 |

Hourly motion, $\Delta\alpha = -2^s{\cdot}0$ $\Delta\delta = +27''{\cdot}0$.

The planet shines like a star of the eleventh magnitude.

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## SCIENTIFIC INTELLIGENCE.

### I. CHEMISTRY AND PHYSICS.

1. *On the aromatic phosphines.*—A. W. HOFMANN has obtained the first known members of the series of aromatic phosphines corresponding to the aromatic ammonias. When two molecules of chloride of benzyl, two molecules of iodide of phosphonium, and one molecule of oxide of zinc are heated together in a closed tube, a white crystalline mass is formed, from which the author obtained a colorless liquid boiling at 180° C., and having the formula, $P\left\{\begin{array}{l}C_7H_7\\H\\H\end{array}\right.$, which is that of benzyl-phosphine. The liquid is insoluble in water, but soluble in alcohol and ether, and yields a crystallized iodhydrate, which has the formula $C_7H_{10}PI$. The corresponding chlorhydrate and bromhydrate appear not to crys-

tallize; the platinum salt forms a yellow insoluble precipitate. Benzyl-phosphine is formed according to the equation:

$$2\Theta_7H_7Cl + 2PH_4I + Zn\Theta = 2P\Theta_7H_7 . H_3I + ZnCl_2 + \Theta H^2.$$

Dibenzyl-phosphine remains in the retort after distilling off the volatile products. When pure, it forms brilliant crystalline needles, which are perfectly free from taste and smell, and insoluble in water. Dibenzyl-phosphine, $P\left\{\begin{array}{l}\Theta_7H_7\\ \Theta_7H_7\\ H\end{array}\right.$, does not unite with acids or even with platinic chloride: oxygen exerts no action upon it even at a high temperature. Its formation is expressed by the equation:

$$2\Theta_7H_7Cl + PH_4I + ZnO = P(\Theta_7H_7)_2H_2I + ZnCl_2 + \Theta H_2.$$

Besides these products, the mother-liquor of dibenzyl-phosphine contains a sticky body insoluble in alcohol, which appears to possess acid properties, but which the author has not succeeded in obtaining in a state of purity.—*Berichte der Deutschen Chemischen Gesellschaft, Jahrgang* v, p. 100. W. G.

2. *On the products of the oxidation of the methyl- and ethyl-phosphines.*—When a slow current of methyl-phosphine is conducted into fuming nitric acid, oxidation takes place, accompanied by the formation of a new acid, which HOFMANN terms monomethyl-phosphinic acid. The acid may be obtained pure by decomposing the lead salt by sulphydric acid. It is a white crystalline mass resembling spermaceti, which is hygroscopic but not deliquescent. It dissolves readily in water; the solution reddens litmus paper, and has a pleasant acid taste. The stability of the acid is remarkable, as it may be repeatedly evaporated with aqua regia without the slightest change. The acid melts at 105° C., and may be, in great measure at least, distilled without change. Its constitution is expressed by the formula $P(\Theta H_3)H_2\Theta_3$: it is bibasic or diatomic, and forms two series of salts, which have respectively the formulas $P(CH_3)HM\Theta_3$ and $P(CH_3)M_2\Theta_3$. Many of the metallic salts are insoluble or soluble with difficulty. Hofmann describes the salts of silver, lead and barium. By the action of nitric acid upon dimethyl-phosphine, the author obtained a second acid, which he terms dimethyl-phosphinic acid, and which has the formula $P(\Theta H_3)_2H\Theta_2$. It is a white crystalline mass resembling paraffin, very soluble in water, alcohol and ether. The crystals melt at 76° C., and volatilize at a higher temperature without decomposition. The silver salt of this acid has the formula $P(\Theta H_3)_2Ag\Theta_2$; it presents fine felted needles extremely soluble in water. The barium and lead salts are uncrystalline, and dry to clear masses like varnish. Hofmann also briefly describes the two corresponding ethyl-acids, the first being crystalline, the second fluid even at −25°. The constitution of the new acids becomes intelligible if we regard them as derivatives from orthophosphoric acid, in which methyl replaces hydroxyl, $\Theta H$.

Thus we have for the phosphorus and corresponding arsenic series the following formulas:

| | | | |
|---|---|---|---|
| Orthophosphoric acid, | $P\Theta\left\{\begin{array}{l}\Theta H\\ \Theta H,\\ \Theta H\end{array}\right.$ | Orthoarsenic acid, | $As\Theta\left\{\begin{array}{l}\Theta H\\ \Theta H,\\ \Theta H\end{array}\right.$ |
| Methyl-phosphinic acid, | $P\Theta\left\{\begin{array}{l}CH_3\\ \Theta H,\\ \Theta H\end{array}\right.$ | Arsen-monomethylic acid, | $As\Theta\left\{\begin{array}{l}CH_3\\ \Theta H,\\ \Theta H\end{array}\right.$ |
| Dimethyl-phosphinic acid, | $P\Theta\left\{\begin{array}{l}CH_3\\ CH_3,\\ \Theta H\end{array}\right.$ | Kakodylic acid, | $As\Theta\left\{\begin{array}{l}CH_3\\ CH_3,\\ \Theta H\end{array}\right.$ |
| Trimethyl-phosphin oxide, | $P\Theta\left\{\begin{array}{l}CH_3\\ CH_3,\\ CH_3\end{array}\right.$ | Trimethyl-arsin oxide, | $As\Theta\left\{\begin{array}{l}CH_3\\ CH_3.\\ CH_3\end{array}\right.$ |

—*Berichte der Deutschen chem. Gesellschaft, Jahrgang* v, p. 104.
W. G.

3. *On the compounds of Tungsten.*—Roscoe has communicated the results of an elaborate and most successful study of the compounds of tungsten with chlorine and bromine. The author began by preparing pure metallic tungsten by the reduction of pure tungstic oxide, $W\Theta_3$. The density of the metal at 12° C. was found to be 19·261. Hexachloride of tungsten is prepared by heating the metal in a current of dry chlorine perfectly free from air. The metal takes fire in the gas at a moderate heat, and forms a sublimate of dark violet crystals, which may be purified by repeated distillations in an atmosphere of chlorine, and finally by distillation in a current of hydrogen. Pure hexachloride, $WCl_6$, is very slowly attacked by cold water; but if traces of the oxychloride, $W\Theta Cl_4$, are present, it is immediately decomposed into a green oxygen compound. It is easily soluble in bisulphide of carbon, and crystallizes from the solution in hexagonal scales. Its melting point is 275° C., and its point of solidification 270°. Its vapor-density at 440° C. was found to be 168·8; at 350°, 190·6. This points clearly to a dissociation, which experiment showed actually to take place; the hexachloride gives pentachloride, $WCl_5$, and free chlorine.

By reducing the hexachloride in a current of hydrogen, and repeatedly distilling the product in the same gas, long, black, brilliant needles of pure pentachloride, $WCl_5$, are obtained, which, when rubbed to powder, have a dark green color like that of potassic manganate. The crystals are very hygroscopic; they fuse at 248° C., solidify at 242° C., and boil at 275°·6 C. The vapor-density at 440° was found to be 186·2, the computed density being 180·7 ($H=1$). Hence the chloride contains one atom of metal. With water it yields the blue oxide, $W_2\Theta_5$, and chlorhydric acid.

Tetrachloride of tungsten, $WCl_4$, remains as a loose, gray-brown, crystalline powder when the hexachloride, or a mixture of hexachloride and pentachloride, is distilled in a current of hydrogen or carbonic acid. It is not volatile, and does not melt under ordinary pressures, but is decomposed by heat into pentachloride and dichloride. At the melting point of zinc, hydrogen reduces it to metal. Water gives a brown oxide ($W\Theta_2$ ?) and chlorhydric acid. The dichloride, $WCl_2$, is prepared by moderately heating the tetrachloride, or by reducing the hexachloride at very high temperatures. It is a gray uncrystalline powder, which is decomposed by water, with evolution of hydrogen and formation of a brown oxide. The author did not succeed in obtaining the chlorides $WCl$ and $WCl_3$.

The two oxychlorides, $W\Theta Cl_4$ and $W\Theta_2Cl_2$, are well known. The monoxychloride, $W\Theta Cl_4$, forms ruby-red needles, which melt at 210°·4, solidify at 206°·7, and boil at 227°·5 C. Its vapor-density corresponds with theory (171). The dioxychloride is best prepared by heating the brown oxide in chlorine. It remains liquid at 440°.

Bromine vapor acts rapidly upon heated tungsten, forming even when excess of bromine is present only the pentabromide, $WBr_5$. The crystals of this compound have a dark color and metallic luster; melt at 276°, solidify at 273°, and boil at 333° C. Water decomposes it into the blue oxide and bromhydric acid. When heated to 350° in hydrogen it yields a body which is probably $WBr_3$, but which is very readily decomposed, giving a black powder, which is the dibromide. The two oxybromides, $W\Theta Br_4$ and $W\Theta_2Br_2$, are formed simultaneously by heating a mixture of two parts of the dioxide and one part of the metal in bromine, and may easily be separated by sublimation, the monoxybromide being much the more volatile, fusing at 277°, and boiling at 327·5°. It is readily decomposed by water, while the dioxybromide sublimes only at a red heat, and is not decomposed by water. Roscoe found for the atomic weight of tungsten the number 184·04, which agrees with that generally received.—*Berichte der Deutschen chem. Gesellschaft, Jahrgang* v, p. 118.
W. G.

4. *On the Decomposition of Potassium Chlorate.*—BAUDRIMONT has investigated the conditions under which potassium chlorate is decomposed, when heated both alone and when mixed with other substances. He finds that this salt melts at 370° C., and begins to evolve oxygen at 400°; that, heated more strongly, oxygen is explosively disengaged, and the temperature rises spontaneously to incandescence, thus proving potassium chlorate to be endothermic. When mixed with a fifth of its weight of cupric oxide, prepared by precipitation, its oxygen is evolved at 240° (160° lower than before) rapidly but uniformly, the sole solid product being potassium chloride. No perchlorate is produced under these circumstances, nor does the cupric oxide undergo any change. The nature of the substance employed was also investigated; it appears that certain substances, such as platinum sponge, argentic oxide, and mercuric oxide, do not in the least facilitate the decomposition; while others, as manganese dioxide and cupric oxide, and, in a less degree, ferric oxide, cobaltic oxide, manga-

noso-manganic oxide, and lead peroxide, cause the evolution of oxygen at temperatures varying from 240° to 360°. The author observed that fine division facilitated the action, precipitated oxides acting more efficiently than those prepared by calcination; that, while the effect of even $\frac{1}{500}$ is noticeable, yet that from $\frac{1}{8}$ to $\frac{1}{2}$ of the oxide is the most efficient quantity; that with these mixtures the rapidity of the decomposition is proportional to the temperature; and that no chlorine is evolved below 300°. Moreover, certain substances, which act chemically on the chlorate, decompose it at even lower temperatures. Thus chromic oxide causes the liberation from it of chlorine and oxygen even below 200°; and a complete transformation into potassium chromate is effected below 290°. Stannic, tungstic, silicic and boric oxides act similarly. Baudrimont attributes the result, in the case of cupric oxide and allied bodies, solely to the action of presence or contact; the point of fusion of the mixture being ten degrees lower than that of the unmixed chlorate.—*Moniteur Scientifique*, xiii, 783, Nov., 1871. G. F. B.

5. *A delicate Test for Phenol.*—LANDOLT, wishing to detect the presence of phenol (carbolic acid) in a well-water from the vicinity of a gas-works, and finding that the ferric chloride test is only of moderate delicacy, and is interfered with even by normal salts, as sodium sulphate, made use of bromine-water. When used in excess, this reagent gives, even with a solution of phenol in 43,700 parts of water, an immediate bulky precipitate of tribromophenol. The odor of phenol cannot be recognized when the solution contains less than 1 of phenol to 2800 of water; and the color developed by ferric chloride appears only when there is more than 1 of phenol to 2100 of water. By this test, the presence of phenol may be shown in 500 c. c. of urine. It may also be used quantitatively.—*Ber. Berl. chem. Ges.*, iv, 770, Oct., 1871.

G. F. B.

6. *On the Physiological Action of Tobacco.*—VOHL and EULENBERG have investigated the narcotic action of tobacco, especially examining the action of the constituents of tobacco-smoke. Finding that the amount of nicotine in snuff is only from ·0392 to ·062 per cent, and in the strongest chewing tobacco only a mere trace or none at all, they conclude that the use of such tobacco cannot result in nicotine-poisoning. They examined a smoking tobacco—which contained four per cent of nicotine—by burning it, one part in a pipe, the other made up into cigars, and drawing the smoke—by means of an aspirator—first through potash-solution to retain the acids, and then through dilute sulphuric acid to collect the bases. The gaseous products were found to consist of oxygen, nitrogen, carbonic oxide and marsh gas. An oily semi-solid substance collected on the surface of the potash-solution, which afforded, when distilled, an oily liquid of sp. gr. 0·8, apparently a mixture of hydrocarbons of the benzol series, and a solid, in pearly scales, having the composition $C_{19}H_{18}$. The potash-solution was distilled, and the distillate was added to the sulphuric acid solu-

tion. The residue, when acidified, gave off a large amount of gas, consisting of carbonic dioxide, hydrogen cyanide and hydrogen sulphide. On distilling the acidified potash-solution, formic, acetic, propionic, butyric, valeric, and carbolic acids, and doubtfully caproic, caprylic, and succinic acids, were detected. The sulphuric acid through which the smoke had passed, which was thick and of a dark brown color, was filtered, partially evaporated, and neutralized with caustic potash; ammoniacal vapors escaped, and a brown oil rose to the surface. On re-distilling, after saturation with potash, ammonia and ethylamine were found in the most volatile portions; the remainder of the distillate was acidified and evaporated, treated first with potassium hydrate and then with ether; the etherial solution distilled, the residue dried and submitted to fractional distillation. The bases were still further purified by re-crystallization of their platinum salts. In this way the whole series of the so-called pyridine bases was obtained, as follows: *Pyridine* $C_5H_5N$, *Picoline* $C_6H_7N$, *Lutidine* $C_7H_9N$, *Collidine* $C_8H_{11}N$, *Parvoline* $C_9H_{13}N$, *Coridine* $C_{10}H_{15}N$, *Rubidine* $C_{11}H_{17}N$, and probably *Viridine* $C_{12}H_{19}N$. No trace of nicotine was found.

The authors investigated the physiological action of (1) those bases volatile below 160° and (2) of those volatile between 160° and 250°. Both portions act like nicotine, producing contraction of the pupil, difficult respiration, general convulsions and death. They act more quickly by the stomach than when sub-cutaneously injected, but even then are not as prompt as nicotine. On post-mortem examination, the lungs and air-passages were found to be highly congested. They think that the disagreeable symptoms produced in the incipient smoker, and the chronic affections which excessive smoking produces, as well as the poisonous effects of tobacco-juice when swallowed, are due to the pyridine and picoline bases, and not to nicotine. They explain the fact that stronger tobacco can be smoked in cigars than in a pipe, by finding that more of the volatile bases are present in the smoke of a pipe; more especially of the very volatile and stupefying pyridine; while in a cigar, little pyridine and much collidine are formed.

The authors compared this action with that of the bases obtained from other plants used for smoking; with those from dandelion, willow wood and stramonium, and with pure picoline from Boghead coal. The action was entirely similar, but with the exception of the willow wood bases, they produced no contraction of the pupil. Picoline in vapor is extremely poisonous, producing great irritation of the air-passages, convulsions and death. From these results, the authors believe that the different effects of smoking opium are due simply to a difference in the proportion of the bases produced by its combustion.—*Arch. Pharm.*, II, cxlvii 130; *J. Ch. Soc.*, II, ix, 1075, Nov., 1871. G. F. B.

## II. Geology and Natural History.

1. *The Hassler Expedition. Tomocaris Peircei.*—In a letter to Prof. Peirce, dated Rio, Feb. 12, and recently published, Prof. Agassiz announces the discovery of a new crustacean answering fully to his statement in a former letter, that among these animals we may expect to find "genera reminding us of some Amphipods, and Isopods aping still more closely the Trilobites than *Serolis.*" This crustacean, which Prof. Agassiz names *Tomocaris Peircei*, was dredged in 45 fathoms about 40 miles east of Cape Frio. It is described as very like *Serolis*, with the marked difference, that the thoracic rings are much more numerous, and the abdomen much smaller; and it is said that its resemblance to Trilobites is unmistakable and very striking, and that it can be referred to no one of the orders or families in Milne Edwards' or Dana's classification.

From the details of Professor Agassiz's description, the animal is evidently one of the Serolidæ, apparently congeneric, perhaps specifically identical, with the *Brongniartia trilobitoides* of Eights (Trans. Albany Institute, vol. ii, p. 53, pl. 1, 2, 1833), which is referred to the genus *Serolis* by Audouin and Milne Edwards (Archives du Muséum d'Hist. nat., tome ii, p. 29, pl. 2, fig. 11, 1839), and retained in the same genus by Milne Edwards in his great work (Hist. nat. des Crust., tome iii, p. 232, 1840). To make this apparent it is necessary to observe that what Prof. Agassiz calls the head includes the first thoracic segment, which in the *Serolidæ* is anchylosed with the head; that what he considers the three posterior segments of the thorax, have been regarded by carcinologists as belonging to the abdomen; and that, as a result of this first homology, what have been regarded as the anterior legs are called maxillipeds. The only point in the whole description which can militate against the view here expressed is in the description of the nine pairs of legs which are said to be "all alike in structure;" the six anterior pairs, however, are "larger than the three last, which are also more approximated to each other," thus agreeing perfectly in position with the three anterior abdominal legs of the ordinary Serolidæ. The perfect agreement in all other respects, however, leaves little doubt of the close affinity between *Tomocaris* and the *Brongniartia* of Eights.

It may be well to notice that among the species referred to *Serolis*, there are several genera, distinct from the typical *S. paradoxa*, and that the species described by Eights represents one of these, although the name *Brongniartia* is preoccupied.

S. I. SMITH.

2. *Discovery of the tusk of an Elephant in Colorado.*—Concerning this discovery, mentioned at page 302, we have received the following note from Prof. Alfred P. Rockwell, dated Institute of Technology, Boston, April 4.

I see in the April number of the Journal a notice of the finding by Capt. Berthoud of the tusk of an elephant near Golden, Colorado. It so happened that I was in Golden within a few days after Capt. Berthoud discovered this tusk, went with him to the spot, and dug it up with my own hands. It was broken considererably in getting it down the cañon, but the pieces, which Capt. Berthoud presented to the Institute of Technology, are now in our collection.

Capt. Berthoud has anticipated me in the sending to you the notice of the discovery. I will only add that the gravel was tolerably compact in which it was firmly bedded, and consisted of rounded pebbles, boulders, and sand; it was arranged in distinctly horizontal layers, and had not been disturbed since its original deposition. It was a small patch preserved in a peculiar way between two projecting points of rock and was evidently but the remnant of what must have once filled the cañon to that height. The width of the cañon at that point may have been 200 to 300 feet. I saw no beds of gravel lower down the cañon.

The gravel bed was covered by about 6 feet of "slide" or débris from the mountain. It was easy to mark the dividing line between it and the gravel. No other bones were found near this tusk. The exact elevation of the spot where the tusk was found is 5675 feet above the level of the sea, as determined by the railroad survey. This is nearly 1000 feet above Denver.

Higher up the valley, at Idaho city, are considerable deposits of gravel similarly arranged in horizontal layers. Still higher up the valley are other deposits of gravel, but whether they are in layers, I cannot say. The general course of the valley is that given by Capt. Berthoud.

3. *On the Elephant in Colorado;* by ALFRED A. WOODHULL, Assist. Surgeon, U. S. A. (From a letter to one of the editors dated Fort Lyon, Colorado, March 15th, 1872.)—About a year ago two teeth of the *Elephas Americanus* were discovered (and are yet preserved) near this post, and another bone, which I judged to be the fibula, was exposed but quickly crumbled.

I am perfectly satisfied as to the identity of the animal. The question is as to the geological character of the bed. It is within a few yards of the Arkansas river and is composed exclusively of coarse sand and small, water-worn, quartzose pebbles. This region is underlaid with sandstone, barren of fossils, that is exposed on the higher ground, and this water-worn débris, deeper toward the river, covers it for various depths up to twelve or more feet, being itself mingled in its superficial parts with ordinary soil as it recedes from the river. How far back from the river this gravelly formation extends, I am not certain, but I think at least several miles. It is imperfectly terraced, especially on the north side of the stream; one level reaches from 20 to 1500 yards from the river, and above this a second terrace is irregularly discernible.

4. *On two new Ornithosaurians from Kansas;* by EDWARD D. COPE. (Read before the American Philosophical Society, March 1st, 1872.)—In this paper two species of Pterodactyls are described, which are identical with two of those described by Professor Marsh in the last number of this Journal, pp. 241–247, viz:

*Ornithochirus umbrosus* Cope = *Pterodactylus ingens* Marsh, and *Ornithochirus harpyia* Cope = *Pterodactylus occidentalis* Marsh. As separate copies of Prof. Marsh's article were distributed March 7th, while the paper of Prof. Cope was not issued before March 12th, the names given by Prof. Marsh have priority.

5. *Preliminary Report of the U. S. Geological Survey of Montana and portions of adjacent Territory, being a fifth Annual Report of Progress;* by F. V. HAYDEN, U. S. Geologist. Conducted under the authority of the Secretary of the Interior. Washington, 1872.—This Report by Dr. Hayden is one of unusual interest. It gives his account of the explorations in the remarkable Yellowstone Geyser region, a part of which has appeared under his name in this volume, besides notes on the geology along the route from Ogden, Utah, to Fort Hall in Idaho, Fort Ellis in Montana, and the Yellowstone; and thence from Fort Ellis to Snake River basin, Fort Hall, Bear River valley, and Evanston, on the Union Pacific railroad; and the text is illustrated by many sketches and several maps.

Dr. Hayden's special report is followed by a preliminary report on the minerals, thermal waters, etc., by Dr. A. C. Peale. We find in it that the siliceous deposit of the springs (geyserite, a variety of opal) afforded in one analysis, silica 83·83, water 11·02, chloride of magnesium 4·00=98·85; the specific gravity was 1·866, and hardness 5. The coal bed, about a mile from Evanston in Utah, is stated to be from 22 to 32 feet in thickness, being thickest to the north; it is one of the largest and best coal mines in the west. Dr. Peale's brief report is followed by other reports as follows:

On the Agricultural Resources of the Territories, by Prof. Cyrus Thomas; on the fossil Flora, Cretaceous and Tertiary, by L. Lesquereux; on the Geology and Paleontology of the Cretaceous Strata of Kansas, by E. D. Cope; on the Vertebrate Fossils of the Wahsatch Group, by E. D. Cope; on the Fossil Vertebrates of the Early Tertiary of Wyoming, by J. Leidy; a preliminary list of the fossils collected by Dr. Hayden's Exploring Expedition of 1871, with descriptions of a few new species, by F. B. Meek; besides zoological reports, on some worms, by Dr. Leidy, on Coleoptera, by Dr. G. H. Horn, on Hemiptera, by P. R. Uhler, on Orthoptera, by Prof. C. Thomas, on Butterflies, by W. H. Edwards, on Reptiles and Fishes, by E. D. Cope; a catalogue of plants, by Prof. T. C. Porter; and of the Mosses, by L. Lesquereux; and, as Part V, an account of the Meteorology of the region, by J. W. Beaman. The volume contains thus a very large contribution to our knowledge of the physical features and condition, the geology, and natural history, of a considerable part of the Rocky Mountain region.

6. *Dana's Mineralogy. Appendix to the Fifth Edition.* 20 and iv pages, 8vo.—An appendix to the last edition of Dana's Mineralogy has just been issued by the publishers, J. Wiley & Son of New York. It has been prepared by Professor G. J. BRUSH. It contains descriptions of eighty-seven minerals proposed as new

during the past four years since the Mineralogy was published, and also notices of some important facts regarding a few old species. The place of each new species in the system is shown by giving it a number corresponding to the position in the series. 19 of the so-called new species belong to the group of sulphides, arsenides, etc.; 4 to that of chlorides and fluorides; 8 are oxides; 8 anhydrous silicates; 23 hydrous silicates; 2 tantalates and columbates; 14 phosphates, arsenates, etc.; 3 borates; 4 tungstates, molybdates, vanadates; 5 sulphates, chromates; 1 carbonate; 1 oxalate; 7 carbohydrogen compounds.

7. *Bentham, Revision of the genus Cassia.* (From Trans. Linn. Soc., xxvii). Read March, 1869. Printed May–July, 1871. 4to, pp. 503–591, with 4 plates.—The earlier pages of this monograph are devoted to a survey of the genus, its systematic history, schemes of arrangement, and geographical distribution of the species. The latter topic is considered under the light which botanical affinity and geographical habitation mutually throw upon each other. Like many large tropical genera, *Cassia* exhibits "phenomena which may be shortly summed up as a general diffusion of uniform primary types, with more or less of divergence into secondary types in different directions in different countries, the smaller groups becoming, generally speaking, more and more local, diverging in different directions and with different combinations of characters in different countries, and the number of identical species over the whole range very few, beyond those which, as weeds of cultivation, are liable to frequent interchange by existing means of transport." It is premised that in the treatment of all such questions, "it seems necessary to consider, as an established fact, the great principle that natural affinity results from community of descent." To anyone who would see with what good account this principle may be recognized and employed in the hands of a naturalist who is completely familiar with the known facts, we commend the present brief discussion.

Three sub-genera are admitted, and these are recognizable by the flower as well as by the fruit. The first, *Fistula*, has only twenty admitted species; the second, *Senna*, over 160; the third, *Lasiorhegma*, about the same number. After vast reduction, Mr. Bentham has still to recognize 338 species. One from Arizona, *C. Covesii* Gray, in Proceed. Am. Acad., vii, p. 399, has been overlooked, naturally enough, as it was out of place in a supplement to the paper it appeared in. It is most probably *Cassia crotalarioides* Kunth, which Bentham describes as having sometimes as few as two pairs of leaflets.

Determinations of some of the principal collections distributed under numbers are appended, a great help to the possessors of large herbaria.

We may here enumerate synoptically the species inhabiting the United States—all of them on the Atlantic side, or along the Mexican frontier. One or two of them have not actually been found within our territorial limits.

Of the *Senna* sub-genus,—known by the pods never opening elastically, the seeds on slender stalks, and the sutural lines of the anthers glabrous—we have at most fourteen species, viz:

I. With short and turgid pod, no gland on base of petiole (all Texano-Mexican species), and

(1.) A single pair of leaflets.

*C. pumilio* Gray: very dwarf; leaflets linear, and peduncle one-flowered.

*C. Rœmeriana* Scheele: less dwarf; leaflets lanceolate, smoothish, and peduncle few-flowered.

*C. bauhinioides* Gray: dwarf; leaflets oblique and ovate-oblong, downy.

(2.) Two or more pairs of oval-oblong leaflets: soft-downy plants, 2 feet high or more.

*C. Covesii* Gray (omitted by Bentham, but almost certainly *C. crotalariodes* Kunth): with 2 or 3 pairs of leaflets, and pubescent pod hardly an inch long.

*C. Lindheimeriana* Scheele: with 5 or 6 pairs of leaflets, and a longer pod.

II. With long and narrow or flat pod, and

(1.) A gland on the base of the petiole, none between the leaflets.

*C. leptocarpa* Benth., from New Mexico and Arizona: has numerous, lanceolate, very acuminate leaflets, and very slender curved pod, 6 to 10 inches long.

*C. occidentalis* L., naturalized on our southern borders: has 4 or 5 pairs of ovate or ovate-lanceolate acuminate leaflets, and thickish-margined slightly curved pod, 3 to 5 inches long.

*C. Marilandica* L., the only species of *Senna* found wild as far north as New England: has 6 to 9 pairs of lanceolate-oblong acutish leaflets, flowers crowded in short-peduncled or almost sessile axillary clusters, and a broadish linear flat pod, 3 or 4 inches long.

(*C. ligustrina* L., a West-Indian species of this group, with numerous oblong-lanceolate acute leaflets, larger flowers than those of the preceding, in a more terminal corymb or panicle, and a smooth pod, 3 or 4 inches long, we still suppose is wrongly credited to the United States. We have, however, cultivated specimens, said to come from Louisiana and Texas, of *C. lævigata* Willd. This is known, in flower, by the fewer leaflets, with glands between them.)

(2.) No gland on the petiole, one between each pair of leaflets or some of them.

*C. Tora* L., to which is joined *C. obtusifolia* L., the common American form: annual herb, with mostly three pairs of wedge-obovate leaflets, and the seeds lengthwise in the very long and narrow commonly curved pod. In the other species they lie crosswise or oblique.

*C. Bahamensis* Mill., which occurs on the Florida Keys, and has been referred to *C. angustisiliqua* Lam. (which is a form of the next): shrub, with three to five pairs of oblong leaflets, a gland between the lower pair; anthers all beakless.

*C. biflora* L., a tropical American species, which barely reaches the Mexican frontier: shrub, with 3 to 8 pairs of oblong leaflets, and the tips of two or three of the lower anthers prolonged into a slender beak.

(3.) No gland either between the leaflets or on petiole.

*C. Wislizeni* Gray, of Arizona: shrub, with 4 to 7 pairs of very small, coriaceous, obovate leaflets, large flowers, and linear flat pod, 3 or 4 inches long.

Of the *Lasiorhegma* sub-genus—the pods of which open elastically, and the sutural lines of the anthers are mostly woolly-pubescent—our representatives are all of the *Chamæcrista* section.

Sub-section *Xerocalyx*, so well marked by its rather rigid and striate, many-nerved sepals, has one tropical species, which has advanced into Texas, viz:

*C. calycioides* DC., which is No. 2036 of Berlandier's collection, found on the banks of the Rio Medina.

Sub-section *Leiocalyx*, with thin sepals not striate, affords the following:

(1.) Leaflets only 4 to 6 pairs: flowers rather large.

*C. Wrightii* Gray, from Arizona: wholly glabrous, low, from a woody perennial root-stock: veins of the narrowly-oblong leaflets nearly simple and inconspicuous.

*C. grammica* Spreng., a West Indian species, of which we find specimens from Key West: diffuse, soft-pubescent throughout; the slightly inequilateral-oblong or cuneate-oblong and rather coriaceous leaflets lineate with the strong pinnate veins.

*C. Greggii* Gray, from Tamaulipas province, at some distance south of the Rio Grande: a rigid, shrubby species, with reticulate veins to the coriaceous leaflets.

(2.) Leaflets 8 to 20 pairs.

*C. nictitans* L.: a widely-diffused annual, extending north into New England, known by its small and subsessile flowers, with only 5 (or at most 6) anthers.

*C. Chamæcrista* L., of about the same geographical distribution, and even more variable, is an annual, or in some southern forms perhaps perennial: has large flowers on slender pedicels, 10 unequal stamens, and thinnish leaflets, with midrib either not far from central or less so, and pinnately-veined on both sides. There are cinereous Texan forms, with the veining inconspicuous or obscure, of which Lindheimer's 232 (coll. 2) is the most remarkable.

*C. procumbens* L. (Herbarium, and of the Spec. Pl. in part only the *C. chamæcristoides* of Colladon), a low perennial or suffrutescent species, of tropical America, and, if rightly identified, also of southern Texas. In his list of determinations, Bentham refers both 2427 and 2479 of Berlandier's collections to *C. procumbens:* in his monograph he mentions the former under *C. procumbens* as seemingly a rather larger variety, with larger stipules and flowers, and longer pedicels, and cites the latter under

*C. cinerea* Cham. and Schlecht., in the dimidiate division. Now our specimens under the two numbers are both alike, and, in the lack of authentic specimens of the species they have been referred to, we cannot now decide to which they belong. But our Texan plant should be known by its leaflets, which are linear, rigid, and 3–4-nerved from the base, the nerves of about equal strength, one of them near the upper margin, but often sending off one or two very short veinlets on that side, and a marginal nerve is more or less apparent. A synonym of the Texan species, whatever it be, is *C. Texana* Buckley, in Proceed. Acad. Nat. Sci. Philad., Dec., 1861. (We now learn that Mr. Bentham regards the whole as a doubtful variety of *C. procumbens*, and that the reference to *C. cinerea* was an oversight.) A. G.

8. *Delpino, on the Fertilization of Coniferæ, and on the Genealogy of the Artemisiaceous tribe of Compositæ as deduced from their mode of fertilization.*—Prof. Delpino, of Florence, now Professor in the State Forest School established at Vallombrosa, is best known in the country for his able annotations upon a paper of E. Müller's, which he translated into Italian, upon the "Application of the Darwinian Theory to Flowers and to the Insects which visit them," the whole paper having been reproduced in English, under this title, in the American Naturalist, last year. Delpino has been paying much attention to dichogamous flowers, and to the difference between those fertilized by the wind (*anemophilous*), or by insects (*entomophilous*), or by animals of whatever sort *zoidiophilous*, as he terms them. *Coniferæ*, as is well known, are *anemophilous*, that is, their fecundation is entrusted to the wind; their light and most abundant pollen is correlated to this, and the structure of the fertile inflorescence is such that the pollen reaches the very orifice of the ovule. In Yew and Cypress, and in other if not all other genera of the sub-orders they represent, Delpino finds that, at the time when the ovule is ready for fecundation, a minute clear drop of liquid appears at the orifice of the ovule; grains of pollen falling upon this are retained, are incited by it to develop the pollen-tube into the liquid first, thence into the ovule, and the drop is then re-absorbed or dries up. Alph. De Candolle, in a recent number of the *Arch. des Science de la Bibl. Universelle*, calls attention to the fact that this droplet was known, as to its appearance, function, and re-absorption, to his late venerable townsman, Vaucher, and is described in his Physiology of the Plants of Europe, published in 1841.

That *Artemisia* should be widely separated from *Ambrosia, Xanthium*, and their allies, must be regarded as an imperfection in the Lessingian arrangement of *Compositæ*, as adopted by De Candolle. We have reason to suppose that the next elaboration of the order will bring them together, and that irrespective of the considerations now brought to bear by Delpino, which certainly have their weight and offer confirmation strong, and very likely independent. The point made by Delpino is, that whereas this vast order of *Compositæ* is especially constructed on *dichogamous entomophilous* principles, i. e., for cross-fertilization by insect agency, one group only is *anemophilous*, namely the *Artemisiaceæ* taken in the extended sense as above indicated. From a study of the floral structure and arrangement in reference to fecundation, Delpino proposes a new classification of the members of his sub-family *Artemisiaceæ*, which need not here be detailed. It calls for the re-establishment of the genera into which *Artemisia* has been divided, and for an equivalent disruption of *Franseria*, &c., which our systematists will not be disposed to adopt. Yet characters of this sort, standing as they must in intimate relation with the well being and continuance of the species, will doubtless prove to be of real classificatory value, and be turned to important account as such.

Prof. Delpino closes this last paper with a brief genealogical commentary, in which, by the application of principles which there is not room here to explain, he makes the ingenious but hardy attempt to trace the filiation of this group in question,—viz., from *Campanulaceæ* through *Lobeliaceæ* to *Compositæ*, in which the *Senecionideæ* offset *Artemisiæ*, and one set of these produced *Iva;* this, the Ambrosineous genera, and from *Ambrosia* through *Franseria* to *Xanthium*, our troublesome cockle-bur.

A. G.

9. *J. Müller, on the Cyathium of Euphorbia.*—The monographer of *Euphorbiaceæ* (*Euphorbia* excepted) in De Candolle's Prodromus, has discussed this question in the *Flora* for Feb. 11, *apropos* to Warming's paper, of which we gave some account in our February number. Dr. Müller confirms the Brownian view throughout, and gives new arguments for regarding the stamineal column below the articulation as a pedicel, and the stamen as "appendicular," notwithstanding its terminal position, in opposition to Warming, who thought it might be truly "apical" or "cauline." Analogies are brought from the structure of other *Euphorbiaceæ*, with which Dr. Müller is so familiar. Species are mentioned of *Euphorbia* in which the calyx of the female flower is unequivocally developed, our *E. hexagona* Nutt. being one. A. G.

16. *Action of foreign Pollen on the Fruit of the fertilized Plant.*—In the Bulletin of the St. Petersburg Academy for November, 1871, Maximowicz has collected the observations and a few experiments upon this subject, and recorded one experiment of his own. He mutually crossed *Lilium Davuricum* and *L. bulbiferum*. Now these have been taken for one and the same by late writers, but are neatly characterized, according to Maximowicz, by the form of their capsule and bulb-scales. In the single experiment the pistil of *L. bulbiferum*, fertilized by the pollen of *L. Davuricum*, set fruit, but failed to mature it. That of *L. Davuricum* fertilized by the pollen of *L. bulbiferum* matured well, but to the surprise of the observer, it formed the long capsule of *L. bulbiferum* instead of the short one of the species. The experiment should be repeated, as it doubtless will be in the ensuing season. A. G.

11. *A. Grisebach, Die Vegetation der Erde nach ihrer klimatischen Anordnung: Ein Abriss der vergleichenden Geographie der Pflanzen.* Leipsic, W. Engelmann, 1872. 2 vols. 8vo.—This new

sketch of the earth's Vegetation in its relations to Climate or Comparative Geography of Plants, upon which Prof. Grisebach of Göttingen has long been occupied, has just reached us, and may hereafter receive the further report which this elaborate treatise deserves, especially if the English translation which has been called for should appear. The work is strictly a geography of plants, and it treats of the climates and vegetations of the twenty-four regions into which the author divides the earth, so that it is upon a plan wholly different from Alphonse DeCandolle's work.

A. G.

12. Mr. Ravenel's interesting notice of the *Arrangement and Morphology of the Leaves of Baptisia perfoliata*, as set forth by the present writer in the December number of this Journal, is reprinted here, as well as in the Annals and Magazine of Natural History; and the perusal brings to our view an abominable misprint, which makes utter nonsense of the last sentence of the penultimate paragraph, to be corrected as follows: A. G.

*Correction.*—In vol. ii, No. 12, p. 463, in line 11, for "fusion" read *torsion;* line 12, for "adopting" read *adapting;* so that the sentence will read: "in the torsion of the axis and the distribution of the stomata, adapting the foliage to its vertical position."

A. G.

13. *Catalogue of the Phænogamous Plants of the United States, East of the Mississippi, and of the Vascular Cryptogamous Plants of North America, North of Mexico.*—Second edition, revised and corrected. Cambridge, 1872. Published by B. Pickman Mann.—This is merely a reprint, with corrections and a few additions, of the Catalogue known familiarly as "Mann's Exchange List," which has been of great service to all collectors of American plants. Since the running numbers have not been changed, it will be possible to use the old and the new editions interchangeably. The "typographical and other errors," which have been found and corrected, are over one hundred and fifty, and Mr. Mann, in his preface, renews his brother's request that persons using the Catalogue would send him notice of all errors discovered. D. C. E.

14. *Illustrated Catalogue of the Museum of Comparative Zoölogy. Supplement to the Ophiuridæ and Astrophytidæ;* by Theodore Lyman.—(Concluded from page 225.) The part of Mr. Lyman's work on which I have most to say is his "Note on Nomenclature, etc.," which is in fact a direct reply to some remarks of mine in a note to the third part of my "*Additamenta*" (p. 50). The prominent place given to Mr. Lyman's reply may excuse my answering it at greater length than its somewhat "terse" language—to use the expression of the reviewer in the "American Naturalist"—might otherwise have induced me to do; and if it needs any apology that I am only coming forward with old ideas and well-known facts, my apology must be, that when a simple truth has not been appreciated and comprehended at its value, there is no other method of getting it into people's heads than trying if a repeated exposition of it will not succeed in procuring it access.

The first part of my note reads as follows: "Though highly valuing the great care with which Mr. Lyman's 'Catalogue' is worked up, and fully acknowledging its great scientific importance, I cannot but blame the unreasonable manner in which he upholds the (fictitious) rights of priority of authors before Linné. Thus *Astrophyton muricatum* (Lmk.) is named *A. costosum*, because it is thus named by Seba (!); *Ophiothrix fragilis* (Abgd.) gives way to *O. rosula* (Linck); *Ophioderma lacertosa* (Lmk.) to *Ophiura levis* ("*Stella levis!*") (Rondelet); *Ophiura texturata* (Lmk.) to *Ophioglypha lacertosa* (Linck),—it is quite another thing if you will, with Mr. Norman, recur to Pennant and write *O. lacertosa* (Pnt.); *Ophiopholis aculeata* (Müll.) to *O. bellis* (Linck). Certainly it ought now to be known, that a specific name can not seek its priority in the time before Linné, when the binominal principle was not yet invented; when there, for this very reason, existed no *true* specific names, but only diagnoses or 'phrases caractéristiques' as means of designating the species, although those diagnoses or short descriptions did sometimes consist of a single word. As to *A. costosum*, the application of this name to *A. muricatum* (Lmk.) is the more useless, because the *Euryale costosa* of Lamarck is, as pointed out by Mr. Lyman himself, a West Indian species, different from *A. muricatum* and from the other two species known from this archipelago."

To this Mr. Lyman gives the following answer: "As to the first of these propositions" ("that names prior to Linnæus have no place in present nomenclature"—after all not a very correct comprehension of my proposition) "I may say, that Linnæus first contrived what is called binomial nomenclature, in which each animal has two names—the generic and the specific. Consistency is the first duty of a naturalist, therefore it was the first duty of the followers of Linnæus to respect and to adopt such binomial names as may be found in ante-Linnæan authors, of whom some were among the most celebrated of zoölogists. When, then, I find the name *Astrophyton costosum* distinctly used by Seba (iii, pl. ix, f. 1, p. 16, 1758), and moreover an excellent figure given, I shall certainly apply that name to the West Indian species to which it belongs. Did not Seba, more than a century ago, publish a fine folio with figures that are better than some of those we see now-a-days, and shall we ignore his names, when they are such as may properly be taken?" But this splendid edifice Mr. Lyman himself destroys in adding: "In putting such a name as *Ophiopholis bellis* for *O. aculeata* I think I have gone too far, because the name *bellis* of Linck is used as part of a diagnosis, and not as a name." In fact, the use of "*Ophiopholis bellis*" is in no way different from all the others, against whose substitution for names given after the introduction of the binominal system of nomenclature I have made a protest.

Let us consult, e. g., "The Revised Rules of Zoölogical Nomenclature, adopted by the British Association in 1865" (with notes by A. E. Verrill, 1869), p. 6:* "As our subject-matter is strictly

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confined to the *binomial system of nomenclature*, or that which indicates species by means of two Latin words, the one generic, the other specific, and as this invaluable method originated solely with Linnæus, it is clear that, as far as species are concerned, we ought not to attempt to carry back the principle of priority beyond the date of the twelfth edition of the '*Systema Naturæ*, 1766.'" [As pointed out in the note, this should have been corrected to the *tenth* edition of 1758; in a few instances one is compelled to go a little further back, i. e. to the "*Museum Tessinianum*," 1753, when the binominal system was already fairly established.] "Previous to that period naturalists were wont to indicate species not by a *name* comprised in one word, but by a *definition* which occupied a sentence, the extreme verbosity of which method was productive of great inconvenience. It is true that one word sometimes sufficed for the definition of a species, but these rare cases were only binominal *by accident* and not by principle, and ought not, therefore, in any instance to supersede the binomial designations imposed by Linnæus." Nothing can be more true, more lucid, more decisive, than this argumentation, and Mr. Lyman's eloquence falls completely to the ground before it. A glance at the works of Linck, Rondelet, Seba, etc., will convince every unbiased naturalist who knows something of the history of science, that these authors had only "definitions" or "phrases caractéristiques," and never meant to give anything else, though they, of course, often, for the sake of convenience, restricted their diagnostic descriptions to one or two words if these appeared sufficient for the purpose. Such designations as "*Stella lacertosa*," "*Rosula scolopendroides*," "*Bellis scolopendrica*," "*Astrophyton costosum*," are evidently only accidentally binominal, scattered as they are among polynominal ones of this character: "*Stella lumbricalis corpore pentagono lateribus lunatis*," "*Pentacerus gibbus et reticulatus*," "*Stella coriacea acutangula hispida*," "*Artocreas minimum ex insula St. Thomæ*," "*Artocreas marinum minusculum Curassaricum*," etc., and therefore have no right of priority. Moreover, if Mr. Lyman—in open rebellion against one of the universally adopted, simple and sound rules of science, followed *now-a-days*, if I am not mistaken, by *all* other zoölogists—will persevere in upholding the *binominal* character of the *biverbal phrases* cited above, he will—"consistency being the first duty of a naturalist"—be obliged to maintain their first part (*Stella*, *Rosula*, *Bellis*) as true generic, their second half as specific denominations. Instead of this, Mr. Lyman, in a quite arbitrary manner, in some instances prefers the first (pseudo-generic) to the second (pseudo-specific) part of the biverbal description, writing first *Ophiothrix rosula*, *Ophiopholis bellis*. This is perhaps the worst consequence of the practice advocated by Mr. Lyman, that it spreads confusion and capriciousness in nomenclature. I have no doubt, therefore, that it will be universally disapproved; but I thought it right, nevertheless, to protest against it, to prevent, if possible, younger naturalists from being induced to take it up.

The rule is very simple: *the priority of a specific name can not be sought in works in which the binominal system of nomenclature is not yet adopted.* A definite year, of course, cannot be pointed out, as a line of demarkation, as it took some time before the Linnæan principle was generally known and universally adopted. The character of the work must decide if its author ranks among the *Ophioderma* to *Ophiura*, *Ophiura* to *Ophioglypha*, etc.?—or to insinuate that I belong to a party who "insist on considering *credit* or *honor* the real reason for using names of authors." This is a gross and unfounded misunderstanding. I never said anything so absurd or narrow-minded; if others have, I am not responsible for them. The rights of an author (A) are not violated by *omitting* his name altogether, but they certainly are *binominal* or the *polynominal* authors, and consequently, if his specific designations have a claim on priority or not. To be sure, Linck and Seba are not among the number!

In the second part of the note alluded to I uttered the following: "There is written so much against the bad practice, that the author of a new genus or generic denomination puts *his own* name after the specific names previously invented by other authors, that it cannot but excite astonishment to see this practice not only generally adopted by most American authors, but also in a work published under the auspices of a scientific celebrity. This is so evident a violation of the rights of the author, and so conspicuously *dangerous to the sound development of science*, that I am at a loss to conceive how this bad practice can still find followers, and that not all naturalists have adopted the simple practice to put the name of the original author of the specific name into parenthesis when the generic denomination has been altered, thus avoiding every ambiguity."

I can perhaps admire the adroitness of Mr. Lyman's reply to this remark, but am sorry that I cannot fully acknowledge its correctness. Mr. Lyman has no right to impute to me any anxiousness for my "reputation"—owing, I think, to the loss of the species to which my name would cease to be attached, in consequence of some unnecessary changes of generic names,* i. e. by substituting another (B) in its place, giving it the appearance as if the principal part of the work done respecting the discovery, description and systematic registration of the species was due to B and consequently not to A. But I am very willing to admit,

* Respecting these substitutions I wrote as follows (Addit. iii. p. 69): "Though I have perhaps myself occasioned this substitution of names through my remarks (l. c. p. 31) on the application of the name *Ophiura*, I am now not sure that it was the right thing to be done. When Forbes and Müller and Troschel divided the genus *Ophiura* (Ag.), they ought certainly to have left this name with the '*Ophiodermas*;' but as they did no such thing, and Forbes limited and defined his genus *Ophiura* in a perfectly correct manner, as did Müller and Troschel their *Ophioderma*, I cannot see that we are now justified in altering them again, not to speak of the rights attained by their being used in many important works. If zoölogists will agree in retaining the names *Ophioglypha* and *Ophioderma* (as done by Mr. Ljungman), *Ophiura* can conveniently be used as a collective designation for all generically undefined or undefinable (i. e. many fossil) species."

that this "violation of rights" is only a matter of secondary importance, and if anybody will argue that it is of no importance at all, I shall not dispute the point further. But the principle followed by Mr. Lyman, and, I believe, by all American authors,* is *prejudicial*, because it will tempt vain men—and many good men *are* vain, naturalists not the least—to create a host of unnecessary new genera or generic denominations, with the evident or secret intention to make an easy harvest of species, to which *their own* name of authority might henceforward be attached, giving in that manner to the common or unscientific reader a false impression of their influence upon the development of natural history, *exempla sunt odiosa!* The only efficient means to stop this fatal practice is clinging to the well-established rule, that the name of the author who first *established and published* a species shall remain with it, may the generic appellation be changed or not—a rule adopted, I believe, by most of the European authors who have paid any attention to this vexed question of nomenclature, and without exception by all *Scandinavian* naturalists.† The practice against which I thought it proper to remonstrate is further only capable of causing confusion and loss of time. Strangely enough, Mr. Lyman and his allies defend their cause by arguing that "nomenclature is a system of exact registration;" very true, but for *the very cause of "exact registration"* it is absolutely necessary that the student is referred at once to the author who *first* published the species, and not to him who afterward referred it to another genus, subdivided the old one, rebaptized it, or perhaps only reformed its orthography, knowing himself, perhaps, nothing of the species, or having sometimes quite a different thing in view. I shall give an example that will, I hope, act as an "*argumentum ad hominem.*" If I am right (as I think I am) in reducing the new genera, *Ophiomaza*, *Ophiomitra* and *Ophiothamnus*, the species now referred to them ought henceforward to be written thus: *Ophiocnemis cacaotica* (Lym.), *Ophiacantha vicaria* (Lym.), *valida* (Lym.) and *sertata* (Lym.), thus referring the reader to consult the works of Mr. Lyman to find the first information, registered in the annals of science, of these animals; if, according to Mr. Lyman, they are written *Ophiocnemis cacaotica* Ltk., *Ophiacantha vicaria* Ltk., etc., the future student will "*operam et oleum perdere*" in finding out where in the world Mr. Lütken had anything to do with these

* In regard to this point Dr. Lütken is quite mistaken, for many American naturalists have always and still do, in all cases, write the name of the original describer of the species. See for examples Prof. Dana's Reports on the Zoöphytes and Crustacea of the U. S. Exploring Expedition, 1846–1852; numerous papers by Dr. Stimpson; most of the zoölogical publications of the Smithsonian Institution, etc. In Prof. Dana's works, the name of the *original* describer of the species is *always* given in parenthesis. Others do this when the synonymy is not given in connection with the species.—Eds.

† Not all of these, however, put the name of authority in parenthesis when the generic name has been changed; Lovén, Sars, Ljungman, etc., usually add, in parenthesis, the name of the old genus, writing, e. g. *Tritonium reticulatum* (*Pleurotoma*) Brown, *Ophiactis Balli* (*Ophiocoma*) Thompson, etc.

species; and if, accidentally, he is acquainted with the fact, that Mr. Lyman established years ago some species with the same specific, but with different generic names, he will, nevertheless, know nothing about their relations to the species he did find enumerated, e. g. in some faunistic, systematic, anatomical, etc., work under *my* authority; whereas, he will be on the right track instantly if that of Mr. Lyman be used instead of mine—the name of this gentleman being of course put in parenthesis, to indicate that his original generic denomination has been changed. The "rules of zoölogical nomenclature," therefore, are very correct in stating that, "in giving the authority for the *specific* name in preference to all others, the inquirer is referred *directly* to the original description, habitat, etc., of the species, and is at the same time reminded of its discovery." "Therefore it is recommended that the authority for a specific name, when not applying to the generic name, should be expressed thus: (Linn.) as *Tyrannus crinitus* (Linn.)."

When Mr. Lyman concludes his remarks with stating that he had no objection to my "Synopsis" provided it be understood as a movement toward a true classification, or as a really convenient tabulation of genera," I must say, that I do not know what I should have expected more, and that my own words amply show that I did not expect more. But when he adds: "Inasmuch as it rests on the structure of the mouth-parts, it cannot be expected to be an exposition of nature any more than a classification of fishes based on their scales, of mammalia on their nervous centres, or mollusks on the character of their shells," he would no doubt have been more just in comparing a classification of the *Ophiuridæ*, based (reluctantly) on the character of the mouth, with the classifications established in *Mammalia*, *Ophidia*, *Gasteropoda*, *Arthropoda*, etc., on the teeth or other "*organa cibaria*"—classifications which are, to say the least, generally esteemed as tolerable approximations to an "exposition of nature." The true system—some naturalists will tell us that such a thing does *not* exist—will only be finally found when all genera (recent and fossil) are known, i. e., it will *never* be found! Every contribution that leads us nearer to this ideal is, however, a step in the desired direction; and we shall be very glad, therefore, to welcome any future communications from Mr. Lyman about the results of his researches on the *Ophiuridæ* in the European museums!

Copenhagen, Dec., 1871. CHR. LÜTKEN.

15. *Additional Note on the Rules of Nomenclature;* by A. E. VERRILL.—Although agreeing in most respects with the views of Dr. Lütken, and especially in regard to the extension of the rule of priority to the ante-Linnean authors, the writer acknowledges that he is one of those "American authors" who believe in and practice the custom of writing the name of the author who first gave the *correct binomial name* to a species, as the authority for *that particular name.* It seems fitting, therefore, to given some of the arguments in favor of this practice (by no means confined to *American* authors), as briefly as possible:

1st. The name of a *species is binomial*, and the *first* part is just as important an element as the *second*. Is the *family* name of a man less important than his Christian name?

2nd. The matter of "credit" or "honor," by some supposed to be connected with the attachment of a man's name to a species, is of little or no account; but if it were of *more* importance, *justice* would demand that we should write as authority the name of the author who has done the most work on the species, or who has given us its complete anatomy and history. Certainly the writers who have, like Linné, Lamarck, Fabricicus, and many others, described vast numbers of species under useless or artificial general in loose, indefinite, Latin diagnoses of two or three lines, costing them perhaps half an hour of time, but costing subsequent naturalists, in the aggregate, many months or years of labor to unravel and understand, are not deserving of more consideration than later systematists, who by a prolonged and careful study of the anatomy have shown their true structure, and have thus arranged them in natural groups, and so brought them properly into the "domain of science."

3d. As to the matter of *convenience*, or saving of time, it seems to me that the argument is opposed to the system advocated by Dr. Lütken. Is it not customary, in looking up unfamiliar names, to consult the *index* of a book? But if the *generic* name has been changed, how can we expect to find in an author's index a name falsely attributed to him, which he never used, and would perhaps have been offended with? If we look through the body of the work we do not fare better, though our labor is increased, for the same specific name may occur many times. Thus, if any one not perfectly familiar with conchological literature undertakes to use, for instance, the Genera of Recent Mollusca, by H. & A. Adams, he constantly finds scores of names of species under genera that are new, or unfamiliar, or perhaps ante-Linnean, and used in a sense unlike that in which the same name is ordinarily used, but all the species have the name of the *original describer* after them (not even in parenthesis, though that would not help much), and if he seeks for the *species* in the works referred to, he must consume a great amount of time to no purpose. What assistance can it be to find Say's name, e. g., after such a name as *Anchistoma hirsutum*, unless we happen to know beforehand in what genus Say placed the species? I presume that every naturalist, however experienced, has met with similar inconvenience and loss of time in using this work. Those, in this country, who try to use the Smithsonian "Check Lists of Shells," constructed on the same plan, find the same and even worse inconveniences.

4th. As to the temptation it affords to vain or young naturalists to do poor or hasty work for the sake of perpetuating their names as "authorities," we have found that the *actual result* is just the opposite that which Dr. Lütken supposes. What can be a *greater check* upon such a person than the certainty that, if he makes a mistake in hastily describing a species, before he has ascertained its true structure and relations, his name will drop into the obscurity of erroneous synomyms? What can be *more encouraging* to one of that class of persons than the certainty that if he names and describes a species, no matter how poorly, or in what false relations, or under what wrong genus, his name must nevertheless always remain attached to it? The effect of the "American" custom is certainly to induce naturalists to attach *more* importance to the study of the structure and true relations of species, and *less* to mere descriptions of new species. And in this country, where any naturalist can easily obtain at least 50 new species in an excursion of a single day, this is of much consequence for the future progress of the science.

16. *New Zoölogical Periodicals.**—No less than three zoölogical periodicals have lately made their appearance, and judging from their first numbers they are of great promise. The one, Archives de Zoölogie Expérimentale et Générale, issued by Professor Lacaze Duthiers, will take a high place among scientific periodicals, and is likely, in French zoölogical literature, to take the position which Siebold and Kölliker's Zeitschrift takes in Germany. Professor Lacaze Duthiers, so well known for his thorough researches upon the Invertebrates of the Mediterranean, contributes an introduction to the first number, stating the aims of the publication, and concludes the number by an elaborate article on the auditive capsules of Gasteropoda. The other original article of this number is written by Mr. Perrier, who has given us an excellent paper on the Natural History of a fresh-water worm (Deto) allied to Nais. This periodical, as well as the other "Journal de Zoölogie," published under the auspices of Professor Gervais, both have notes and reviews on scientific works published in countries outside of France, a feature which thus far has received but little attention from French scientific journals. Holland, which already publishes so many scientific memoirs and periodicals of great excellence, adds a purely zoölogical archive to its list, edited by Professor Selenka. The first number contains a tolerably complete embryology of one of the naked Gasteropods by Selenka, and a long paper by C. K. Hoffman on the anatomy of Echinoderms; both these papers are excellently illustrated. Professor Selenka intends to issue his Niederländische Archiv für Zoölogie whenever sufficient material is at hand; he solicits articles either in German, French or English.
A. A.

17. *East India Crustaceans. On Indian and Malayan Telphusidæ*, Part I, by James Wood-Mason, Esq.—Mr. Mason is publishing excellent papers on Indian Crustaceans in the Journal of the Asiatic Society of Bengal. The paper on the Telphusidæ appears in vol. xl of this Journal. Figures are given of the several species, which are admirably drawn and lithographed.

18. *Greenland Meteorite.*—Mr. E. Seymour writes us from his office for the sale of rocks, minerals and fossils, 52 Beekman st., N. Y., as follows: I have been commissioned by Professor Norden-

* Archives de Zoologie Expérimentale et Générale. Sous la Direction de H. de Lacaze Duthiers. Paris.—Niederländische Archiv für Zoologie herausgegeben von Em. Selenka. Haarlem–Leipzig.—Journal de Zoologie par Paul Gervais. Paris.

skiöld, of Stockholm, Sweden, to sell one of the celebrated Greenland meteorites lately found by him. This meteorite weighs 10,000 lbs. and the price is $12,500 in gold. He has a few other large specimens, adapted to public collections, of smaller size. Specimens of any desired size may be obtained for private collections at $8.00 per pound or 75 cents per ounce.

## III. Astronomy.

1. *Recent auroral displays in the United States.*—In vol. 1, p. 146 (July, 1870), we have given the dates upon which auroras were reported by at least one of the observers of the Smithsonian Institution for the year 1869, and for three months of the year 1870. In vol. i, p. 309 (April, 1871), we gave the continuation of these observations to the close of the year 1870. We now furnish a similar summary for the year 1871. The observations for the first eight months of the year were taken from the monthly reports of the Department of Agriculture; the observations for the last four months were furnished by the Secretary of the Smithsonian Institution, the auroral observations having been omitted in the reports of the Department of Agriculture for these months. We regret to find in the February report the announcement that the publication of the meteorological tables in the monthly is discontinued. A large number of persons have been accustomed to consult these tables with great interest, and we trust the Commissioner of Agriculture will reconsider his decisiou respecting the publication of these tables.

*Auroral displays in the United States in the year* 1871.

| | | | |
|---|---|---|---|
| Jan. | 3, 6, 7, 10, 13, 16, 18, 19, 20, 23, 29, | Total | 11 days. |
| Feb. | 3, 10, 11, 12, 13, 15, 16, 20, 21, 22, 24, 26, 27, | " | 13 " |
| March, | 1, 2, 3, 9, 10, 15, 17, 19, 20, 22, 24, 25, 26, 27, 28, | " | 15 " |
| April, | 1, 5, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 29, | " | 16 " |
| May, | 1, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 21, 22, 23, 25, 26, | " | 17 " |
| June, | 4, 7, 8, 9, 10, 11, 12, 14, 17, 18, 19, 21, 22, 23, 24, 26, 30, | " | 17 " |
| July, | 7, 8, 10, 20, 21, 22, 24, 26, 28. | " | 9 " |
| Aug. | 5, 9, 10, 11, 12, 13, 15, 16, 17, 19, 21, 23, 24, | " | 13 " |
| Sept. | 1, 2, 4, 6, 7, 8, 9, 10, 11, 13, 14, 17, 20, | " | 13 " |
| Oct. | 2, 4, 6, 7, 10, 12, 14, 15, 16, 17, 18, 19, 24, 25, 30, | " | 15 " |
| Nov. | 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 23, 25, | " | 19 " |
| Dec. | 1, 8, 9, 10, 12, 13, 14, 16, 18, 23, 25, 28, | " | 12 " |
| | Total for the year 1871, | | 170 days. |

The following is a summary of the Smithsonian observations for the past three years:

| | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1869, | 13 | 13 | 18 | 23 | 14 | 17 | 18 | 15 | 22 | 17 | 9 | 13 | 192 |
| 1870, | 19 | 18 | 23 | 21 | 22 | 14 | 20 | 19 | 21 | 21 | 18 | 17 | 233 |
| 1871, | 11 | 13 | 15 | 16 | 17 | 17 | 9 | 13 | 13 | 15 | 19 | 12 | 170 |

The correspondence of these results with the number of spots visible on the sun's surface is quite noticeable. The disturbance of the sun's surface attained its maximum in 1870, and is now rapidly declining. It is anticipated that the number of auroras visible in the United States in subsequent years will exhibit a similar decline. E. L.

2. *Note on the Zodiacal Light.*—The *Comtes Rendus* for Jan. 22, 1872, contains an abstract from a note of Mr. E. Liais, giving the results of observations of the zodiacal light at Rio Janeiro and at various places upon the high plateaus of the interior of Brazil. Mr. Liais finds that the light is visible as far as the anti-solar point of the heavens. Polariscopic observations have not enabled him to discover any trace of polarization. He has also at various times within the last four years studied the light by the aid of the spectroscope, and has found that it gives a spectrum apparently continuous, though, perhaps, containing dark lines.

These results would indicate that the light is derived from the sun by reflection; and the absence of polarization, if certainly made out, shows that the matter reflecting the solar rays is not gaseous, but made up of solid corpuscles not endowed with the properties of specular reflection, but scattering the light irregularly. With regard to the connection between the base of the zodiacal light and the corona, he remarks that although the light in the latter is polarized, while that of the former is not so, a fact indicating that the latter is gaseous, and the former composed of solid particles, the corona may possibly be the base of the zodiacal light, its gaseous condition being a result of its proximity to the sun, in consequence of which the solid particles are volatilized by the intense heat.

The observations of Janssen during the recent solar eclipse are of interest here, as confirming the polarization of the corona, and showing that it emits light giving a continuous spectrum with the solar dark lines.

Angström on one occasion observed the bright line of the auroral spectrum in that of the zodiacal light; but that it belongs to the spectrum of the latter is rendered doubtful by the fact that it has been observed in the light from all portions of the sky on nights in which the whole heavens were feebly luminous with a diffuse light. The essentially monochromatic character of this light would render the line visible even when superposed upon the spectrum of the zodiacal light, as, if the latter is really continuous, it would be extremely feeble when observed with an instrument of high dispersive power.

Polariscopic observations upon the zodiacal light were made at Agosta in December, 1869, by the members of the eclipse expedition, and are reported by Mr. A. C. Ranyard in the Monthly Notices of the Royal Ast. Soc., for March 10, 1870. On the evening of the 19th, the light being especially brilliant, Mr. Ranyard observed it with a Savart's polariscope, and thought that he detected dark bands indicating polarization in a plane passing through the sun. This observation was confirmed by Mr. Burton of the same party, who, on looking through the instrument, saw the dark bands distinctly. On the following evening the light was visible but less brilliant than before, and Secchi thought he detected faint bands on viewing it with a Savart, but was not sure of his observation. These results are in opposition to those of M. Liais, and indicate that the light is reflected, either from matter in such a condition that its particles are small compared with the wave-length of light, hence possibly in the form of gas, or from matter capable of giving specular reflection. It is not impossible indeed that the light consisted of portions reflected in both modes, the relative proportions of polarized and unpolarized light varying in different times of the year and in different parts of the earth's orbit, and further observations are needed in order to determine this point. A. W. W.

3. *The American Eclipse Expedition.* (From "*Nature*," of Feb. 22.)—I deem it but proper and just that I should correct a mistake that has just met my eye in Dr. Schellen's excellent work on Spectrum Analysis.

On page 332 of the 2nd German edition we find "Die erstere Expedition wählte unter der Anführung von Professor Morton die Stationen im Staate Iowa,

"(1) Burlington mit den Beobachtern Professor Mayer, Kendall, Willard, Phillips, und Mahoney, denen sich der als gewandter Spectroskpist bekannte Dr. C. A. Young, Professor am Dartmouth College (Hanover), und *Dr. B. A. Gould für die photographischen Aufnahmen hinzugestellen.*"

In the English translation, edited by Mr. Huggins, the above reads, "The first expedition, under the guidance of Professor Morton, selected stations in the State of Iowa as follows:—

"(1) Burlington, where its observers were Professor Mayer, and Messrs. Kendall, Willard, Phillips, and Mahoney, together with Dr. C. A. Young, Professor of Dartmouth College (Hanover), well known as an experienced spectroscopist, and Dr. B. A. Gould, to whose charge the photographic department was committed."

Dr. Gould had no connection with the photographic expedition, but placed himself under Professor Coffin's general organization, so that he could have facilities for making observations on the corona, and in searching for the suspected intermercurial planet.

The Burlington station of the Philadelphia eclipse expedition was placed under the direction of Dr. Alfred M. Mayer, and the photographs pointing page 337 of Dr. Schellen's work are two of the five plates secured by him during totality.

Also the diagram on page 338 is from Dr. Mayer's report on the eclipse (published October, 1869), an abstract of which, with accompanying copies on glass of the original negatives, was presented by M. Delaunay to the Institute of France. The Rev. T. W. Webb laid them before the Royal Astronomical Society, where the report and the photographs were discussed at length at the meeting of November 12, 1869.

HENRY MORTON, President
Stevens Institute of Technology, Hoboken, New Jersey.

4. *Aurora of February 4th.*—This aurora, particular account of which is given by Prof. Twining at page 273 of this volume, was seen at Suez and also at Bombay.

It was also observed at the Cape of Good Hope, as announced in the following account by E. J. Stone of the Royal Observatory at the Cape, dated Feb. 19, copied from *Nature* of April 4. An aurora of a very unusual splendor for the latitude was seen here on Sunday evening, February 4, 1872. The sky, extending in azimuth over 197° from N. E. to nearly W. S. W., was generally illuminated. The brilliance of the glow varied considerably in different directions from time to time during the night. On the south horizon there was a bright bluish segment of light, whose position in azimuth and brilliance varied slightly from time to time. The streamers were well seen, and their convergence toward the point to which the south pole of a magnet is directed could be most distinctly traced. The streamers extended at about nine o'clock to the constellation Orion, and Sirius was well within the auroral glow. With a spectroscope I saw one bright line in the spectrum of the auroral light, but the spectrum was too faint to allow of any successful attempt to determine the refrangibility of the light. Unfortunately our magnetical equipment is such that I can give no information respecting the extent of the magnetical disturbance at the time. The aurora was seen as far north as Bloemfontein, latitude 29° 8′ south. A faint aurora was seen here in October, 1870, but no such aurora as that of February 4, 1872, appears to have been visible for at least fifty years. The aurora was well seen over a large portion of the colony, and considerably frightened the natives.

5. *A New Planet* (118).—Dr. R. Luther has discovered a minor planet (118), Peitho, at Bilk.

| 1872. | M. T. at Bilk. h. m. s. | | h. m. s. | | ° ′ ″ |
|---|---|---|---|---|---|
| March 15, | 14 18 59·6 | R.A. = | 12 7 26·73 | N.P.D. = | 79 42 33·5 |

An observation made by Dr. Tietjen, at Berlin, is as follows:

| 1872. | M. T. at Berlin. h. m. s. | | h. m. s. | | ° ′ ″ |
|---|---|---|---|---|---|
| March 21, | 9 33 23 | R.A. = | 12 1 36·36 | N.P.D. = | 78 20 46·1 |

The daily motion obtained from these observations is in R.A. $-60^{s}\cdot 6$, and in N.P.D. $-3' \ 45''$. The planet is of the eleventh magnitude.—*Athenæum*, March 30, 1872.

## IV. Miscellaneous Scientific Intelligence.

1. *Topography of the Punjab Oil Region*; by Benjamin Smith Lyman, Mining Engineer. 14 pp. 4to. (From the Trans. Amer. Phil. Soc., vol. xv, p. 1.)—The oil of this region, according to Mr. Lyman, comes mainly from rocks of the Eocene Tertiary age, part of which are nummulitic. The following observations are made on the oil.

The oil has been bored upon at Gunda, and at first fifty gallons of it a day were pumped from the well; but the yield, of course, grew quickly less (like the ordinates of a parabola), and after the whole amount had reached two thousand gallons (about five months), the daily yield was less than ten gallons. In the region, oil flows also at five other places from natural springs from a gill to three quarts a day, and there are traces of it at yet two other places, making eight in all. Asphalt, or dried oil, is found in small quantities at four of these places, and at four other places, at two in notable quantities. At most of the asphalt places there are traces of rock tar or asphalt melted in the heat of the sun; and at one of them (Aluggud) as much as 100 gallons. Besides these dozen places where oil or asphalt is found, there are half a dozen places where there are small traces of one or the other, enough to attract notice in the minute examination of the country by its inhabitants. About half of all the places are in the northeastern corner of the region; about half toward the southwestern corner; and one or two in the northwestern corner toward the middle.

The Aluggud oil (now dried to asphalt) seems to have come from rocks of Carboniferous age, to judge by their fossils, though other things would rather show that they were of later age. If they are Carboniferous, then the nummulitic rocks are wanting above them, and have thinned completely away from a thickness of 2,000 feet, only thirty miles distant. This oil is also the only case of oil outside of the older Tertiary rocks anywhere in the whole region.

All the other oil springs or shows of oil in the southern part of the region, are on the northern side of the Salt Range, and in the nummulitic limerock or close above it. The northern ones are either in the nummulitic lime rock of the Choor Hills, the same probably as that of Salt Range; or in the Gunda rocks (chiefly sandrocks) that lie south of them, also accompanied by nummulites.

In every case the oil seems to come from a deposit of very small horizontal extent, sometimes only a few feet, seldom as much as a few hundred yards; only in one case, that of the Chhota Kutta and Burra Kutta oil springs, near Jaba, does the deposit seem to extend as much as half a mile. Here, too, the oil comes from a thickness of about a hundred feet, and the natural springs yield at one place as much as three quarts a day. At all the other places the oil comes from a much smaller thickness of rock, from forty feet at Aluggud and twenty at Gunda and Punnoba downward. Scarcely do any two oil springs come from the same bed of rock.

The oil is dark green in color, and so heavy as to mark 25° of Beaumè's scale, or even less. The Gunda oil has been burned a little by the natives with a simple wick, resting on the side of an open dish; but the Punnoba oil is more inflammable, and needs a special tube for the wick, though the main opening of the dish or lamp may stay uncovered. The oil, generally, however, has been little used for burning except at Punnoba; but has been sought for as a cure for the sore backs of camels. The asphalt was also highly prized forty years ago by the natives as medicine, taken in pills, especially for broken bones. It was carried far and wide, and was called "negro's fat," because it was generally believed to have dripped from the brain of a negro that had been hung up by the heels before a slow fire.

It is perhaps needless to say that there is nothing whatever in the mode of occurrence of the Punjab oil, to uphold the chimerical belief that rock oil ever passes by distillation, emanation, or otherwise, from one set of rocks to another, or that it originates in any different rocks from those in which it is found; and nothing to show that it has been formed by any other method than the very natural and sufficient one of the slow decomposition of organic matter, deposited along with the other materials of the rock. Neither is there anything to show that the oil has been driven by the upward pressure of water, from the lower parts of a bed of rock through its pores to a higher part of the same bed; on the contrary, as the rocks near most of the oil springs dip pretty steeply, if such an action of water were possible, all the oil would long ago have been altogether forced out of the rock at the outcrop. Indeed, such an idea is quite inconsistent with the fact that even a slight amount of oiliness in the pores of a body is a complete bar to the entrance of water; much less could water (without soap) scour the oil from one mass of rock and make it flow into another mass filled with moisture. If oil wells are more numerous in some regions along the tops of rock saddles, the reason is clear, that the oil-bearing bed lies too deep for boring conveniently elsewhere.

Wild hopes have sometimes been entertained that a large amount of oil might, by boring near the oil springs, be struck in some cavity below the oil-bearing bed; but it is safe to say that they are not justified by anything whatever, either in the Punjab or in any other part of the world, either in the practical experience of oil-boring or in the general laws of physics.

2. *The Pacific Gulf Stream, or Oceanic Current flowing northward along by the Asiatic Continent.*—S. Wells Williams, the distinguished Chinese scholar, has recently published a translation of the diary of a Chinese writer on an excursion to the Lewchew Islands on a Government expedition in 1801. Besides giving many interesting facts respecting the Lewchewans, it shows that the Pacific Gulf stream, *Kuro-Siwo* in Chinese, was then well known to the Chinese navigators. We copy a paragraph in evidence of this fact, and also to show something of the spirit of a Chinese traveller in those days. The author Li Ting-yuen was at the time the junior member of the Imperial Commission despatched from Pekin to accompany the Lewchewan delegation in 1801.

"The sailors came to us to-day, to say that it was the right time to sacrifice to the Heh-kao or Kuro-siwo, i. e. the Black Sewer; and it appears from the account of Wang, a former envoy to Lewchew, that it was the practice when the vessel reached the Kuro-siwo, to throw a live sheep and a pig into it to propitiate the god, and then to scare him by drawing up the guard on deck. We had now been out three days, and did not know where this Black Sewer ran; but the Lewchewan captain said, 'We go back and forth here, but do not know where it is, only when we see

*Tiao-yu tia* we know that the god resides there and then worship him out at sea, by throwing a live sheep and pig overboard, burning some silk and pouring out a libation, but we do not call out the guard.' The whole of to-day two vessels were seen some scores of miles ahead of us.*

3. *On the Climate of Boston.* From a recent meteorological article by R. T. PAINE, of Boston.—The three warmest of the last 47 years were in 1823, 1825 and 1870 (m. t. 51·71°, 51·43° and 51·22°); the three coldest were 1836, 1837 and 1868 (m. t. 46·01°, 46·66° and 47·12°); the extreme variation in the annual temperature is therefore here 5·70 degrees.

The extreme range of the thermometer at Boston in the 47 years, was 114 degrees, from 100° on July 11th, 1825, to 14 *below* zero on February 8th, 1861. The greatest *sudden* change was a fall of 60° in 18 hours, from 46° at one P. M. of February 7th, 1861, to 14° *below* 0 at sunrise of 8th; but three days, or 79 hours, later, on February 11th, noon, it had risen 74 degrees to 60 above 0.

The extremes of the barometer in the 47 years were 31·16 inches on February 5th, 1863, and 28·47 on November 25th, 1846—difference, 2·69 inches.

The average *annual* fall of rain in Boston is 45·73 inches; the greatest fall was 67·84 in 1863; the least only 29·95, in 1846; the greatest *monthly* fall was 12·50 inches, July, 1863; the least, 0·25 inches, in May, 1826, and 0·26 in December, 1828; but within the last 10 years, 0·62 inch, in September, 1865.

4. *Climate of the Post-tertiary, or Quaternary, after the Glacial era.*—The April number of Woodward's excellent "Geological Magazine," contains an important article on the post-glacial climate of Britain, by S. V. Wood, Jr., F.G.S., sustaining the view, before presented, that there was a second period of cold in the Quaternary. The existence, in caves and other quaternary deposits, of the remains of quadrupeds that required a temperate climate, and also in some places of the remains of the reindeer, a subarctic species, is thus accounted for. Various other arguments are brought to bear on the conclusion. Professor Geikie, in a following article, argues that the warm-climate quadrupeds may have been pre-glacial. But various facts bear against this view.

* Mr. Williams adds the following note:

This notice of the Great Pacific Gulf Stream is interesting as showing that Chinese and Japanese navigators had both noticed it and given it the same name of *Heh-shwui kao,* i. e. Black Water Channel or Sewer, or Black Sewer, which has the same meaning as *Kuro-siwo.* In a subsequent date, our traveler says he was talking with the Lewchewans about this stream. They said, "We have heard that on the surface of the ocean to the westward is the Kuro-siwo, and near the sea of Fuhkien; it was formerly called *Tsang-ming* and *Tungming;* we Lewchewans do not know about this and have never crossed it. Why is this?" I replied. "Many people cross the sea, but those who write about it are few: while those who are not sea-sick, and sit all day on the poop deck and there write down what they see, are fewer still. One man leads and all others follow, their ears devouring his words, but who can confidently believe all he says? This is the reason why the Lewchewans, though they annually cross the ocean, still know nothing about the *Kuro-siwo,* and constantly affirm that there is none."

5. *Colorado Expedition.*—Major POWELL has returned from the cañons of the Colorado, having left his party in the field in charge of Professor Thompson. Since the party started in April last, it has passed through the cañons of Green River and the cañons of the Colorado, to the mouth of the Paria, at the head of Marble Cañon. Here the major left his boats for the winter, and he expects to return as soon as there is a favorable stage of water, and embark for the second trip through the German Cañon.

On the way down the party explored the region to the west of the Green and Colorado, tracing the courses of the larger streams emptying into the two great rivers to their sources in the Wahsatch Mountains and Sevier Plateau, and examined the geology of the great mesas and cliffs.

Early in the winter a base-line 47,000 feet in length was measured on a meridian running south from Kanab, and the party is now engaged in extending a system of triangles along the cliffs and peaks among lateral cañons of the Colorado.

During the past season the party has discovered many more ruins of the communal houses once occupied by the prehistoric people of that land. Many of these houses stood on the cliffs overhanging the cañons, and many more are found in the valleys among the mountains to the west. Stone implements, pottery, basket-ware, and other articles were found buried in some of the ruins.

The major found a tribe of Utes on the Kaibab Plateau who still make stone arrow-heads and other stone implements, and he had opportunity to observe the process of manufacturing such tools.—X. *in Harper's Weekly.*

6. *Cruise of School-ship "Mercury" in the Tropical Atlantic Ocean*, 1870–1871. 34 pp. 8vo, with a map of the cruise.—This School-ship was sent out from New York by the Department of Public Charities and Correction of the city as a means of giving nautical instruction to vagrant boys. It sailed from New York by way of Madeira to the Canaries and Sierra Leone; thence through the tropics to Barbadoes; thence through the Caribbean Sea to the north of Cuba, and back to New York. The vessel was under the command of Capt. Giraud, and, in accordance with the orders received, he made lines of soundings, observations on the temperature of the air and water, and on currents. The results were submitted to Prof. Henry Draper, of the University of the city of New York, and are recorded in this pamphlet. The introduction says:

"Professor Draper's report, which is herewith submitted, contains precise tabulated statements of the meteorological observations of the voyage, of the direction and velocities of the currents, and of the temperatures at the several depths obtained, together with an analysis of the specimens of water from various depths. The report also contains a diagram of the bed of the Atlantic from Sierra Leone to Barbadoes, as established by the soundings, and is replete with interesting disquisitions on all the questions of deep-sea explorations. The specimens of animal life which were obtained from the bottom were forwarded for examination by Professor Draper to Dr. Carpenter. He reports that they are the ordinary forms of deep-sea foraminifera. With the specimens Professor Draper also sent a table of the temperatures, and in respect to them Dr. Carpenter remarks, 'that they are of great interest, and especially those at one hundred and two hundred fathoms. They show,' he continues, 'how thin is the surface stratum affected by the gulf-stream, or by direct solar radiation. The sudden drop,' he remarks, 'in the temperature at two hundred fathoms, between 17° 46′ west longitude, and 19° 36′ west longitude, and the continuation of this reduction with the increased westing as far as 50° 38′ is a very curious phenomenon, and I cannot help connecting it with some great oceanic movement, especially as at 68° 47′ west longitude, and at 83° the higher temperatures reappear. I trust that hereafter much attention will be given to this point.'

"The conclusion at which Professor Draper has arrived, from a careful examination of the results obtained, is that there exists, all over the bottom of the Atlantic and Caribbean Sea, a stratum of cold water, and that the cruise of the Mercury must be considered as offering confirmatory proof of the correctness of Dr. Carpenter's theory, drawn from the cruises of the English exploring vessels, that there is a general movement of the lower waters of the Atlantic toward the equator, and a corresponding flow of the surface-waters toward the poles."

It should be here added that this movement of the oceanic waters was long since advocated by the meteorologist, Wm. C. Redfield, of New York.

7. *Public Aquarium at Naples.*—Anton Dorhn gives, in *Nature* of April 4, an account of the great aquarium in process of erection at Naples under his direction, besides discussing some of the objects which science may gain from it. The building is rectangular, measuring 100 feet by 70, with a height of 40 feet, and is 100 feet from the sea. The lower part is to be occupied by the tanks of the great aquarium, to be opened to the public; and the upper will contain twenty-four rooms for laboratories, a library and collections, with lodging rooms for three or four zoologists. There will be 53 tanks in the lower story, one of them 32 feet long, 10 broad and 3½ deep, another, 26 feet long, and twenty-six 8 feet by 3½ feet. The tanks throughout are furnished with a continuous current of sea water. Upstairs, the library room is large enough to hold 25,000 volumes. The principal laboratory room will contain twenty to thirty tanks of different sizes; and besides there are private laboratories for the chief zoologist and the first assistant, and other small laboratory rooms, and rooms for collections.

8. *Corrected longitude results across the North American Continent.* Note from G. W. Dean (April 8, 1872).—Soon after the paper relating to the "U. S. Coast Survey Longitude Determinations across the Continent" had been printed in the December number of this Journal,* it was discovered that the corrections for

* This Journal, III, ii, 447.

personal equation had inadvertently been applied to the longitude results, with the wrong algebraic sign. The following longitude results are therefore printed:

| Stations. | Difference of longitude. λ | | | Personal equation. | Corrected difference of longitude. | | | Probable errors. |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | s. | s. | h. | m. | s. | s. |
| Camb. to Omaha, | 1 | 39 | 15·159 | −·130 | 1 | 39 | 15·029 | ±·008 |
| " to Salt Lake, | 2 | 43 | 4·257 | −·110 | 2 | 43 | 4·147 | ±·008 |
| Omaha to " | 1 | 3 | 49·081 | +·020 | 1 | 3 | 49·101 | ±·008 |
| Camb. to S. Fr'ncisco, | 3 | 25 | 7·260 | +·070 | 3 | 25 | 7·330 | ±·007 |
| Omaha to " | 1 | 45 | 52·094 | +·200 | 1 | 45 | 52·294 | ±·010 |
| Salt Lake to " | 0 | 42 | 3·024 | +·180 | 0 | 42 | 3·204 | ±·008 |

9. *A Contorted Halo;* by H. W. PARKER. (Communicated.)—A remarkable prismatic effect in a cloud, was visible at Amherst, Mass., 11 A. M., March 1st. A large, white sheet of cirro-stratus, at its doubly-lobed end near the sun, exhibited bright spectrum colors in bands of very irregular breadth, several times repeated, and flexed in zig-zag curves, accordant with the structure and outline of the mass. The beautiful iridescence covered nearly a third of the cloud, and the bands were bent far back on themselves, some of them even twice, with nothing of the figure of circular halos.

10. *Logan Chair of Geology in M'Gill University, Montreal.*—Sir William E. Logan has recently given $18,000, in addition to the sum of $2,000 before contributed by him, toward endowing the chair of geology in M'Gill College. Principal Dawson, under whose charge the department of geology has been for many years, will be the first occupant of the chair.

11. *American Association for the Advancement of Science.*—The 21st meeting is appointed to be held at San Francisco, California, to commence August 5th. Details of the arrangements, which are not yet perfected, will be announced in the next number of this Journal.

12. *British Association.*—The next meeting of this Association, the forty-second, will be held at Brighton, and will commence Wednesday, the 14th of August. Dr. Wm. B. Carpenter is president for the year.

13. *Annual Report of the Board of Regents of the Smithsonian Institution for* 1870. 494 pp. 8vo. Washington, 1871.—This Report contains in its valuable Appendix memoirs of Prof. A. D. Bache, Arago, Magnus, Prof. C. Dewey, besides papers—on the nature and origin of Force, by W. B. Taylor; on a Physical Laboratory, by Prof. Henry; on the relation of Food to Work, by Rev. S. Haughton, of Dublin; on the Diamond and other Precious Stones, by Babinet; and various papers on ethnological, physical, and meteorological subjects.

14. *Annals of the Lyceum of Natural History of New York.*—Nos. 4–5 of vol. x contain the following papers: on the lingual dentition of *Helix turbiniformis*, by T. Bland and W. G. Binney; on the *Ascidea Manhattensis* and *Mammaria Manhattensis*, by

J. A. Telkampf; on the N. American Crustacea in the Museum of the Smithsonian Institution, by Wm. Stimpson.

OBITUARY.

Samuel Finley Breese Morse.—Prof. Morse died at his residence in New York city, on the 4th of April, at the advanced age of 81 years. Few Americans have attained so world-wide a renown as Mr. Morse, growing chiefly out of his success in devising and introducing the system of electric telegraphy which bears his name. Mr. Morse was the eldest son of Jedidiah Morse, D.D., an American clergyman, better known as a geographer, whose writings were the first devoted to the elucidation of American geography, his educational works of this character remaining for more than a generation in general use.

Prof. Morse was born in Charlestown, Mass., April 27, 1791. He graduated at Yale College in 1810. His scientific tastes had their first development and stimulus while he was an undergraduate student of Prof. Silliman the elder, a warm personal attachment growing up between teacher and pupil, which endured undiminished to the end of two lives prolonged far beyond the usual term of human experience. But the first choice of Mr. Morse after graduation was for the fine arts, which he pursued in London in 1811 under Benjamin West the painter, in company for a time with Washington Allston. He was also successful in sculpture, his "Dying Hercules," which was crowned by the gold medal of the Adelphi Society of Arts of London, being esteemed as unsurpassed by any American artist to this day. The National Academy of Design of New York had its origin in 1826 chiefly from his efforts, and he was its first president, an office which he held by successive elections until 1842. His early scientific tastes were revived by his intimate associations with Prof. James Freeman Dana in New York, where the two were colleagues in the Athenæum. It was in Dana's hands that he saw for the first time, and immediately after its discovery by Sturgeon of England, a soft iron electro-magnet. In 1829 he again visited Europe in prosecution of his artistic studies, and while yet abroad was elected to the professorship of the literature of the arts of design in the University of the City of New York. The germs of his immortal invention, which were undoubtedly long before slumbering in his mind, appear to have been stimulated by a discussion which took place on board the packet-ship Sully in the autumn of 1832, while on his way to America, and then took on a more definite form; and soon after his arrival in New York he occupied himself in maturing his plans and realizing his conceptions by an attempt to construct an apparatus. In 1835 he completed his first rude single receiving instrument, which he produced in duplicate in 1837. In the number of this Journal for January, 1838,* will be found the first notice of the Morse system of telegraphic notation, with a specimen of the electrical record as then in use, and such as the writer saw it in the inventor's rooms in the University of New

* This Journal, I, xxxiii, 185.

York, in the autumn of 1837. Failing to secure any encouragement from the national government of his own country toward the construction of an experimental line, in 1838 he in vain sought aid or protection of his rights as an inventor in Great Britain and France; and it was only after several years of disappointment and poverty that he was gratified by the appropriation of $30,000 by the U. S. Congress (March 4th, 1843), for the purpose of encouraging his first attempt to construct a line of telegraph between Washington city and Baltimore, a work which, after many difficulties, he completed in 1844.

From that time to this the system of Morse has spread with great rapidity, until it now reaches the remotest hamlets of the North American continent, covering the whole land with its pulsating nerves of iron, and communicating with all the civilized regions of the globe, in most of which his system is the one in use. Honors were showered upon the inventor by most of the leading governments of Europe, either by decorations or by more substantial grants of money, in acknowledgment of his great services. His Alma Mater in 1848 gave him the degree of LL.D.

Prof. Morse was distinguished by great amenity of manner and kindliness of heart, which endeared him to a large circle of friends. He never claimed for himself the honors of a *scientific discoverer*, nor did he seek to enlarge the boundaries of human knowledge by original investigations. He was emphatically an *inventor*, using the discoveries of science to carry out and perfect his inventions. Gifted with a far-reaching mind, and indomitable energy, he conferred in this way a great blessing on the human race. B. S.

Pictet de la Rive, the eminent Swiss physicist, died at Geneva on the 15th of March, at the age of sixty-two.

Die Elbthalgebirge in Sachsen, von Dr. H. B. Geinitz. Zweiter Theil. Seeschwämme, Korallen, Seeigel, Seesterne, und Haarsterne, mit 6 Tafeln Abbildungen.

Development of Limulus polyphemus, by A. S. Packard, Jr. (Mem. Boston Nat. Hist. Soc., Vol. II.)

Note sur les Tremblements de Terre en 1868, avec Supplements pour les années antérieurs de 1843 à 1867, par Alexis Perrey, Prof. Hon. à la Faculté des Sci. de Dijon. (Bull. Ac. Roy. de Belgique, Febr. 1870.)

Les Oscillations des Côtes de France, by A. Delesse. Delesse gives in this paper many facts with regard to modern changes of level on the coast of France. It is published in the Bulletin of the Société de Geographie for January, 1872.

Report of the Chief Commissioner of Mines for the Province of Nova Scotia for the year 1871, by D. Honeyman. 88 pp. 8vo. Halifax, 1872.

Descriptions of some new species of fossils, from the shales of the Hudson river group in the vicinity of Cincinnati; by James Hall. Published October, 1871, in advance of the Twenty-fourth Report of the State Cabinet.

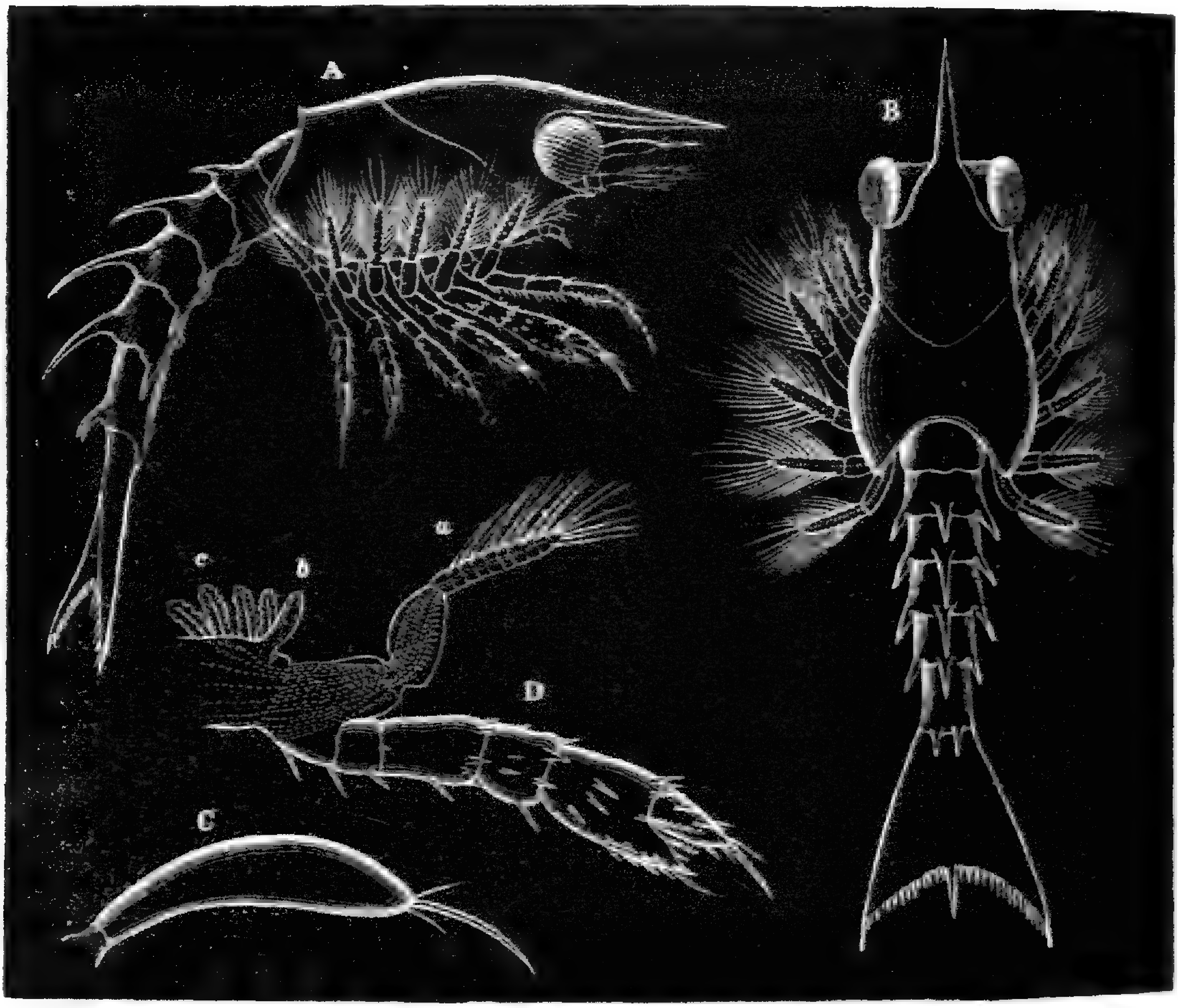
Notes on some new or imperfectly known forms among the Brachiopoda, etc., by James Hall. Published March, 1871; reprinted with explanation of figures, March, 1872.

Catalogue of the Pythonomorpha found in the Cretaceous strata of Kansas, by E. D. Cope. (Proc. Am. Phil. Soc., December, 1871.)

On the Families of Fishes of the Cretaceous of Kansas, by E. D. Cope. (Proc. Am. Phil. Soc.. January, 1872.)

Contributions to the Ichthyology of the Lesser Antilles, by E. D. Cope. (Trans. Am. Phil. Soc., vol. xiv.)

Description of the genus Protostega, a form of extinct Testudinata, and of species from Kansas and New Jersey, by E. D. Cope. (Proc. Am. Phil. Soc., March, 1872.)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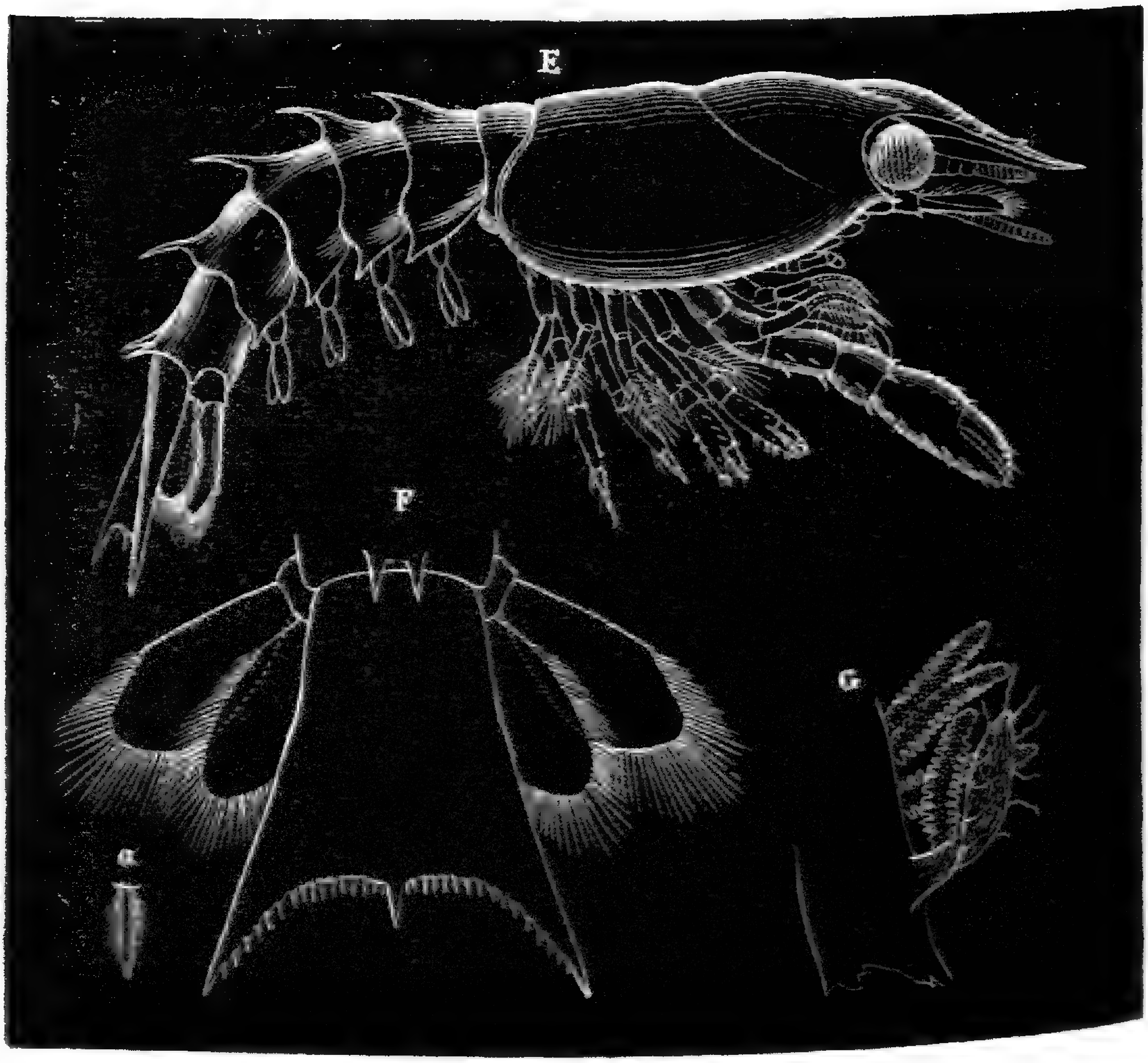
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AMERICAN

# JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

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## ART. LI.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XXI.—*The Early Stages of the American Lobster* (HOMARUS AMERICANUS Edwards); by S. I. SMITH.

THE majority of the published observations on the development of the higher crustacea have been confined to the changes taking place in the embryo within the egg, or immediately after leaving it. Of the later stages, which connect the newly hatched young with the adult, little is known. So far as the published accounts are known to me, this is the case in the history of the common lobster of Europe. On the development of the lobster of our own coast nothing has been published. The investigation, of which this article is a short notice, was undertaken to supply this deficiency in the history of the later development of the lobster, and is one of the results obtained through the facilities for collecting and studying our marine animals, offered last summer by the U. S. Commissioner of the Fisheries, Professor Baird.

The specimens were all obtained in Vineyard Sound, or the adjacent waters, during July, and were mostly taken at the surface in the day-time, either with the towing or hand net. They present three quite different stages in the true larval condition, besides a later stage approaching closely the adult. The exact age of the larvæ of the first stage was not ascertained, but was probably only a few days, and they had, most likely, moulted not more than once, perhaps not at all. Between the third stage, here described, and the last, there is probably an intermediate form wanting. The descriptions and figures have all been drawn from specimens preserved in alcohol, as there was no opportunity for studying them while alive.

*First Stage.*—The larvæ of the first stage observed were frequently taken at the surface, and were obtained from the well of a lobster smack, where they were swimming in great abundance near the surface of the water. In this stage (pl. IX, figs. *A*, *B*, *C*, *D*) they are free-swimming Schizopods, about a third of an inch (7·8 to 8·0$^{mm}$) in length, without abdominal appendages, and with six pairs of pediform cephalothoracic appendages, each with the exopodus* developed into a powerful swimming organ. The general appearance is represented in the figures. The eyes are bright blue: the anterior portion and the lower margin of the carapax and the bases of the legs are speckled with orange; the lower margin, the whole of the penultimate, and the basal portion of the ultimate segment of the abdomen, are brilliant reddish orange. They are very active, swimming about very much like the species of *Mysis* and *Thysanopoda*.

The antennulæ (fig. *C*) are short and sack-like, with a single articulation at the base and three setæ at the tip. The antennæ have large well-developed scales, furnished along the inner margin with long plumose hairs, but the flagellum is shorter than the scale, not divided into segments, and with three plumose setæ at tip. The mandibles are unlike on the two sides; the inferior edges are armed with acute teeth, except at the posterior angle, where there is a small molar area; the palpi are very small and the three segments just indicated. The exognathus in both pairs of maxillæ is composed of only one article, and is furnished with several setæ at tip. In the first maxillipeds, the exognathus is an unarticulated process, furnished with short plumose hairs on the outer side. The second maxillipeds have the principal branch cylindrical, not flattened and appressed to the inner mouth organs as in the adult; the exognathus is short and as yet scarcely flabelliform; and the epignathus is a simple process, with not even the rudiment of a branchia. The external maxillipeds are pediform, the endognathus as long as and much resembling the endopodi of the posterior legs, while the exognathus is like the exopodi of all the legs, being half as long as the endognathus, and the terminal portion furnished along the edges with long plumose hairs. The epignathus and the branchiæ are very rudimentary, represented by minute sack-like processes. The anterior thoracic legs, which in the adult develop into the big claws, are exactly alike, and no

* To prevent confusion the terms here used are those proposed by Milne Edwards to designate the different branches of the cephalic and thoracic appendages: *endopodus*, for the main branch of a leg; *exopodus*, for the accessory branch (*a* in fig. *D*); *epipodus*, for the flabelliform appendage (*b*); and *endognathus*, *exognathus*, and *epignathus*, for the corresponding branches of the mouth organs.

longer than the external maxillipeds. The pediform branch is, however, somewhat stouter than in the outer legs, and subcheliform. The legs of the second and third pairs (fig. *D*) are similar to the first but not as stout. The legs of the fourth and fifth pairs are still more slender, and styliform at the extremity as in the adult.

The exopodal branches of all the legs and of the external maxillipeds are quite similar, and differ very little in size. In life, while the animal is poised at rest in the water, they are carried horizontally, as represented in figure *B*, or are curved up over the carapax, sometimes so as almost to cover it. The blood circulates rapidly in these appendages, and they undoubtedly serve, to a certain extent, as respiratory organs, as well as for locomotion. By careful examination, small processes were found representing the normal number of branchiæ to each leg.* These rudimentary branchiæ, however, differ somewhat in different specimens, being very small, and scarcely distinguishable, in what appear to be younger individuals, from the rudimentary epipodi, while in others, apparently older, they are farther developed, being larger, more cellular in structure than the epipodi, and even showing an approach to crenulation in the margins, as in figure *D*.

The abdomen is slender, the second to the fifth segments each armed with a large dorsal spine curved backward, and with the lateral angles produced into long spines, and the sixth segment with two dorsal spines. The proportional size and the outline of the last segment is shown in figure *B*; its posterior margin is armed with a long and stout central spine, and each side with fourteen or fifteen plumose spines or setæ, which are articulated to the margin.

*Second Stage.*—In the next stage the larvæ have increased somewhat in size, and the abdominal legs of the second to the fifth segments have appeared. The rostrum is much broader, and there are several teeth along the edges. The basal segments of the antennulæ have become defined, and the secondary flagellum has appeared but is not subdivided into segments. The antennæ and mouth organs have undergone but slight changes. The first thoracic legs are proportionately larger and stouter

* The number of branchiæ, or branchial pyramids, in the American lobster is twenty on each side: a single small one upon the second maxilliped, three well-developed ones upon the external maxilliped, three upon the first thoracic leg, four each upon the second, third and fourth, and one upon the fifth. This number is perhaps different in the European species. De Haan (Fauna Japonica, Crustacea, p. 146) gives the number, for the genus *Homarus*, as nineteen on each side, giving only two for the external maxilliped, while Owen (Lectures on the Anatomy of the Invertebrate Animals, 2d ed., p. 322) and Edwards (Hist. nat. des Crust., i, 86) give the whole number on each side as twenty-two, although Edwards in the second volume of the same work, under *Homarus*, p. 333, gives twenty as the number.

than in the first stage, and have become truly cheliform. The succeeding legs have changed little. The epidodi of all the legs and of the external maxillipeds have increased in size, and the branchial processes are distinctly lobed along the edges, and have begun to assume the form of true branchiæ. The segments of the abdomen have the same number of spines but they are relatively somewhat smaller, and the last segment is relatively smaller and broader at base. The appendages of the second to the fifth segments differ considerably in size in different specimens, but are nearly as long as the segments themselves; their terminal lamellæ, however, are represented only by simple sack-like appendages, without sign of segmentation, or clothing of hairs or setæ. The penultimate segment is still without appendages.

*Third Stage.*—In the third stage (pl. IX, figs. *E*, *F*, *G*) the larvæ are about half an inch (12 to 13mm) in length, and the integument is of a much firmer consistency than in the earlier stages. The antennulæ are still rudimentary, and considerably shorter than the rostrum, although the secondary flagellum has increased in length, and begins to show division into numerous segments. The antennæ retain the most marked feature of the early stages—the large size of the scale—but the flagellum is much longer than the scale, and begins to show division into segments. The mandibles, maxillæ, and first and second maxillipeds have changed very little, although in the second maxillipeds, the extremity of the exognathus begins to assume a flagelliform character, and the branchia is represented by a small process upon the side of the epignathus. The maxillipeds have begun to lose their pediform character. The anterior legs have increased enormously in size, and those of the second and third pairs have become truly chelate, while the swimming exopodal branches of all the legs, as well as of the external maxillipeds, are relatively much smaller and more unimportant. The epipodi (fig. *D*) are furnished with hairs along the edges, and begin to assume the characters of these appendages in the adult. The branchiæ (fig. *D*) have developed rapidly, and have a single series of well-marked lobes along each side. The abdomen still has the spines characteristic of the earlier stages, though all of them are much reduced in size. The appendages of the second to the fifth segments have become conspicuous, their lamellæ have more than doubled in length, and the margins of the terminal half are furnished with very short ciliated setæ. The appendages of the penultimate segment (fig. *F*) are well developed, although quite different from those in the adult. The outer lamella wants wholly the transverse articulation near its extremity, and both are margined, except the outer edge of the outer lamella, with long plumose hairs. The last segment is relatively smaller and more quadrangular in outline, and the spines of the posterior margin are much smaller.

*Fourth Stage.*—In the next stage observed, the animal, about three fifths of an inch (14 to $17^{mm}$) long, has lost all its schizopodal characters, and has assumed the more important features of the adult lobster. It still retains, however, the free-swimming habit of the true larval forms, and was frequently taken at the surface, both in the towing and hand net. Although resembling the adult in many features, it differs so much that, were it an adult form, it would undoubtedly be regarded as a distinct genus. The rostrum is bifid at tip, and armed with three or four teeth on each side toward the base, and in some specimens with a minute additional spine, on one or both sides, close to the tip. The flagella of the antennulæ extend scarcely beyond the tip of the rostrum. The antennal scale is very much reduced in size, but is still conspicuous and furnished with long plumose hairs along the inner margin, while the flagellum is as long as the carapax. The palpi of the mandibles have assumed the adult character, but the mandibles themselves have not acquired the massive molar character which they have in the older animal. The other mouth organs have nearly the adult form. The anterior legs, although quite large, are still slender and just alike on the two sides, while all the thoracic legs retain a distinct process in place of the swimming exopodi of the larva.

The lateral angles of the second to the fifth abdominal segments are prolonged downward into long spiniform teeth, the appendages of these segments are proportionately much longer than in the adult, and the margins of their terminal lamellæ are furnished with very long plumose hairs. The lamellæ of the appendages of the penultimate segment are oval, and margined with long plumose hairs. The terminal segment is nearly quadrangular, as wide at the extremity as at the base, the posterior margin arcuate, but not extending beyond the prominent lateral angles, and furnished with hairs like those on the margins of the lamellæ of the appendages of the penultimate segment.

In this last stage, the young lobsters swim very rapidly by means of the abdominal legs, and dart backward, when disturbed, with the caudal appendages, frequently jumping out of the water in this way like shrimp, which their movements in the water much resemble. They appear to be truly surface animals as in the earlier stages.

From the dates at which the different forms were taken, it is probable that they pass through all the stages here described in the course of a single season. How late the young, after reaching the lobster-like form, retain their free-swimming habit was not ascertained.

EXPLANATION OF PLATE IX.

Figure *A*. Lateral view of the larval young in the first stage observed, enlarged 10 diameters.
" *B*. The same in a dorsal view, the abdomen held horizontally.
" *C*. Antennula, enlarged 20 diameters.
" *D*. One of the thoracic legs of the second pair, enlarged 20 diameters; *a*, exopodus; *b*, epipodus; *c*. branchiæ.
" *E*. Lateral view of the larval young in the third stage, enlarged 8 diameters.
" *F*. Terminal portion of the abdomen seen from above, enlarged 15 diameters; *a*, one of the small spines of the posterior margin of the terminal segment, enlarged 75 diameters.
" *G*. Basal portion of one of the legs of the second pair, showing the epipodus and branchæ, enlarged 20 diameters.

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ART. LII.—*Remarks on the Nomenclature of Achromatic Objectives for the Compound Microscope;* by Dr. J. J. WOODWARD, U. S. Army.

FOR some years past, while most of the Continental opticians have continued to give arbitrary designations to their achromatic object glasses, such as No. 1, No. 2, &c., or System A, System B, &c., the English and American manufacturers, affecting a higher degree of accuracy, have undertaken to name the objectives they construct by their real or supposed agreement in magnifying power, with single lenses of specified focal lengths. We hear accordingly of inch, half-inch and quarter-inch objectives, &c., by which we are expected to understand combinations agreeing in magnifying power with single convex lenses of the focal lengths named.

At first sight nothing could appear simpler or more exact than such a nomenclature; nevertheless recent articles in the journals would seem to indicate that the general plan is capable of considerable modification in its practical application, and that grave misunderstandings have hence arisen.

Under these circumstances, it appears desirable to give some account of the principles involved, and of the practical difficulties to be considered in their application, particularly as the microscopical text-books contain little or no information on the subject. In fact, the only scientific discussion of the matter with which I am acquainted is the paper of Mr. Charles R. Cross, "On the focal length of microscopic objectives." (Journal of the Franklin Institute, June, 1870, p. 401). This paper gives a reasonable formula for the approximate computation of equivalent focal lengths, and furnishes some other valuable information, but does not discuss all the points at issue. I shall have occasion to refer more than once to this excellent paper, which the reader would do well to examine in connection with the following remarks.

We learn from the elementary treatises on optics that when an object is placed in front of a single convex lens at a distance somewhat greater than its focus for parallel rays, a real image is formed on the other side of the lens, which may be received on a screen. This image will be larger, and formed at a point more distant from the lens, the nearer the object approaches to the focus for parallel rays; and two equations are given which express the relationship of the distances to each other and to the magnifying power, viz:

$\frac{1}{f}=\frac{1}{p}+\frac{1}{p'}$, and $\frac{p'}{p}=m$, in which $f$ is the length of the focus for parallel rays, $p$ the distance of the lens from the object, $p'$ its distance from the image, and $m$ the true magnifying power, that is, the size of the image divided by the size of the object; $p$ and $p'$ are termed the conjugate foci and are variable quantities; $f$ is termed the principle focus, and has an unchangeable value for each single lens.

If now we combine the above equations, representing $p + p'$ or the sum of the conjugate foci by $l$, we may deduce the formula $f=\frac{m\,l}{(m+1)^2}$ which represents in the case of any single convex lens the relationship existing between the length of the principal focus, the magnifying power, and the distance from the object to the screen. This formula, which I think rather more convenient than that of Mr. Cross, differs from it only in using $m =$ the magnifying power, instead of $n =$ the reciprocal of the magnifying power; it may be deduced from his by substituting for $n$ its value $\frac{1}{m}$ and reducing, or it may be derived directly from the primitive equations. In either shape the formula yields the same numerical results, and if for any single convex lens $m$ and $l$ are given, the accuracy of the value of $f$ resulting, will be limited only by the degree of precision with which $m$ and $l$ have been measured.

If now there were any such actual equivalence between achromatic objectives and single lenses as the nomenclature assumes, it would only be necessary to set up the objective to be rated, in such a manner that the image of a micrometer should be focussed upon a white screen, using of course no eye-piece, to measure the distance from the micrometer to the screen, to determine the magnifying power by measuring the image of the micrometer, and substituting these values of $l$ and $m$ in the working formula to calculate the value of $f$. Unfortunately, however, if with any compound objective we repeat this operation several times, merely varying the distances, we obtain as many different values for $f$ as there are distances used, instead of obtaining but one value for all distances as we do with a single lens.

Mr. Cross (loc. cit. p. 409) has already pointed out this circumstance which results from the fact that the modern achromatic objective has considerable thickness, from its anterior to its posterior surfaces, and that it has properly speaking no true optical center. He gives two examples, in one of which a change of 5·24 inches in distance corresponded to a change of ·0067 inch in calculated focal length; in the other a change of 6·10 inches in distance corresponded to a change of ·0029 inch in calculated focal length, the objectives used in the experiment being uncorrected $\frac{1}{4}$ths, so called. If, however, Mr. Cross had used for this purpose lower powers, or had made greater variations in the distances employed, he would have found much greater discrepancies. For example, by measuring the magnifying power first at 25 and then at 50 inches, and deducing the value of $f$ by the formula of Mr. Cross, I obtained in two cases the following equivalent focal lengths. For a so-called $1\frac{1}{2}$ inch, at 50 inches distance, 1·2187 inches; at 25 inches distance, 1·2468 inches; difference ·0271 inch. For a so-called $\frac{1}{5}$th, at 50 inches distance, ·1982 inch; at 25 inches distance, ·1893 inch; difference ·0089 inch.

Moreover, since the achromatic objectives of different makers are constructed on different series of curves, and the component lenses placed at different distances apart, it will be found that if two achromatic objectives magnify the same at any given distance, they will no longer do so if the distance is materially changed.

Hence I am compelled to agree fully with the observations of Mr. Cross (loc. cit. p. 401), that the nominal focal length assigned to an achromatic objective can only serve in any case as "a general appellation serving to group together objectives of *approximately* the same magnifying power," and must conclude, therefore, that the English and American nomenclature possesses no real claim to strict scientific accuracy, and especially that the comparison made by some with the case of the celestial telescope is not valid.

But besides the inevitable inaccuracy resulting from this source, there are in the case of the higher powers of modern makers two other sources of much more considerable error. The first of these involves the case of all those objectives which are provided with a screw collar to correct for thickness of cover; the second involves the case of objectives with two fronts, one for wet and the other for dry, or those with but one front which can be used wet or dry by merely changing the correction given by the screw collar.

The correction for thickness of cover is made, as is well known, by changing the distance between the front combination of the triplet and the posterior two combinations. As a consequence, the magnifying power of the objective at any given distance, or with any given eye-piece, is least when the objective is corrected for uncovered, and greatest when it is corrected for the thickest cover through which it will work. The ratio of this change is very different in different objectives. I select a few from my note book in illustration, purposely omitting to name the makers.

| | Magnifying power at uncovered. | Magnifying power at covered. |
|---|---|---|
| No. 1, - - - | 200 - - - | 225 |
| No. 2, - - - | 250 - - - | 275 |
| No. 3, - - - | 300 - - - | 333 |
| No. 4, - - - | 350 - - - | 500 |
| No. 5, - - - | 570 - - - | 630 |
| No. 6, - - - | 900 - - - | 1100 |
| No. 7, - - - | 975 - - - | 1180 |
| No. 8, - - - | 890 - - - | 1250 |

These values were obtained by throwing the image of a micrometer on a card board screen, using the objective without an eye-piece, and the distance from micrometer to screen in each case remained the same, the screw collar and the focal adjustment of the objective being modified. Of course, for all intermediate positions of the screw collar intermediate values result. The distance used was 48 inches in some of the cases, 50 in the others. With shorter distances, the amount of the difference is diminished, but its ratio to the magnifying power at uncovered is not materially changed, as any one can convince himself by comparing a stage micrometer, as seen by any corrected objective, with an eye-piece micrometer, first at uncovered and then with the full correction for cover.

Now it is evident that even if, by the formula of Mr. Cross, or otherwise, we could obtain accurate equivalent focal lengths for any one position of the cover correction, the result would not be true for any other position of the cover correction.

We are told by a recent writer that the practice of the opticians is to name the combination at its performance uncovered, that is, at precisely the adjustment least used. If, however, scientific accuracy in the matter is desirable for any purpose whatever, it is evident from the above that at least the maximum and minimum should be furnished by the maker.

It is also evident that the considerations here offered, aside from their bearing on the nomenclature of objectives, have a high practical value to all those who attempt to make micrometric measurements with modern high power objectives; for the practice recommended in the text-books, and too generally pursued, is to give values to an eye-piece micrometer by comparing it with a stage micrometer at a fixed position of the draw tube, and to use these values in subsequent measurements.

Now as these values vary considerably with the cover correction, it is to be feared that the majority of the measurements, made with high powers during the last twenty years are sadly inaccurate.

The difficulties in the way of a nomenclature based upon equivalent focal lengths have been still further increased since the introduction of immersion objectives. The compound objective is usually furnished with two fronts, one for wet and one for dry use. Of these the wet usually gives the greatest magnifying power at any given distance. I have also measured an objective which, when corrected for the thickest cover through which it will work dry, is just corrected for uncovered wet, and by approximating the posterior pair of combinations still nearer to the anterior, corrects for cover wet, thus increasing the magnifying power when the objective is in use wet precisely as if two fronts were used.

The difference in magnifying power resulting from the modifications given to make the objective perform wet is quite considerable, as may be seen by the following extracts from my note book.

| | Magnifying power. Dry. | | Wet. | |
|---|---|---|---|---|
| | Uncovered. | Covered. | Uncovered. | Covered. |
| No. 1, | 225 | 250 | 250 | 275 |
| No. 2, | 425 | 490 | 450 | 500 |
| No. 3, | 700 | 900 | 900 | 1000 |
| No. 4, | 770 | 910 | 900 | 1100 |
| No. 5, | 790 | 930 | 975 | 1180 |

Of these objectives No. 1 had but one front, the correction for wet being made by the cover correction; the others had two separate fronts, one for wet, the other for dry.

Now it is just in connection with these complex objectives, with double fronts or other devices to correct for wet and dry, that the greatest diversity of nomenclature exists. In one quarter it is claimed that the system should have two names, one based on its magnifying power at uncovered wet, the other on its magnifying power at uncovered dry; in other quarters the practice has been to give the system but a single name derived from the magnifying power at uncovered dry alone. It is evident, however, that neither of these plans has any pretension to scientific accuracy, and that if the makers will not give at least the maximum and minimum for both dry and wet, the purchaser must learn to measure for himself.

A similar remark applies to the angle of aperture as stated by the makers, for each objective sold. As a rule they give the greatest angle attainable by the combination, which is generally,—not always,—the angle at the correction for thickest cover, their usual practice in this case being the reverse of their usual practice with regard to magnifying power. Now I have seen objectives with an angle of 170° and upward at full cover correction, which did not exceed 140° at uncovered. It is evident, therefore, that the maker should furnish with each glass both the maximum and minimum angle, or the microscopist must measure for himself.

After a full consideration of all the circumstances, I am disposed to think that the best interests of both makers and purchasers would be consulted if the present nomenclature were abandoned altogether, and objectives named instead by their precise magnifying power without eye-piece at some selected distance. It would be well if all the makers could be brought to agree on some fixed distance; but until we obtain this happy uniformity, which perhaps is not to be anticipated, it is only necessary for each maker to state the distance he selects. By this plan objectives without correction for cover would be named by one number, objectives with correction by two, and those with two or more fronts or backs by two or more pairs of numbers.

Thus we should have objectives without cover corrections named precisely 2, 3, 4, 5, 6, 7, 8, 9, and so on up to 100 or more, the number indicating the exact magnifying power, say at twelve and a half inches from micrometer to screen. Objectives with cover corrections would be named 30 to 40, 35 to 46, 75 to 89, 125 to 140, &c., the numbers representing the minimum and maximum magnifying powers at the selected distance. Objectives with wet and dry fronts would require a separate name for each; thus 78 to 95 dry, 98 to 130 wet, &c.

By this plan the real magnifying power of the glass and its limits of variation would be accurately stated, whereas at present even those makers who are most careful about their nomenclature do not hesitate to call a glass an $\frac{1}{8}$th provided its power at uncovered approximates that of a single lens of $\frac{1}{8}$th of an inch focus more nearly than it does a $\frac{1}{6}$th or a $\frac{1}{10}$ th. Hence glasses which differ materially in magnifying power at uncovered, receive the same name, and the changes in power produced by the cover correction, are invariably ignored.

If the plan I here recommend be adopted, the precise distance from micrometer to screen which may be chosen does not appear to me to be of very great importance. Many persons would I suppose prefer 10 inches to 12½. I have selected the latter number because many of our larger stands have tubes too long to permit the convenient measurement of low powers with eyepiece and stage micrometers, in the manner I shall presently describe, if the distance be taken at 10 inches, whereas on most stands, with the help of the draw tube, 12½ inches can be used conveniently with all powers from the three inch upward. I do not, however, insist on any particular distance, but only that the distance selected shall be stated in each case until some uniform plan shall be generally agreed upon.

In this connection I may add that the actual plan of the Continental opticians is also unsatisfactory. In the matter of angle of aperture, when they give it at all, they also, as a rule, give only the maximum. In the matter of magnifying power, when they give any information, they attempt, as a rule, to give the magnifying power of the objective with each eye-piece as actually looked through when in use. But as the magnifying power of the combination under these circumstances involves the distance of distinct vision for each observer, it is evident that the figures thus furnished cannot have any practical value.

Pending the adoption of some such system as I have suggested above, it will be necessary for the microscopist to measure for himself the magnifying power of the objectives he uses, whenever he desires to be possessed of the real information concealed behind all the several systems of nomenclature at present in use. Mr. Cross in his paper gives two modes of doing this. I myself have been in the habit of using a dark room, and throwing the image of the micrometer on a white screen, by the direct rays of the sun. Very nearly equal accuracy may be attained, however, by any microscopist who possesses an ordinary glass eye-piece micrometer and a stage micrometer. The glass eye-piece micrometer, it will be recollected, is slipped through the eye-piece in such a manner as to be just in the focus of its eye-glass, that is, in the plane which is occupied by the image formed by the objective when it is seen most distinctly. If now the field glass of such an eye-piece be removed, and the stage micrometer carefully brought into focus, a comparison of the divisions of the eye-piece and stage micrometers will give the magnifying power of the objective alone at the distance actually existing between the two micrometers. Thus, for example, if the stage micrometer is in $\frac{1}{1000}$ths and the eye-piece micrometer in $\frac{1}{200}$ths of an inch, five times the number of eye-piece divisions corresponding to one division of the stage micrometer will be the magnifying power of the objective at the cover correction employed, for the distance selected. We may then apply the following simple rule, derived from the formula of Mr. Cross.

Multiply the distance between the two micrometers in inches and decimals, by the magnifying power, and divide by the square of the magnifying power plus one; the result will be the equivalent focal length (for the given conditions) in decimals of an inch.

It will, moreover, be found in practice that for powers equivalent to those of a $\frac{1}{4}$th or shorter focal lengths a still simpler rule may be adopted, and that the distance between the two micrometers, divided by the magnifying power, will give very nearly the same results as are obtained by the more complex rule, but this of course is not true for lower powers.

It must, however, be constantly borne in mind that the results obtained in any case are true only for the cover correction and distance used.

For the convenience of those who may undertake such comparisons, I append a table in which the real magnifying powers of single convex lenses are given for three different distances. In the treatises on optics the magnifying powers of single lenses are sometimes stated at some given distance from the lens to the screen, but I know of no table which shows their powers at given distances between image and object.

This table is calculated by substituting the numerical values of $f$ and $l$ in the equation $f=\frac{ml}{(m+1)^2}$, when $m=$ the magnifying power remains as the only unknown quantity and is easily computed. I have carried out the values of $m$ to two decimal places only; but in practice the nearest whole number will be found sufficiently accurate.

*Table of the magnifying powers of single convex lenses.*

| Focal length for parallel rays. | Magnifying power at $12\frac{1}{2}$, 25, and 50 inches distance from micrometer to screen. | | |
|---|---|---|---|
| | 12 1-2 inches. | 25 inches. | 50 inches. |
| 3 inches, | 1·50 | 6·17 | 14·59 |
| 2 " | 4·00 | 10·40 | 22·95 |
| $1\frac{1}{2}$ " | 6·17 | 14·59 | 31·30 |
| 1 inch, | 10·40 | 22·95 | 47·99 |
| $\frac{2}{3}$rds of an inch, | 16·69 | 35·47 | 72·98 |
| $\frac{4}{10}$ths " | 29·21 | 60·48 | 122·99 |
| $\frac{1}{4}$th " | 47·99 | 97·98 | 197·99 |
| $\frac{1}{5}$th " | 60·48 | 122·99 | 247·99 |
| $\frac{1}{6}$th " | 72·98 | 147·99 | 297·99 |
| $\frac{1}{8}$th " | 97·98 | 197·99 | 397·99 |
| $\frac{1}{10}$th " | 122·99 | 247·99 | 497·99 |
| $\frac{1}{12}$th " | 147·99 | 297·99 | 597·99 |
| $\frac{1}{15}$th " | 185·49 | 372·99 | 747·99 |
| $\frac{1}{16}$th " | 197·99 | 397·99 | 797·99 |
| $\frac{1}{18}$th " | 222·99 | 447·99 | 897·99 |
| $\frac{1}{20}$th " | 247·99 | 497·99 | 997·99 |
| $\frac{1}{25}$th " | 310·49 | 622·99 | 1247·99 |
| $\frac{1}{50}$th " | 622·99 | 1247·99 | 2497·99 |

*Note.*—Since writing the foregoing article, I have read with pleasure a paper on the same subject by Dr. R. H. Ward

("Remarks on uniformity of nomenclature in regard to microscopical objectives and oculars," American Naturalist, March, 1872, p. 136). This paper contains much valuable matter, and should be read by all who are interested in this subject. I learn from it for the first time that the method of determining the magnifying power of objectives by removing the field glass of the eye-piece and using eye-piece and stage micrometer as described above, has already been used by Dr. J. J. Higgins of New York (American Naturalist, Dec., 1870, p. 628), to whom I hasten to give the credit due.

I am very glad to find Dr. Ward indicates the feasibility of the substitution of magnifying powers at a fixed distance as names for objectives instead of alleged equivalent focal lengths. I must, however, differ from him when he recommends that the distance should be measured from some part of the objective to the screen, instead of from the micrometer to the screen; for however desirable this may be made to appear, it is not feasible. Nor can I agree with him in regarding ten inches distance as having anything special to recommend it. To the question he asks at the conclusion of his paper, "at what point of the screw collar adjustment shall the objective be placed for rating its angular aperture and amplifying power?" I reply without hesitation that for each purpose accuracy demands that the maximum should be given as well as the minimum; that the maker should state not merely one limit, but both.

Dr. Ward's paper also contains some interesting suggestions on the subject of the nomenclature of eye-pieces, a matter which will, however, I think, particularly in the case of the ordinary eye-piece, require further discussion. I agree fully with Doctor Ward that eye-pieces should be named by their magnifying power: but the question at once arises, how shall this be accurately measured? To this subject I may recur at some future time.

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## ART. LIII.—*On a new form of Lantern-Galvanometer;* by

ALFRED M. MAYER, Ph.D., Professor of Physics in the Stevens Institute of Technology, Hoboken, N. J.

ON the 21st of December, 1871, I delivered a lecture on Magnetism before the American Institute, at the Academy of Music, in the city of New York. It was necessary for the experimental discussion I then made of the earth's magnetism to use a galvanometer, so constructed that the least deflection of its needle would be visible to a very large audience; at the same time the astatic condition of this needle had to be so controlled that it could readily be altered during the progress of the lecture; while finally, the arrangement of the damping magnets had to be such as allowed me instantly to bring the needle into the magnetic meridian when disturbed therefrom, whenever I set in action the huge electro-magnet used on that occasion. Indeed, one of the principal uses to which this galvanometer was applied, in the lecture, was the exploration of the magnetic condition of the space surrounding this electro-magnet. This I accomplished by rotating, around the line of "the dip," as an axis, wire coils at various distances and positions, and leading the induced magneto-electric currents through the galvanometer.

The lantern-galvanometer, which I will now proceed to describe, I devised on the 13th of last November, and as subsequent work with it has convinced me of its value in the lecture-room, I have decided to give it this formal publication.

Referring to the figure; M is a plane mirror inclined 45° to the vertical. In front of this are the back condensing lenses of an oxyhydrogen lantern; while the front lens of the condenser is placed in a horizontal position at *c*, *above* the mirror. The back condensing lenses are of such curvatures that when the calcium light is placed about two inches from the one nearest it, a nearly parallel beam issues from them to fall upon M, thence to be reflected to the upper condensing lens at *c*,* on which rests a disc of glass on whose border is photographed a divided circle. In the center of this disc is a short needle point on which freely rotates a magnetic needle. Above the needle is the projecting lens L, the pencils from which are reflected in any desired direction by means of the plane mirror R, which revolves on a horizontal axis and has also a motion in azimuth around the axis of the lens.†

The horizontal condensing lens is five inches in diameter, and the magnetic needle is four inches long. With this arrangement I have obtained sharp and bright images of the graduated circle 16 feet in diameter.

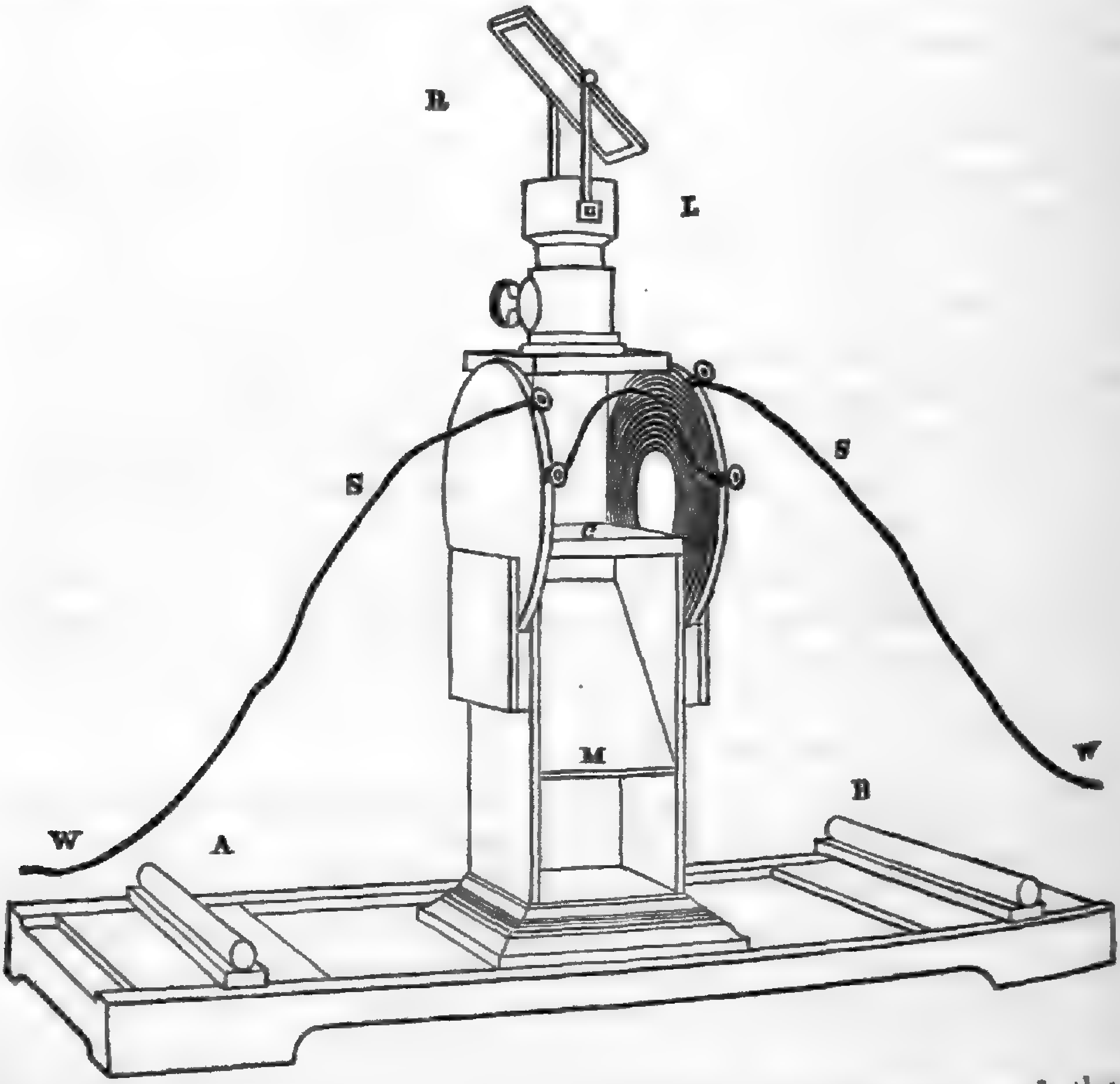
* This arrangement of lenses, which is due to President Morton, gives a bright and uniformly illuminated field free from coloration.

In the *Quarterly Journal of Science*, Oct. 1871, is a report of Prof. Morton's account of this invention ["the vertical lantern"], delivered before the American Institute, as follows: "The original idea and general plan of the instrument shown, was, as the speaker stated, due to Professor J. P. Cooke, of Cambridge; his own work in connection with it being confined to the devising of a convenient mechanical arrangement of parts, the improvement of the combination of condensing lenses with the reflecting lenses [mirror?] so as to secure a white and evenly illuminated field on the screen, and the discovery that an ordinary silvered mirror would serve for the final reflection as efficiently as a metal speculum or glass silvered by Foucault's plan, which are so difficult to obtain and keep in order."

† In a college course of lectures it is sometimes convenient to reflect the image of circle and needle down on a white covered table below the class. The galvanometer can then be placed on the lecture table.

To deflect this needle by means of an electric current I place as close to the condensing lens as possible the two vertical wire spirals S, S, formed of $\frac{1}{10}$ inch copper wire of *square* section, so as to bring the convolutions as close together as possible. The turns of the spirals are separated with very thin vulcanite ribbon, coated with paraffine, and are wrapped on the faces of vulcanite discs. The spirals have an internal diameter of four inches and an external diameter of ten inches, and each contains 49 feet of wire in 26 turns. The four terminals of the spirals are connecting screws, two of which serve to connect the spirals so that a current will circulate in the same direction in both. The spirals are so placed that a line joining their centers will pass through the center of the magnetic needle.

The vertical-lantern rests on a base three feet and a half long, with guides on its sides, between which slide boards carrying two bar-magnets, A and B, 15 inches long and one inch in diameter, as shown in the figure. These magnets can-




not only approach to and recede from the lantern, and thus alter their distances from the galvanometer-needle, but they can also rotate around their centers on vertical axes. The like poles of the magnets and of the needle point in the same direction; and by sliding the magnets to or from the lantern-needle we render the latter more or less astatic. Also, in case the needle should not hold to the meridian as you approach the magnets, it can be made to do so by rotating one or both of them in the horizontal plane; and thus, also, can be neutralized any exterior disturbance which may tend to deflect the needle from the magnetic meridian.

The needle may be also rendered astatic, in the usual way, by suspending it by a silk fiber and attaching to this needle a wire which passes through a hole in the condenser and in the inclined mirror and carries beneath the latter another needle with poles reversed.

In working with thermal currents we use a smaller needle and condenser which allows the spirals to approach nearer; but for thermal currents it is better to wind close around the needle a flat coil of only one wire in breadth, and to use a suspended astatic system of which the *lower* needle is the stronger and is under the control of the damping magnets.* The breadth of the coil used in this last device need not exceed $\frac{1}{20}$th of an inch, and its image on the screen can answer for a rough zero point.

I will now give a few experiments in which this galvanometer has been used; and they will serve to show its usefulness.

*Experiment* 1. A coil of $2\frac{1}{2}$ feet in diameter, containing 40 turns of 300 feet of $\frac{1}{16}$th inch wire, was placed, with its plane, at right angles to "the dip." Its terminals were connected with the galvanometer whose needle was rendered astatic by means of the the damping magnets. I now quickly rotated the coil 180° around an axis at right angles to the direction of dipping-needle. The galvanometer needle was deflected about 12° by the magneto-electric current induced by the earth's magnetism.

*Exp.* 2. I placed the coil, used in Exp. 1, on a wooden wheel provided with a commutator and rotated it around an axis at right angles to the dip. The galvanometer-needle went steadily up to a deflection of 85° and was held there as long as the coil revolved.

*Exp.* 3. The two cores of the large electro-magnet of the Stevens Institute of Technology were placed end to end, thus forming one iron bar, seven feet long and six inches in diameter. This was surrounded by its eight bobbins containing in all 2000 feet of $\frac{1}{8}$ inch copper wire; and through them was sent the electricity developed by the most advantageous combination of 60 plates of zinc and carbon, 10×8 inches.

* The upper needle of this astatic combination swings in the interior of the coil which incloses both the needle and the condenser *c*; the lower needle swings under the inclined mirror M, and is attached to the upper needle by means of a stiff wire which passes through holes in the condenser and to the inclined mirror. In another combination I have placed this lower needle *above* the coil, and have "damped" it by means of a magnet placed above the reflector R.

A coil of 20 inches in diameter formed of one turn of $\frac{1}{20}$ inch wire was rotated 180° around a vertical axis $3\frac{1}{2}$ feet from the end of the magnet. The needle was deflected 3°.

*Exp.* 4. A coil of 20 inches in diameter having 5 turns of $\frac{1}{20}$ inch wire was rotated 180° around a vertical axis, at a distance of $3\frac{1}{2}$ feet from end of magnet. Deflection of needle was 30°.

*Exp.* 5. Same as Exp. 4, only coil had 10 turns of wire instead of 5. Galvanometer needle deflected 50° to 60°.

*Exp.* 6. A coil of 20 inches in diameter formed of 10 turns, $\frac{1}{20}$ inch wire was revolved 180° around a vertical axis $6\frac{1}{2}$ feet from end of magnet. Deflection of 22°.

*Exp.* 7. The coil used in Exp. 6, was placed three feet eight inches above center of axis of the magnet and revolved 180° around a vertical axis; the needle was deflected 80°.

*Exp.* 8. A coil of $2\frac{1}{2}$ feet in diameter, formed of 40 turns of 300 feet of $\frac{1}{16}$ inch wire, was placed 28 feet distant from the center of the magnet, and with its plane coinciding with the plane of the magnet's equator. On rotating it around a vertical axis the needle was deflected 20°.

The following experiments will show the excellent proportions (arrived at by a long series of experiments) of the coil used in Exps. 1, 2 and 8, for the evolution and study of the electric currents induced by the earth's magnetism.

*Exp.* 9. The coil used in Exps. 1, 2 and 8 was laid on a table and its terminals connected with a galvanometer, which is used in connection with Nobili's thermo-electric pile. The needles of this instrument made one oscillation in nine seconds. I lifted the east side of the coil only six inches; the needle was deflected 10°. Lifting the same side nine inches, the needles went to 22°. I now placed the coil in a north and south vertical plane and suddenly tilting its top six inches to the east or to the west the needles went to 60°. Tilting the coil nine inches sent the needles with a blow against the stop at 90°.

The advantages of the new galvanometer may be summed up in a few words. It gives on the screen a bright clear image of only the graduated circle and of the needle. It can readily be rendered more or less astatic to adapt it to the character of the electric currents worked with. The direction of its needle is completely under the control of the damping magnets; and, finally, it is of simple construction and can be rapidly adjusted to the requirements of any special experiment.

## ART. LIV.—*Descriptions of some new species of Primordial Fossils;* by S. W. FORD.

### *Hyolithes impar*, n. sp.

THE shells of this species are plump, elongate bodies, tapering to an acute point. The largest specimen obtained would, if perfect, be one and three-fourths inches in length. The usual length, however, is about one and one-fourth inches. The section is generally broadly and regularly oval, but in some specimens is rather more flattened on the ventral side than in the diagram of the one below given. Some specimens show a tendency to become keeled along the dorsum, but this feature is rare and not well defined in any case. In an imperfect specimen 1·14 inches in length, the rate of tapering on the ventral side is ·10 of an inch in a distance of ·60 of an inch. The width of the tube at the aperture is ·32, and the depth ·26 of an inch. In this specimen the lower lip projects beyond the limit of the dorsum ·14 of an inch. The surface is ornamented with fine engirdling lines, which upon the ventral side curve gently forward, thence more sharply backward upon the sides until they reach a point at about the middle of the depth, where they are again deflected, and flow across the dorsum in uninterrupted, slightly forward-bending curves. There are also prominent sub-imbricating lines of growth, which give to some of the specimens an exceedingly rugose aspect.

The operculum is of an oval form, irregularly convex externally, and for the most part concave within. The nucleus is situated at the center, and in perfect specimens is vertical and acute. On either side of the nucleus, in the line of the longer diameter, there exists a conspicuous groove, which gradually widens in passing from the center out to the edge. With the exception of the nucleus, which barely separates them, these grooves divide the operculum externally into two equal parts. These are respectively the dorsal and ventral limbs. The ventral limb is smooth on the outside, or broken only by concentric lines. Its convexity is greatest at the nucleus. The dorsal limb has nearly, sometimes quite, the same degree of convexity, but may be

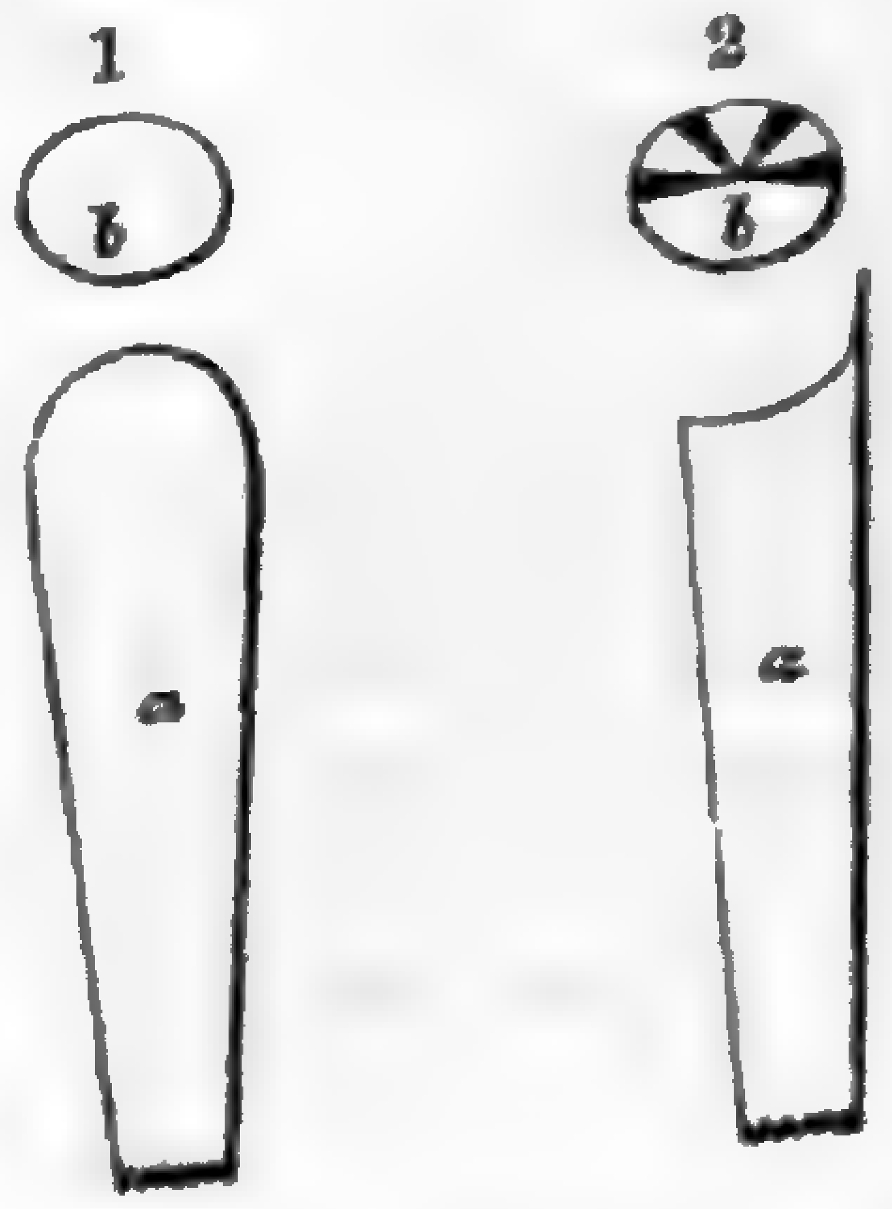



Fig. 1 *a*, outline of a shell of *H. impar*, seen from the most flattened or ventral side; 1 *b* transverse section. 2 *a*, side view to show the form of the aperture and the extension of the lip. 2 *b*, is the interior of an operculum, natural size.

readily distinguished from the ventral by the presence of two obscure ridges radiating from the nucleus to the margin, and enclosing a triangular space along the central portion of the limb. The two limbs are so situated relatively to each other as to give to the base of the operculum a curvature equal to that indicated by the form of the aperture of the shell. In the interior of the operculum there is a little pit directly beneath the nucleus. From this point radiate two strong wedge-shaped ridges corresponding to the exterior grooves. There are also two ridges of similar form running from the same point to the margin of the dorsal limb, lying beneath, and included within, the limits of the triangular space seen on the outside of that limb. All of these ridges are widest at their junction with the margin. They severally terminate in the central pit, and divide the interior into four unequal parts.

The surface of the operculum is covered with fine concentric striæ, from 8 to 10 in the space of ·06 of an inch. Along with these there sometimes occur coarser lines of growth. The interior is both radiately and concentrically striated. The concentric lines are mostly coarser, fewer in number, and far less regularly disposed than those on the outside. The radiating lines are very numerous, and with the concentric lines give to the interior a singularly reticulated appearance under the magnifier. They are barely visible to the naked eye.

This is a well marked species, and offers but little variation of form. It is closely related to *Hyolithes communis* Billings,* but is nevertheless quite distinct therefrom. In *H. communis*, according to Mr. Billings, the shell is sometimes longitudinally striated, which is not the case, so far as observed, in the shells of this species. The opercula are also different. In the operculum of *H. communis* there are but two ridges in the interior. These correspond to the longitudinal ridges of our species as shown in figure 2 *b*. There is also a slight variation in the rate of tapering of the two species. They are, therefore, entirely different. A species of about the same size and form occurs in the Potsdam sandstone of Wisconsin (16th Reg. Rep., p. 135, pl. 6, figs. 30 and 31).

This species occurs abundantly in one of the thin deposits of even-bedded limestone, and one of the bands of limestone conglomerate included among the primordial slates east of Troy, N. Y., commonly associated with *Hyolithes Americanus*, *Obolella desquamata*, *Olenellus asaphoides* and *Conocephalites trilineatus*. The true character of its operculum was first detected by Mr. Billings.

The specimens were collected by the writer.

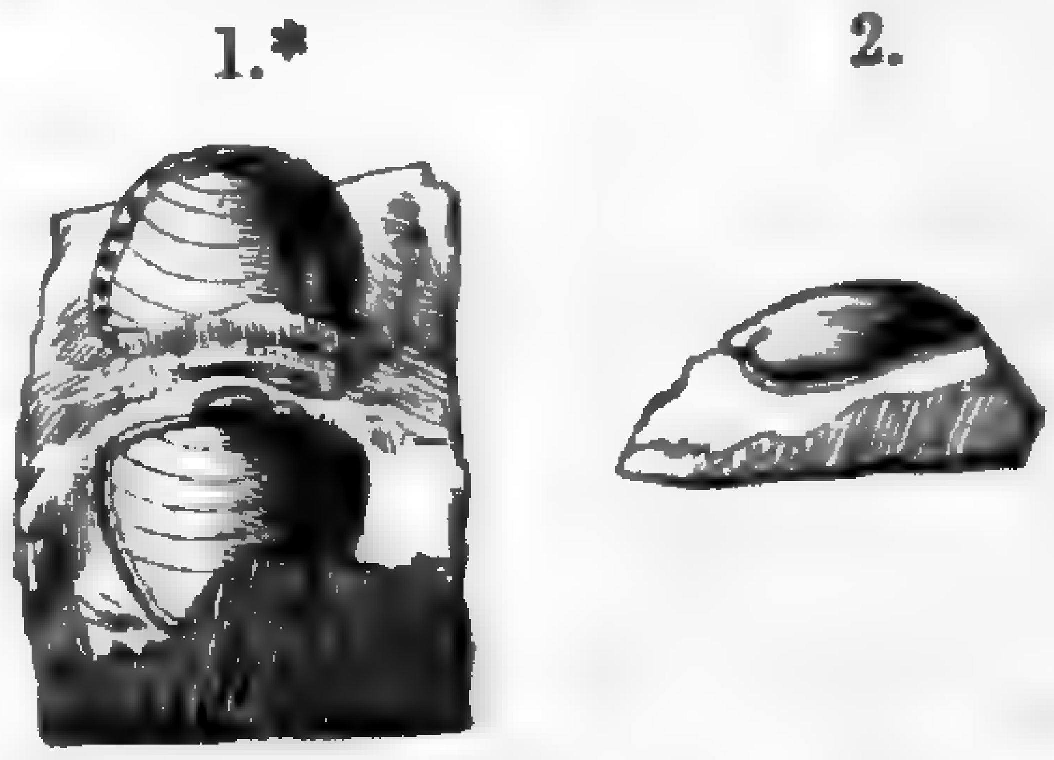
* Canadian Naturalist, vol. vi, p. 214, December, 1871.

*Agnostus nobilis*, n. sp.

Head and pygidium of nearly the same size and form, both exceedingly convex. The head is broadly semi-elliptical, wider than long, the length to the breadth about as 5 to 6. Convexity greatest along the median line, reaching its maximum on a straight line joining the posterior angles. From thence the slope is nearly equal to the front and sides. The sides, anterior margin, and part of the posterior margin, abruptly concave, rounded, and slightly incurved. Posterior angles rounded. The posterior outline is slightly concave for a short distance on either side of the middle, leaving a strong, tapering, median projection. The extremity of this projection is truncate, and appears to form a nearly flat articulating face. The head is surrounded by a narrow convex border directed a little downward, of uniform width, or but slightly attenuated on the posterior outline. On either side of the head this border is set off with a row of prominent tubercles from seven to eight in each row. No tubercles have been observed on the extreme front and posterior portions of the border. The surface of the head, including the border, is transversely crossed by numerous faintly impressed lines, curving backward, for the most part invisible to the naked eye.

The pygidium is of equal length and width with the head. The convexity, however, is a trifle greater along the middle, and the anterior angles rather less rounded than the corresponding angles of the head. The greatest convexity occurs at the anterior third of the pygidium. The anterior outline is slightly concave at the middle, and is then feebly rounded in passing outward and backward to the angles. The contour of the sides and posterior margin the same as that of the sides and anterior margin of the head. A narrow marginal border similar to that of the head, though not tuberculated, surrounds the pygidium, terminating on either side of the concave portion of the anterior outline. The surface is covered with delicate lines similar in character and direction to those of the head.

1.* 2.



The two extremities are connected by a single thick thoracic ring. This ring is partly shown in fig. 1. From the appearance of the figure, however, there would seem to be room for

* Fig. 1. A nearly perfect specimen of *Agnostus nobilis*. The posterior limit of the head is not well shown in the figure, but may be made out clearly in the specimen. Fig. 2. Side view of the head of another individual. The tubercles on the border are wanting in this figure owing to their removal on the side of the specimen represented.

a second ring, but this appearance is due to the damaged condition of the head.

Two specimens only of this species have been obtained, one a head with a small portion of the pygidium; the other a nearly perfect individual. The dimensions of the latter are as follows: Length of entire animal ·64 of an inch. Length of head along the median line ·30, width at posterior angles ·36 of an inch. Median length of pygidium ·30, width at anterior angles ·36 of an inch. Width of head and pygidium, at one-third the length of each from their smaller extremities, each ·28 of an inch. Width of thoracic ring ·10 of an inch. This is likewise the width of the concave portion of the pygidium with which it lies in contact. Greatest depth of pygidium ·14 of an inch. Greatest depth of head ·12 of an inch.

The proportions of the other head are slightly different, the length being ·34, the width ·39, and the greatest depth ·14 of an inch. The specimens were found lying close to each other in the same hand fragment of limestone. Occurs in even-bedded limestone east of Troy, N. Y., in the same layer with *Olenellus asaphoides*, *Agnostus lobatus*, *Obolella cœlata*, and *O. desquamata*.

Collected by the writer.

This is a remarkably beautiful species of *Agnostus*, its large size, symmetrical form, extreme convexity, and prominently studded head-rim all rendering it a most interesting and conspicuous object. In a fossil so simple in its structure as this, and in which the apparent differences between the opposite extremities of the body are so slight, it is difficult to determine certainly which is the head, and we do not feel quite sure that the part thus referred is really such. Prof. Hall has described under the name of *Agnostus parilis* a species of the same type from the Potsdam sandstone of Wisconsin (16th Reg. Rep., p. 179, pl. x, figs. 23 and 24), but that species is vastly smaller than this one. It differs also in having a small elongated node upon the pygidium along the middle, a plain instead of tuberculated border around the head, and in having the marginal rim of both the head and pygidium proportionally broader at their smaller ends. It lacks, too, the fine surface lines of our species. The proportional depth of the two species is very likely about the same. No entire specimens of *A. parilis* have been illustrated, the two extremities having been referred to each other, and no doubt rightly, from their similarity of form. The species is stated to occur near the middle of the formation.

Troy, March 30th, 1872.

ART. LV.—*Descriptions of New Species of Fossils from the Cincinnati Group of Ohio;* by F. B. MEEK.*

ANOMALOCYSTITES (ATELEOCYSTITES?) BALANOIDES M.

THE only specimens of this fossil that I have seen are in a bad state of preservation, being distorted by pressure, and consisting only of the lower portions of the body, and some of the extremely thin segments of the thickened part of the column connecting with the base of the same. One side of the body was evidently flat, or a little concave, and the other convex; and the entire outline, as seen on either of these sides, was probably oblong-suboval; while the lateral margins are distinctly carinated, at least toward the lower part.

Although this species is evidently closely allied to the genera *Anomalocystites* and *Ateleocystites*, I am not positively sure that it would be found to fall strictly into either, if we had the means of comparing its entire structure. It certainly differs conspicuously, at least in its specific characters, from the typical and only known forms of both of these groups. In the first place, it is much larger than *Anomalocystites cornutus*, and has the middle two pieces of its lower range on the flat side proportionally longer; that is, longer than the marginal pieces, instead of the reverse. Its base is also more deeply sinuous on this side than in the New York species. On comparing its convex side with that of *A. cornutus*, we observe still more marked differences, the three principal plates of the lower range in our type being all decidedly longer than wide, instead of the reverse, and the middle plate considerably longer than that on each side of it; while the carinate marginal pieces, which are quite distinctly seen in this view of our species, are scarcely visible on this side of the New York species. There are doubtless also equally great differences in the arrangement and structure of the parts farther up, on both sides, if we had the means of making comparisons of this part of the body.

In size, our species corresponds more nearly with *A. disparilis* from the N. Y. Oriskany sandstone; but from what has already been stated, it will be seen to differ too widely in the form and proportions of its lower range of plates to render a comparison necessary.

Compared with *Ateleocystites Huxleyi* of Billings, the type and only known species of that genus, our species will be found not only to differ in its much greater size, but also in having its base greatly more widely and deeply sinuous on the flat side, for the reception of the column; while its central two

* These fossils are to be fully illustrated in the final report of the Ohio Geological Survey.

pieces taper more rapidly upward, and are longer in proportion to the lateral ones. Its lateral pieces, on the contrary, taper more decidedly downward, and differ in having their lower ends curved inward. The convex side of *A. Huxleyi* and the upper parts of our type being unknown, we have no means of carrying the comparison further; but enough can be seen to show beyond doubt that the two forms are at least clearly distinct specifically.

Whether these several forms belong to one, two, or three genera, it must be evident, I think, to any one accustomed to study these old types of the *Echinodermata*, that in a systematic classification of the *Cystoidea* they will have to stand together in a distinct family, *Anomalocystidæ*, occupying a somewhat analogous position among the various types of that group to that of the family including *Eucheirocrinus* (= *Cheirocrinus* Hall, 1860: not of Eichwald, 1856), among the typical *Crinoidea*.

*Locality and position.*—Upper part of the hills at Cincinnati, in the Cincinnati group of the Lower Silurian. The best specimen I have seen belongs to the collection of C. B. Dyer, Esq., of Cincinnati. I am also under obligations to Prof. O. C. Marsh of New Haven, for the use of another more crushed specimen of the same or an allied species. Both of the specimens were discovered, I am informed, by G. W. Harper, Esq., of Cincinnati.

## Dalmanites Carleyi M.

Small; entire outline unknown, but probably subovate; cephalic shield about twice as wide as long, rounded in front, and more or less nearly straight across behind, thus presenting a somewhat semi-circular outline, exclusive of the produced posterior lateral extremities, which are about as long as the glabella, rather broad at their connection with the cheeks, and tapering rapidly to their posterior ends; glabella wide in front, and rapidly narrowing behind, defined by a moderately distinct furrow on each side, and not very prominent at any point; anterior lobe large, transversely subrhombic in outline; lateral lobes small, and separated by furrows that extend inward so as to leave only a very narrow central space; anterior pair each subtrigonal, and about twice the size of those of the middle pair, which are each transversely ovate, while those of the third or posterior pair are smallest; neck furrow moderately well defined, and continued as posterior marginal furrows of the cheeks, and curving backward a little on the posterior lateral spines; occiputal segment comparatively thick in its antero-posterior diameter at the middle, where it is rather elevated, and rounded convex in the posterior outline; palpebral lobes ascending and narrowing rapidly outward to the summit of the eye; cheeks narrow, and sloping abruptly from the eyes to a shallow marginal groove; eyes comparatively large, situated full half their antero-posterior diameter from the posterior margins of the cheeks, and elevated somewhat above the height of the glabella, truncato-subconical in form, the visual surface curving around so as to form about three-fourths of a circle at its base; lenses of comparatively moderate size, showing about seven in a vertical row at the middle, and twelve or fourteen in the longest oblique rows. Surface of anterior lobe of glabella showing small, obscur egranulations; other parts of the cephalic shield nearly smooth, or less distinctly granular.

Thorax unknown. A pygidium found in the same association may be described as follows: subtrigonal, rather depressed, as wide as long, or a little wider, very nearly rounded or almost subangular behind, the posterior extremity being a little curved upward; mesial lobe depressed, but a little more convex than the lateral, and of about the same breadth or slightly narrower at the anterior end, and narrowing to the posterior end, which does not reach the margin, composed of about thirteen distinct segments, and two or three other very small obscure ones behind these; lateral lobes separated from the mesial lobe by moderately distinct furrows, and sloping off gently, with slight convexity of outline, to the lateral and posterior margins, showing each about thirteen segments which are not furrowed, and extend very nearly, but not quite, to the margin, the smaller posterior ones being directed very obliquely backward, surface showing rather fine irregular scattering granulations.

Length of cephalic shield, exclusive of the posterior lateral spines, 0·35 inch; including them, about 0·60 inch; breadth, 0·67 inch; antero-posterior diameter of eyes, 0·12 inch; height of same on outer side, 0·08 inch. Length of an associated but detached pygidium of about the corresponding size, 0·42 inch; breadth of do., about 0·48 inch.

I am not positively sure that the pygidium found associated with the cephalic shield here described belongs to the same species; but as several specimens of each have been found in the same bed, and they correspond well in size and surface characters, there is very little reason to doubt that they belong to the same trilobite.

In size and general appearance this species resembles *D. callicephalus* Hall, from the New York Trenton group; but it differs materially in having the posterior lateral angles of the cephalic shield produced into long spines, instead of merely terminating in broad, rounded, wing-like expansions. It also has the eyes proportionally shorter, and more remote from the posterior margins of the cheeks, as well as much more curved around, than represented in the figures of the New York species.

Again, the surface of its cephalic shield is less strongly granulated. There are likewise equally well marked differences in the pygidium found associated with our species, which shows in each lateral lobe thirteen well defined segments, without sulcation; while in *D. callicephalus* these lobes are described as having each only nine segments, that are marked with strong furrows.

Although fully satisfied that the species here described is distinct from *D. callicephalus,* I was in doubt whether or not it might be the same form for which Prof. Hall had proposed the name *Dalmania breviceps* (=*Dalmanites breviceps*),* and consequently withdrew the description from a paper on some Ohio fossils that I had submitted for publication. I observed some important differences in our specimens from the character given in the description of *D. breviceps;* but fearing that these might possibly be due rather to some accidental condition of the specimens of that species, I preferred to wait until a figure of that form should be published. As that has recently been done, and I find, on comparison with this figure, that our specimens show well marked and constant differences, there is no longer any reason for hesitation in regarding them as belonging to distinct species. The differences distinguishing the two forms are the following: in the first place, the anterior lobe of the glabella of our species has a more nearly rhombic form, being much more narrowly rounded at each end; again, it differs in having three well defined pairs of lateral lobes to the glabella, instead of only two, the anterior of these three pairs being as large as both of the others, and each triangular in form. The neck segment of our species likewise differs in being fully twice as thick as that of *D. breviceps*, while its palpebral lobes have an entirely different form, and its eyes are decidedly more strongly curved and farther removed from the posterior margin of the cheeks.

The specific name of this trilobite is given in honor of S. T. Carley, Esq., formerly of Cincinnati, one of the earliest and most successful collectors and students of the Cincinnati fossils.

*Locality and position.*—Three hundred feet above low-water mark, at Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian. The specimens studied and figured belong to the collection of U. P. James, Esq.

### Proetus Spurlocki M.

General form, exclusive of the spines of the cephalic shield, ovate-subelliptic, with moderate convexity. Cephalic shield

* The name *Dalmania* having been pre-occupied for a genus of insects, it ought not to be retained for these trilobites. I therefore prefer to follow Prof. Barrande and others in using for the group the name *Dalmanites.*

having the form of half of an ellipse divided through its shorter diameter, its posterior margin being straight, and its anterior narrowly rounded; posterior lateral angles produced into long sharp spines, that extend back nearly or quite the entire length of the thorax; glabella a little less than one-third the breadth of the posterior part of the head, separated from the cheeks on each side by a well defined furrow, but without having the neck furrow behind distinctly marked; other characters of the glabella unknown; eyes sublunate, nearly their own length in advance of the posterior margins of the cheeks.

Thorax apparently shorter than the head, showing in the specimen examined only seven segments (one or two being probably concealed by the slipping backward of the cephalic shield); mesial lobe moderately prominent, scarcely equaling the breadth of the lateral lobes anteriorly, and tapering more rapidly backward, with its segments not arching forward. Lateral lobes less convex than the middle one; pleuræ nearly straight and transverse, and furrowed for a little more than half way out, with their outer extremities merely rounded in front, and nearly rectangular behind, without any distinct backward curvature.

Pygidium subsemicircular, scarcely one-half as long as the cephalic shield, and provided with a smooth flattened margin; mesial lobe moderately prominent, narrower than the lateral, tapering posteriorly, where it terminates rather abruptly, without passing quite upon the flattened margin, showing only very obscure traces of five or six segments on its anterior half. Lateral lobes more depressed than the mesial one, and with flattened margins rather more than one-third the breadth at the anterior end of each, and each showing obscure traces of six or seven furrowed segments.

Entire surface smooth.

Length of a specimen apparently very slightly shortened by the slipping of the cephalic shield a little back upon the thorax, 0·33 inch; breadth at the widest part across the posterior part of the head, 0·25 inch; length of head, 0·27 inch; do. of pygidium, 0·11 inch.

Until I saw the published figure of *Proetus parviusculus* Hall, I had thought it possible that this might be the same, although it did not seem to agree in several characters with those mentioned in the previously issued description of that species. On comparing it with the figure of that form, however, it will at once be seen to present well marked differences. In the first place its cephalic shield is decidedly longer in proportion to its breadth, and more narrowly rounded in front; while the posterior lateral spines of its cheeks are nearly or quite twice the proportional length of those in *P. parviusculus*. Its eyes are also placed decidedly farther forward, and its neck segment is much less distinctly defined. When we come to its thorax, we also see equally well marked differences, its pleuræ not being curved backward and falcate as in that species, nor having their furrows extending so far outward. It almost certainly has one or two segments less, though the slight slipping backward of the cephalic shield leaves some little room for doubt on this point. I have, however, also an inferior specimen before me, belonging to the collection of Dr. H. H. Hill of Cincinnati, believed to belong to this species, and this certainly has only eight thoracic segments. Again, the pygidium of our species differs in having distinctly flattened, smooth, and very obscure furrowed segments on the lateral lobes, that do not extend outward upon this border, while on that of *P. parviusculus* the segments are strongly defined, without furrows, and extend very nearly or quite to the border, so as scarcely to leave any flattened margin.

The specific name is given in honor of T. W. Spurlock, Esq., of Cincinnati, who discovered some of the new fossils loaned to the Ohio Survey, and is well known in that city for his long devotion to the study of the natural sciences.

*Locality and position.*—Cincinnati group of the Lower Silurian, at a horizon of about 100 feet below the tops of the hills, at Cincinnati, Ohio. Mr. Dyer's collection.

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## Art. LVI.—*On the Age of the Copper-bearing Rocks of Lake Superior;* by T. B. Brooks and R. Pumpelly.

Some observations made by us in the southwestern part of the Upper Peninsula of Michigan demonstrate a wide difference in age between the Cupriferous series of sandstones, conglomerates and melaphyres on the one hand, and the Lower Silurian sandstone, with which they have generally been considered as nearly identical in age, on the other. Both series have been referred by Foster and Whitney to the Potsdam, by Sir William Logan to the Chazy, while Mr. Bell of the Canadian Corps considers the Cupriferous series to be Triassic, the latter argeeing herein with Jackson and with the view afterwards abandoned by Owen.

The principal facts on the south shore of Lake Superior are as follows: A series of red sandstone and shales, lying everywhere nearly horizontally, borders the Michigan shore between the Saulte St. Mary and Bête Gris Bay on Keweenaw Point. From the former place to west of Grand Island, this sandstone is overlaid on the south by other Silurian rocks, and between

Grand Island and Marquette the whole series sweeps around to the southwest, on its way to form the western, as it had hitherto formed the northern, rim of the great Michigan basin. Where this southwesterly bend begins, the outcrop-line of the sandstone divides, and from Marquette westward we find, with short interruptions, the sandstone beds flanking the northern foot of the Huron mountains, and dipping gently, 5° to 15°, toward the trough of Lake Superior.

In this part of its course, where it may be said to belong to the Lake Superior basin proper, it forms a marginal band along the lake shore, varying in breadth from a few rods to one or two miles. But west of the Huron Islands it widens with the southwesterly curving of the topographical axis of the Huron mountains, and fills with its horizontal strata the broad trough lying between these hills and the range of copper-bearing rocks of Keweenaw Point. In this depression there still remain one or two hills formed by remnants of the younger Trenton limestone. The trough, partly occupied by the waters of Keweenaw Bay, has for its western slope the beds of this Lower Silurian sandstone, which rise, at what seems to be the original angle of deposition, from the waters of the bay to form the broad belt of nearly level sandstone country which makes up the eastern half of Keweenaw Point.

At the western edge of this belt, its nearly horozontal strata abut against the steep face of a wall formed by the upturned edge of beds of the Cupriferous series of melaphyre and conglomerate, which dip away from the sandstone at angles of 40°–60°, according to geographical position. This sharply defined and often nearly vertical plane of contact, having been seen by the earlier geologists at several points along a distance of many miles, and having been found to be often occupied by a thick bed of chloritic fluccan, which was looked upon as the product of faulting motion, was considered as a dislocation.

This idea seemed to gain corroboration in the fact that, on the western side of Keweenaw Point, sandstones bearing considerable resemblance to those of the eastern horizontal beds occur, apparently conformably overlying the Cupriferous series.* Both sandstones came to be considered as identical in age, and as forming the upper member of the group.

There were many circumstances which made it difficult for us to accept this conclusion. One obstacle lay in the enormous amount of dislocation required; for instance, at Portage Lake, where the strata of the Cupriferous series, with an actual thickness of several miles, dip away from the supposed *longitudinal* fault at an angle of about 60°.

* It is not yet known whether these sandstones on the west side of Keweenaw Point are upper members of the Cupriferous series or belong to the Lower Silurian.

Again, there are at least two patches of sandstone lying on the upturned melaphyre beds near Houghton, though it was not easy to prove that they were not brought thither by glacial action. Mr. Alexander Agassiz informs me that he has found in the horizontal sandstones near this so-called "fault," abundant pebbles of the melaphyre and conglomerate of the Cupriferous series.

Sir William Logan hints at a similar doubt as to the proximate equivalence in age of these two series of rocks.* During last autumn, traveling sometimes together and sometimes apart, we made a reconnaissance of the country between Bad river in Wisconsin and the middle branch of the Ontonagon, east of Lake Gogebic † in Michigan. Our route was chiefly confined to the surface of the upper member of the Michigan Azoic, which we have provisionally considered to be the equivalent of the Huronian.

From Penokie Gap, on Bad river, to near Lake Gogebic—a distance of nearly sixty miles—the quartzites and schists of this formation are tilted at high angles and form a belt one-fourth to one-half mile in width, bordered on the south by Laurentian gneiss and schists. On the north, it is everywhere overlaid by the bedded melaphyre (containing interstratified sandstones) of the Cupriferous series. These form ridges and peaks which rise 200 to 300 feet above the surface of the Huronian belt.

These ridges, forming the "South Mineral Range," unite at their western end with the Mineral Range proper, which forms really through its whole length the tongue of land known as Keweenaw Point. Between these two ranges lies the southwestern part of the Silurian trough, which has been mentioned before as extending inland from Keweenaw Bay.

Here, as there, it is filled with the horizontally stratified Silurian sandstone, forming a generally level country. For a distance of nearly thirty miles, between the Montreal river in Town 47 and Lake Gogebic, we found the Cupriferous series apparently conforming in strike and dip with the Huronian schists, and both uniformly dipping to the north at angles of 50°–70°.‡ But in approaching Lake Gogebic from the west, we find that erosion of Silurian or pre-Silurian age has made a deep indentation entirely across the Cupriferous series and the Huronian, and into the Laurentian, so that at a short distance

* Geol. of Canada, page 85. And again in Geol. Survey of Canada, Rep. of Progr. 1866–69, pp. 472–475. In the last mentioned place, he protests strongly against the idea that the copper-bearing rocks of Lake Superior are Triassic.

† Wrongly written Agogebic on many maps.

‡ We observed several dips in the Huronian of 25°–40°, while in the overlying Cupriferous series none lower than 50° were found. While this may point toward non-conformability, the greater dip of the overlying beds would make it probable that the lower dips were of a local character and due to minor undulations in the Huronian.

west of the lake these rocks end in steep and high declivities, at the base of which lies the level country of the Silurian sandstone, in which is cut the basin of the lake. From this point eastward, this ancient erosion had made great inroads upon the continuity of the Cupriferous and older rocks before the deposition of the Silurian sandstone. The melaphyre ridges are broken into knobs, or are wanting, and no Huronian was found as far as the Ontonagon river, seven miles away, and the limit of our observations.

On this river, in the center of the northwest quarter of Sec. 13, Town 46, Range 41, the Silurian sandstone was found exposed in cliffs 50–60 feet high. The strata are horizontal, or at most have a barely perceptible tendency to a northerly dip. About 150 steps from the base of this cliff, there are outcrops of Laurentian schists whose bedding trends N.E. toward the cliff of horizontal sandstone, and dips 45°–60° S.E. The nearest observed outcrop of the Cupriferous series is in the S.E. corner of Sec. 5, about four miles distant. It is a characteristic amygdaloidal melaphyre, whose bedding planes strike nearly E. and W., and dip 50° to N. In general terms, the conclusions we are drawn to are these:

I. The Cupriferous series was formed before the tilting of the Huronian beds upon which it rests conformably, and consequently before the elevation of the great Azoic area,* whose existence during the Potsdam period pre-determined the Silurian basins of Michigan and Lake Superior.

II. After the elevation of these rocks, and after they had assumed their essential lithological characteristics, came the deposition of the sandstone, and its accompanying shales, as products of the erosion of these older rocks, and containing fossils which show them to belong to the Lower Silurian, though it is still uncertain whether they should be referred to the Potsdam, Calciferous or Chazy. The question would still seem to be an open one, whether the Cupriferous series is not more nearly related in point of time to the Huronian than to the Silurian.

Our observations have detected a lack of conformability between the Laurentian and Huronian at several points on the Upper Peninsula. On the other hand, in the region we have been discussing, which is the only one where the Huronian and Cupriferous are seen in contact, there seems to be a well-marked concordance between these two. There is abundant evidence on the Upper Peninsula that the Silurian sandstone was not deposited until after the Huronian beds had assumed both their present structural position and lithological characteristics, and after they had undergone an enormous amount of erosion.

* Islands of Laurentian gneiss, etc., existed in the Huronian sea over parts of this area.

Some of the most salient topographical features of the Upper Menomonee had been sculptured to the depth of two hundred feet or more before that time, and were afterward buried and wholly obliterated by the Lower Silurian deposits, and have been partially restored by the subsequent erosion to which that valley now owes its features. We now find ridges, consisting of the nearly vertical beds of Huronian quartzite and iron ores, capped with the horizontal sandstone, of which last patches still remain in place on the end and side declivities. Where the sandstone was deposited at the base of these cliffs, we find it consisting largely of a breccia of the debris of quartzite and iron ore, identical in character with these substances in the unbroken ledge. It would probably be perfectly safe to apply the same remark to the Cupriferous series. Its members were formed, as we have seen in the previous pages, before the elevation of the Huronian rocks. The deposition of the Silurian rocks bordering on Lake Superior should seem to have taken place during the progress of a gradual depression, which caused the coast line of that part of the Silurian sea to be represented by the bold cliffs of the interior of the Azoic land. In the eastern declivity of the mineral range of Keweenaw Point, we may see, then, one of these shore cliffs instead of the exposed side of a gigantic fault.

It is probably to this process of deposition of the Silurian sandstone over an area, which after having undergone an enormous amount of erosion was being gradually submerged, that we owe the absence of outcrops of the Cupriferous series beneath the sandstone at so many points on the south shore. It would be difficult indeed to account for their total absence at L'Anse, for instance, by supposing them to have thinned out, when at a distance of 18 miles they have a thickness measured by miles, a thickness they exhibit wherever they are known, at points hundreds of miles apart on the north and south shores.

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ART. LVII.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XXII.—*On Radiata from the Coast of North Carolina;* by A. E. VERRILL.

## POLYPS; ALCYONARIA.

*Leptogorgia Carolinensis*, sp. nov.

Corallum somewhat flabelliform, branching nearly in one plane, but the branches are not normally coalescent. The large branches are irregularly dichotomous, but the smaller ones are irregularly pinnate and sometimes partially bipinnate; the branchlets are alternate and diverge at a wide angle, sometimes nearly at right angles, and are usually from ·25 to ·50 of an inch apart, and generally not more than ·5 to 1 inch long before dividing. The branches are rather stout, terete or subcompressed, usually but little crooked. The branchlets are terete, slender, but not elongated, rather rigid when dry, slightly tapering to the end. The axis is dark, dull wood-brown in the larger branches; translucent amber-yellow in the branchlets; light yellowish wood-color at the base. The polyp-cells are small and usually very little raised, arranged in four to six irregular alternating rows on the sides of the large branches, and in two to four rows on the smaller ones, leaving only a narrow naked median space, along which there is generally a distinct line corresponding to the large longitudinal ducts.

Color of the cœnenchyma bright brick-red. Height 12 inches, breadth about the same; diameter of the larger branches, ·15 to ·20 of an inch; of the branchlets, ·05 to ·07.

The spicula of the cœnenchyma are light red, and consist of minute "double-spindles" of several degrees of stoutness, but mostly rather short, thick, and blunt. The largest and stoutest ones are ·096$^{mm}$ by ·042, ·096 by ·036, ·090 by ·048; they have a very narrow naked median zone, and two close whorls and a terminal cluster of rough warts on each end; many other smaller and shorter ones have but one whorl and a terminal cluster of warts. The most slender ones are small and acute at the ends, with a wide naked zone and with two or three more distinct whorls of few warts on each end; they measure ·132$^{mm}$ by ·030, to ·120 by ·036. There are also many forms of more minute spicula. The polyp-spicula are bright red, slightly spinulose, and vary in size from ·096$^{mm}$ by ·018 to ·072 by ·010.

Near Fort Macon, N. C.,—Lieut. C. S. Smith, U. S. A.; Dr. A. S. Packard; Dr. H. C. Yarrow, U. S. A.

In the largest specimen four main branches of nearly equal size spring directly from the base.

*Leptogorgia setacea* Verrill.

*Gorgonia setacea* Pallas, Elenchus Zoöph., p. 182, 1756 (*non* Dana).
*Pterogorgia simplex* Val., Comptes-rendus, xli, p. 13.
*Xiphigorgia setacea* Edw. and Haime, Coralliaires, vol. i, p. 172, 1857.

Corallum long, slender, flexible, usually undivided, if not always so, of nearly uniform size throughout, slightly flattened, owing to a thickening of the cœnenchyma on the polypiferous margins, the middle of the broad sides being smooth. Cells rather large, oblong, raised on broad, low, rounded verrucæ, which form either a single row or two alternating rows on each margin. Axis black, slender, flexible, terete, of nearly uniform size throughout. Color light yellow and purple, the smooth median bands yellow centrally; the verrucæ deep purple, with a yellow area around the cells.

Length 56 inches; greatest diameter ·08 by ·10 of an inch.

The spicula of the cœnenchyma are bright purple and pale yellow, and consist of comparatively large, mostly rather stout, blunt, closely warted double-spindles, with a smaller number of slender, acute ones and some small, rough, glomerate forms. The larger and stouter spicula have a narrow naked zone, with two or three close whorls of spinulose warts, and a rounded terminal cluster on each end; they measure ·144$^{mm}$ by ·048, ·132 by ·060, ·120 by ·060, ·114 by ·048, ·108 by ·036. The longest slender spicula are thin, tapering regularly to the acute ends, and have a rather wide naked zone, with three and sometimes four whorls of minute warts on each end; the largest are ·144$^{mm}$ by ·036, ·132 by ·048, ·132 by ·036, ·132 by ·042. The polyp-spicula are bright yellow, minute, slightly spinulose, oblong or slender, simple spindles, mostly varying in size from ·114 by ·018 to ·090 by ·009.

Near Fort Macon, N. C.,—Dr. H. C. Yarrow.

This species is of great interest both on account of its singular form, and because it has always been an imperfectly known species, without a definite location, either geographically or systematically. Pallas stated that his specimens were attached to American shells, but with one exception the axis alone remained, and no additional information has been published in regard to its habitat since his time, so far as known to me.

The species described by Prof. Dana, under the same specific name, has a calcareous axis and belongs to *Juncella.*

### ANTHOPODIUM, gen. nov.

Corallum with an encrusting, firm cœnenchyma, from which arise prominent, tubular verrucæ, with rather large polyps at the summit. The surface of the cœnenchyma and verrucæ is minutely granulous with rough irregular spicula, closely united together. The spicula are of many forms and sizes, and are remarkable for their irregularity and roughness; the most prominent kinds are very roughly warted and spinulose oblong forms, and rougher lacerate club-shaped ones, many of which are flattened at the large end. Besides these there are numerous rudely spinulose spindles, and an abundance of the small, short, glomerate kinds.

This genus is allied to *Telesto* on one side and *Callipodium* V. on the other. It resembles the latter somewhat in general appearance and mode of growth, but has very different spicula; to the former it is somewhat allied in the structure of the cœnenchyma and polyp-tubes, and especially in the interlocking of the rough spicula, but the spicula are very different in structure; the walls are thicker and more rigid; and the mode of growth quite different.

*Anthopodium rubens* V., sp. nov.

Corallum encrusting, creeping over the dead axis of *Leptogorgia* and forming a continuous, thin, firm, finely granulous crust, from which the elongated verrucæ arise nearly at right angles, though usually inclined upward. The polyp-cells are large, at the summit of the tubular and nearly cylindrical verrucæ, which are variable in height and are much crowded in some parts and irregularly scattered in others; their surface is finely granulous, with minute rough spicula. Height of the longest verrucæ ·28 of an inch; diameter ·06. Color, uniform light red.

The spicula of the cœnenchyma and verrucæ are light but bright red; the larger ones are irregularly oblong, blunt at the ends, and covered throughout with rough, often lacerate, spinulose warts; some of these were ·288$^{mm}$ by ·084, ·264 by ·072, ·228 by ·096, ·216 by ·084. With these there are many irregular, rudely spinulose, acute spindles of about the same length, but more slender, measuring ·204 by ·048, ·192 by ·060. There are many smaller obtuse, fusiform, oblong and glomerate spicula, of various sizes, covered with rough spinulose warts, like the larger ones. The club-shaped spicula are less numerous, and usually smaller than the largest oblong ones, but are similarly covered with rude spinules. There are also many small oblong spicula, with a smooth naked median zone, and bearing a few small acute spinules on each end, and other similar ones with small distant spinules on all parts; some of these are irregularly branched, either with three, four, five, or more points, but regular crosses are rare. The polyp-spicula are deep red, simple, fusiform, or club-shaped spicula, with a few irregular minute spinules, or with the surface merely uneven; they are about ·156 long and ·036 in diameter.

Fort Macon, N. C.,—Prof. E. S. Morse.

In addition to the preceding the following species of Alcyonaria were collected at Fort Macon by Dr. H. C. Yarrow.

*Renilla reniformis* Cuvier (Ellis sp.).

*Leptogorgia virgulata* Edw. and Haime (Lamk. sp.).

*Titanideum suberosum* V. (Ellis sp.)

*Telesto fruticulosa* Dana.

## Actinaria.

*Calliactis sol* Verrill.

*Cereus sol* (*pars*) Verrill, Bulletin Mus. Comp. Zoöl., i, p. 58, 1864; Memoirs Boston Soc. Nat. Hist., i, p. 24, 1864.

Dr. Yarrow has sent numerous specimens of this species from Fort Macon, and also a colored drawing, showing the appearance while living. The base, as in the other species of the genus, is dilated, with a thin border, often expanding into lobes and radiately lined; just above the base there are two circles of conspicuous pores. The tentacles are numerous, crowded together toward the margin, in length more than half the diameter of the disk (about ·5 of an inch in the figured specimen), moderately slender and scarcely acute. The lobes of the mouth are bright yellow; a broad circle of purple surrounds the mouth; the rest of the disk is light blue with darker radii; the tentacles are bright orange-red; the body is light purplish-red, with dark red blotches and longitudinal streaks, especially near the base. Other varieties of coloration occur.

It lives like the other species of the genus, adhering to dead shells inhabited by hermit-crabs. A variety of this, or an allied species, is abundant on the eel-grass and algæ.

*Paractis rapiformis* Edw. and Haime.

*Actinia rapiformis* Lesueur, Jour. Acad. Nat. Sci. Phila., i, p. 171, 1817; Verrill, Mem. Boston Soc. Nat. Hist., i, p. 35, 1864.

This species, still very imperfectly known, was collected in considerable numbers by Dr. Yarrow, who found them thrown on the beach after south-west storms, resembling, when in that condition, a boiled onion, or something of that sort. According to Dr. Yarrow's notes and drawing, when expanded the body is elongated and very changeable in form, up to three inches or more long and 1·5 in diameter; the surface in expansion is vertically sulcated or fluted, nearly smooth. The body is pinkish flesh-color and translucent when adult, darker and transparent in the young. The tentacles are numerous, rather short, tapering, sub-equal, pale greenish olive, with a pale orange line along their insertion, and a blackish band around the base, connected with a dark line radiating from the mouth. The mouth was frequently everted, but no acontia were observed. Toward the summit the surface of the body is minutely wrinkled and capable of attaching sand to itself; close to the tentacles it is thinner and smooth. This species has once been found on the shore of Long Island Sound, near New Haven Light.

The following species were also collected by Dr. Yarrow:

*Sagartia leucolena* V., Proc. Bost. Soc. Nat. Hist., x, p. 336, 1865.

*Aulactinia capitata* V., (Ag. MSS.) Mem. Bost. Soc., N. H., i, p. 20, 1864.

*Cladactis cavernata* V., (Bosc) Trans. Conn. Acad., i, p. 473.

*Paranthea pallida* V., (Ag. sp.) Proc. Essex Inst., v, p. 322.

*Cerianthus Americanus* V., Mem. Bost. Soc., N. H., i, p. 32.

## Madreporaria.

*Astrangia Danæ* Ag., 1847.

The *Astrangia astræiformis* Edw. and Haime (1848) is a form of this species with the cells crowded together, which occurs in some New England specimens, as well as in southern ones, although less frequently than in the latter. I have hitherto considered the two forms distinct species, but am now in possession of specimens from Vineyard Sound, Mass., which induce me to unite them.

*Oculina arbuscula* V., Mem. Bost. Soc., N. H., i, p. 40.

*O. implicata* V., op. cit., p. 41.

## ACALEPHS.*

*Physalia Arethusa* Til.

*Parypha cristata* Ag. (McCrady sp.) Piles of wharf.

*Hydractinia polyclina* Ag. Common.

*Aglaophenia trifida* Ag. Very common.

*Dynamena cornicina* McCrady.

*Diphasia* sp.

*Sertularia Carolinensis* V., sp. nov.

Stem long and slender, very flexible, giving off numerous slender, falcate branches, one to three inches long, arranged spirally. The branches are mostly simply pinnate, but some of the lower ones are bipinnate, with the branchlets falcate. The hydroid cells are small, unequally alterate, rather closely appressed, with an oblique, slightly bilobed aperture. The capsules are stout elliptical, about four times as long as the hydroid cells, and with the breadth about one third of the length, swollen in the middle, narrowed toward the aperture, which is nearly simple, with the margin slightly uneven. Height about one foot.

## ECHINODERMS.

*Thyone Briareus* Sel. (Lesueur sp.) Abundant.

*Pentamera pulcherrima* Ayres. Four specimens.

*Thyonella gemmata* V., gen. nov. (Pourt. sp.)

*Colochirus gemmatus* Pourtales, Proc. Am. Assoc., 1851, p. 11.

*Thyonidium gemmatum* Selenka, Zeitschrift für Wissenschaftl. Zoöl., xvii, 1867, p. 345, tab. xix, figs. 100, 101.

This species differs so much in structure from the typical species of *Thyonidium* that it should form the type of a distinct genus. It has but ten tentacles, of which the two inferior ones are smaller, while in *Thyonidium* there are twenty tentacles, two small ones alternating with two large ones. The test in the present species is thicker and filled with an usually large amount of calcareous plates. Other differences are to be found in the oral plates, the genital organs, etc.

*Mœra Atropos* Mich., 1855. Common.

The name *Mœra* is preoccupied for a genus of Crustacea (Leach, 1813); the name of the present genus must, therefore, be changed.

*Mellita pentapora* Lütk. Brazil to Vineyard Sound, Mass.

* All the Acalephs and Echinoderms, unless otherwise stated, were collected by Dr. H. C. Yarrow.

*Lytechinus variegatus* A. Ag. (Lamk. sp.) Common.

This species is widely distributed, occurring from Bahia, Brazil and the West Indies to Bermuda and the coast of New Jersey, at Great Egg Harbor.

*Echinocidaris punctulata* Desml. Common.

Gulf of Mexico to Long I. Sound and Vineyard Sound.

*Asterias arenicola* Stimp. Common.

Florida to Massachusetts Bay.

*Astropecten articulatus* Lütk. (Say sp.) Not common.

*Luidia clathrata* Lütk. (Say sp.) Common.

*Ophiura olivacea* Lym. (Ayres sp.) Common.

South Carolina to Vineyard Sound.

*Ophiophragmus Wurdemanni* Lym. Common, Dr. E. Coues.

*Ophiothrix angulata* Ayres. Common in cavities of sponges.

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ART. LVIII.—*On a Meteoric Iron lately found in El Dorado county, California;* by CHARLES UPHAM SHEPARD, Sr., Massachusetts Professor of Natural History in Amherst College.

FOR my knowledge of the meteoric iron of El Dorado Co., I am indebted to Mr. Alfred Stebbins, librarian of the Mercantile Library Association of San Francisco. A letter from him, dated April 26th, inclosed a few grams of turnings obtained during the separation of a slice of the mass destined for the collection of the geological survey now in progress under the direction of Prof. Whitney.

The mass is described by Mr. Stebbins as having the size and shape of a man's head. It was found in a field, and, as usual, was first taken to a blacksmith's shop, where it was soon found to be an unmanageable subject for working, and hence, fortunately, found its way into scientific hands. Its surface possesses the indentations common to these bodies—the crust or coating being partially oxidized. It weighs eighty-five pounds.

I find the turnings to have a specific gravity of 7·80, which may perhaps be a trifle above what the mass possesses, as it is presumable that the turnings have suffered a slight condensation in the process of separation.

The fragments sent are free from all traces of sulphur. A single analysis upon one gram has afforded me,

| | |
|---|---|
| Iron, | 88·02 |
| Nickel, | 8·88 |
| Insoluble, consisting of a mixture of $\overline{\text{F}}\text{e}$ and $\dot{\text{F}}\text{e}$, with minute silvery particles of supposed phosphor-metals (Schreibersite). | 3·50 |
| | 100·40 |

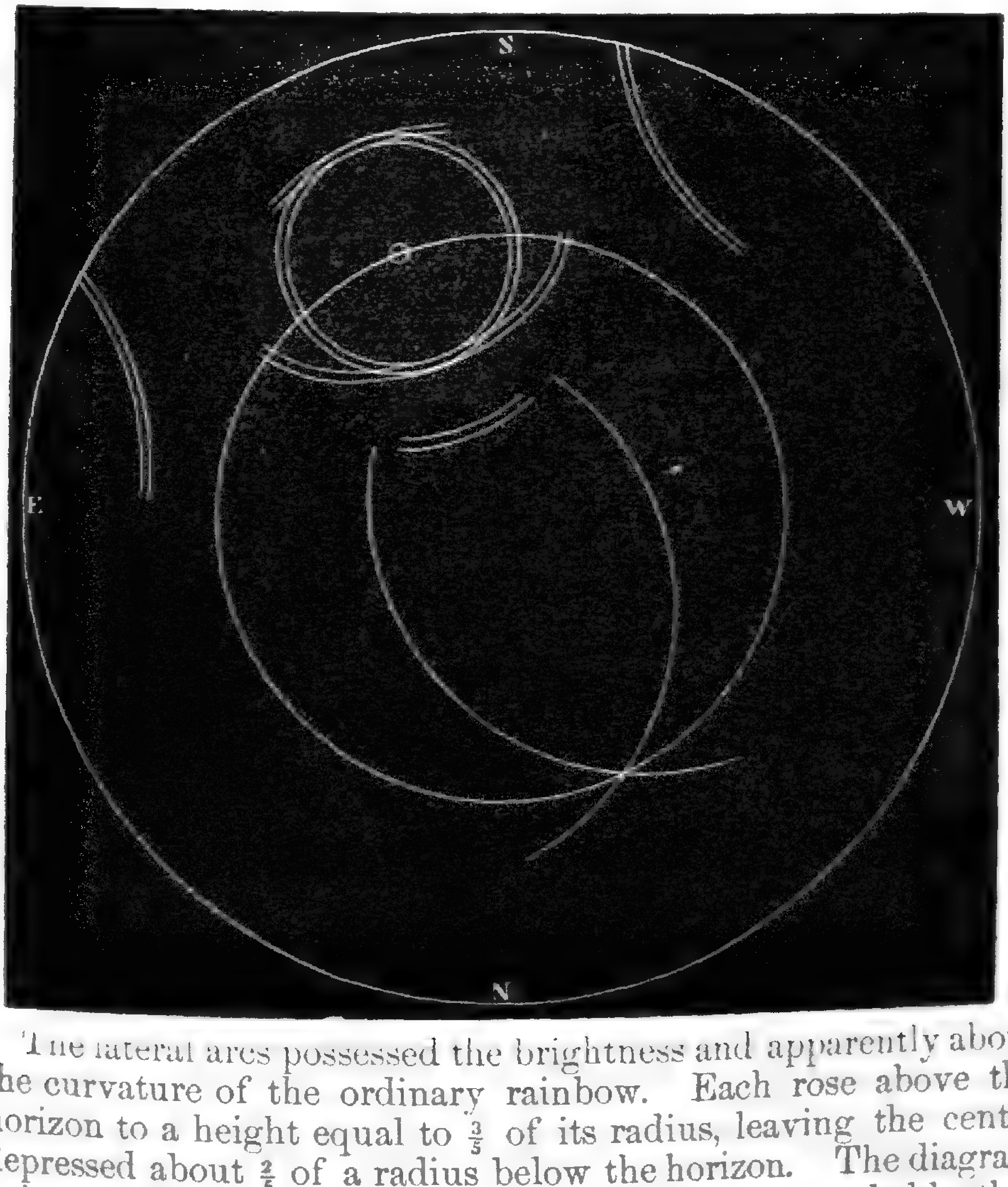
The amount of material at command was too small to search for the other metals commonly found in meteoric irons.

Amherst, May 6, 1872.

ART. LIX.—*On a Solar Halo;* by Prof. WILLIAM WOOLSEY JOHNSON, of Kenyon College, Gambier, Ohio.

THE accompanying diagram represents a combination of solar halos witnessed by myself and others at Gambier on the morning of March 2nd, the sun having an altitude of about 40°.

The double circles represent prismatic halos, the single circles white ones. The halo of 22° and its contact arcs were red on their inner edges. The short arc above and the lateral arcs were blue on the inner edge. The points of contact on the halo of 22° were intensely bright. The upper contact arc was plainly elliptical in form, the lower too short to exhibit decided curvature.




The lateral arcs possessed the brightness and apparently about the curvature of the ordinary rainbow. Each rose above the horizon to a height equal to $\frac{3}{5}$ of its radius, leaving the center depressed about $\frac{2}{5}$ of a radius below the horizon. The diagram being first constructed upon a globe, it appeared probable that the centres were situated upon the great circle of which the sun is the pole, and at distances of 120° from each other and from the culminating point of this circle.

Gambier, O., March 25, 1872.

ART. LX.—*On Molecular and Cosmical Physics;* by W. A. NORTON.

[Continued from page 340.]

4. THE electric envelopes of the two molecules effectively attract each other at all distances greater than *Oa*, or thereabouts. Beyond *Oc*, or within the sphere of the outer repulsion, this effective attraction becomes very feeble, and the repulsion is chiefly heat-repulsion.

It is assumed, throughout the investigation, that the value of $r$ is the same for the receptive as for the active molecule; whereas it is undoubtedly greater; but the only general result, worthy of note, that can follow from any error committed in making this assumption is, that the intensity of the molecular heat-repulsion will be less, as compared with that of the effective attraction exerted by the one envelope upon the other, and hence that the amount of derived heat-pulses required, in coöperation with the natural heat-repulsion, to neutralize this attraction, will be greater.

5. The extraneous heat that is received by the molecules of the body, constitutes a series of repulsive impulses over and above those naturally exerted by the molecules. They have a direct tendency to lower the curve of molecular action at all points—thus increasing *Oa*, diminishing *Oc*, *ac*, and *bm*, and increasing *dn*.

6. The extraneous heat-impulses received have also a certain indirect effect. They urge each molecular envelope farther from the central nucleus, and thus alter the ratio $\frac{n}{m}$; that is, a certain portion of the living force of the heat-pulses is expended in this act, to be afterward given out as the temperature falls. The direct tendency of this recess of the envelope is to diminish the values of both $n$ and $m$, since its distance from both the center of attraction and center of repulsion is increased. But inasmuch, as we have seen (p. 337), that the latter center lies nearest the envelope, the proportional decrease will be greater for $m$ than for $n$, and thus the value of $\frac{n}{m}$ should be augmented, and the curve of molecular action will tend to rise at all points, and expand—*Oa* diminishing, and *Oc* increasing. The curve then tends to fall from the direct action of the heat-pulses, and rise from their indirect action in raising the molecular envelopes; and the actual result should be the difference of these two tendencies. We may accordingly expect that heat may in some instances augment the effective attraction of cohe-

sion between molecules. It in reality has this effect upon iron and india-rubber, at ordinary temperatures, and upon water at temperatures below that of maximum density (39° F.).

7. The distance of a molecular envelope from the atom with which it is associated may be increased by augmented attractive impulses exerted upon it from another molecule, as well as by repulsive heat-impulses taking effect from below. The effect of such recess of the envelope from the atom upon the molecular forces, and upon the curve of effective molecular action will, in general, be the same in either case.

8. The effective attraction which the electric envelopes of two contiguous molecules exercise upon each other, at all distances greater than *Oa*, or thereabouts (p. 339), increases in proportion as the distance becomes less and approximates more nearly to *Oa*. It follows from this that the molecular envelopes should be more expanded, that is, be farther from the atoms which they surround, in the solid and liquid than in the gaseous state of bodies; also more expanded in the interior of bodies than at their surfaces.

9. We have seen (p. 440) that the direct tendency of an expansion of a molecular envelope, from whichever of the two causes assigned it may arise, is to augment the range of effective molecular attraction, and increase the maximum value of the attraction. But an opposite tendency to this is at the same time in operation, which results from an increase in the quantity of luminiferous ether lying below the envelope, by reason of the mere fact of the recess of the envelope from the central atom, and also, when this recess is effected by heat-waves, because of the momentary condensation of the ether that attends the reflection of a portion of the wave-force from the central atom. We cannot decide, in a given case, which of these two tendencies will prevail over the other; but it may be seen that the former tendency is most likely to prevail in the more condensed state of the envelope that occurs in the gaseous condition, and at the surfaces of bodies, and the latter in the more expanded state that occurs within solids and liquids. Upon this idea we will term the corresponding molecular conditions *primary* and *secondary*. We are then to look for the secondary condition in solids and liquids; and for a tendency toward the other as the molecular envelopes contract with falling temperature. We should at the same time observe that the secondary tendency is reinforced by the direct repulsive action exerted by the heat-pulses upon the molecules, while the primary is antagonistic to this repulsive action. It is, therefore, to be expected that the primary molecular condition in which a rise of temperature will be attended with an augmentation of tenacity, and a possible contractile action, will be much less likely to occur than the

opposite condition. Now, as a matter of fact, the tenacity of the great majority of solids and liquids decreases as their temperature rises; which shows that they are in the secondary molecular state. But wrought iron and india-rubber are exceptions among solids, and water below the temperature of 39° F. among liquids. For heat contracts india-rubber and water (below 39° F.); and the tensile strength of bar-iron augments as the temperature rises, until it reaches about 500° F. Beyond this a farther rise of temperature has the opposite effect. From this we may infer that bar iron in cooling, from a high temperature, passes back from the secondary into the primary condition at about 500°. Water does the same at 39°. The temperature at which the change occurs in india-rubber is not known.

10. We have now distinctly recognized the important theoretical principle, that *primitive molecules are subject to a change of physical condition, with varying circumstances; and that this change consists in a recess of the molecular envelope from the central atom, or an approach toward it, and is attended with a change in the intensities of the several molecular forces exerted by the molecule at a given distance, and in that of the effective molecular action at any supposed distance.* This principle furnishes the key to the explanation of a multitude of general and special phenomena, which have hitherto remained inexplicable, on the prevalent notion that the atoms of bodies have certain inherent, unvarying forces—repulsive at one distance and attractive at another, or indeed upon any supposition of vibratory or other modes of atomic motion as sources of special forces.

It is important to observe here, that this change of the physical and mechanical condition of molecules, may, in special cases, be either *transitory* or *permanent;* and that any change effected may either wholly or only partially pass off when the inciting cause has ceased to act. This may be seen on attentively considering the change in the condition and extent of the portion of the ethereal atmosphere of a molecule lying below the envelope, that attends the expansion or contraction of the envelope from either of the causes that have been assigned. It may be seen that the disturbed envelope may return to its original position, or more probably may stop short of it more or less.

11. These principles serve to explain the distinction between perfect and imperfect *elasticity.* It has been conclusively established by the experiments of Hodgkinson, Chevandier and Wertheim, and others, that many, and probably the great majority of solids, when relieved of any strain to which they may have been exposed, do not entirely recover themselves, but have a certain *set;* which, from being very minute when it first

becomes measurable, may be made to increase by exceedingly small amounts, by giving small increments to the force by which the strain is produced. Now it is plainly impossible that any mass of molecules, simple or compound, constituting a solid body, can be made to assume an indefinite series of positions of equilibrium, differing very slightly from each other, unless the effective forces exerted by the molecules at a given distance experience some change; and such changes cannot take place, in the mutual actions of compound molecules, except as the result of minute changes in the mutual actions, at a given distance, of their constituent primitive molecules. The defect of elasticity noted must then be attributable to some change in the physical and mechanical condition of the primitive molecules, induced by the strain. Also, if any solid is perfectly elastic, for the particular degree of strain to which it may be exposed, it must be because its primitive molecules do not undergo any permanent change attended with a diminution in the molecular actions that are opposed to the extraneous force.

In accordance with the general theoretical principles stated above, solid bodies are not perfectly elastic, except for small forces of distortion, and consequent small displacements in the relative positions of the molecules, because their molecular envelopes expand, or contract, with the displacements produced, and the molecular reactions are diminished in consequence. Highly elastic substances (glass, ivory, &c.) should then be such as do not undergo any marked change of molecular condition when considerable displacements are produced. Now it appears, as a result of calculation, that when the molecular ratio $\frac{n}{m}$ (p. 338) has the value 6·9,* the effective attraction exerted by one envelope upon another remains very nearly the same for considerable augmentations or diminutions in the distance between them, about the natural position of equilibrium (the point $a$ in the curve of molecular action, p. 339); also that when the ratio $\frac{n}{m}$ is greater than 6·9, the corresponding effective attraction increases, from any distance less than $Oa$, fig. 4, to a certain distance greater than $Oa$; and that when the same ratio is less than 6·9, the attraction in question increases, from any distance greater than $Oa$, to a certain distance less than $Oa$. Thus the maximum value of this attraction is at the distance $Oa$ when $\frac{n}{m}=6·9$, at a greater distance when $\frac{n}{m}>6·9$, and at a less distance when $\frac{n}{m}<6·9$. This will appear on consulting the following table, giving the results of the calculations.

* The more accurate value is 6·7, in this and the following cases.

*Effective attractions between contiguous molecular envelopes.*

| $n=5·143m$ | | $n=6·5m$ | | $n=6·9m$ | | $n=7m$ | | $n=7·3m$ | | $n=7·576m$ | | $n=8m$ | | $n=12·41m$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $x$ | $f'$ | $x$ | $f'$ | $x$ | $f'$ | $x$ | $f'$ | $x$ | $f'$ | $x$ | $f'$ | $x$ | $f'$ | $x$ | $f'$ |
| $r$ | 0·286 | $r$ | 0·625 | 0·8$r$ | 0·567 | 0·7$r$ | 0·381 | 0·7$r$ | 0·485 | 0·6$r$ | 0·183 | | | | |
| 1·3$r$ | 0·372 | 1·1$r$ | 0·648 | 0·9$r$ | 0·677 | 0·8$r$ | 0·598 | 0·8$r$ | 0·691 | 0·7$r$ | 0·581 | 0·6$r$ | 0·514 | 0·4$r$ | 0·081 |
| 1·5$r$ | 0·379 | 1·2$r$* | 0·649 | $r$ | 0·725 | 0·9$r$ | 0·704 | 0·9$r$ | 0·787 | 0·8$r$ | 0·776 | 0·7$r$ | 0·727 | 0·5$r$ | 1·515 |
| 1·6$r$ | 0·371 | 1·3$r$ | 0·637 | 1·1$r$* | 0·738 | $r$ | 0·750 | 0·95$r$ | 0·811 | 0·9$r$ | 0·874 | 0·8$r$ | 0·906 | 0·55$r$* | 1·860 |
| 1·7$r$ | 0·360 | 1·4$r$ | 0·618 | 1·2$r$ | 0·732 | 1·05$r$* | 0·757 | $r$* | 0·825 | 0·95$r$* | 0·884 | 0·85$r$* | 0·954 | 0·6$r$ | 2·070 |
| 1·8$r$ | 0·347 | 1·5$r$ | 0·596 | 1·3$r$ | 0·712 | 1·1$r$ | 0·761 | 1·1$r$ | 0·829 | $r$ | 0·894 | 0·9$r$ | 0·981 | 0·7$r$ | 2·253 |
| 2$r$* | 0·321 | 1·6$r$ | 0·571 | 1·4$r$ | 0·688 | 1·2$r$ | 0·752 | 1·2$r$ | 0·814 | 1·1$r$ | 0·897 | 1·1$r$ | 0·988 | 0·8$r$ | 2·268 |
| 2·2$r$ | 0·295 | 1·7$r$ | 0·545 | 1·5$r$ | 0·660 | 1·3$r$ | 0·732 | 1·3$r$ | 0·788 | 1·2$r$ | 0·865 | 1·2$r$ | 0·959 | 0·9$r$† | 2·203 |
| 2 5$r$† | 0·252 | 1·8$r$ | 0·520 | 1·6$r$ | 0·631 | 1·4$r$ | 0·705 | 1·4$r$ | 0·757 | 1·3$r$ | 0·832 | 1·3$r$ | 0·919 | $r$ | 2·100 |
| 4$r$ | 0·143 | 2$r$ | 0·472 | 2$r$ | 0·516 | 1·5$r$ | 0·676 | 1·5$r$ | 0·724 | 1·4$r$† | 0·805 | 1·4$r$ | 0·879 | 1·1$r$ | 1·988 |
| 10$r$ | 0·032 | 10$r$ | 0·044 | 10$r$ | 0·047 | 1·6$r$ | 0·645 | 1·6$r$ | 0·690 | 1·5$r$ | 0·768 | 1·5$r$ | 0·836 | 10$r$ | 0·092 |
| 20$r$ | 0·009 | 20$r$ | 0·012 | 20$r$ | 0·013 | 10$r$ | 0·048 | 10$r$ | 0·050 | 10$r$ | 0·052 | 10$r$ | 0·056 | 20$r$ | 0·026 |

$f'=\frac{n}{(r+x)^2}-\frac{m}{x^2}$. The values of $f'$ are in terms of $\frac{m}{r^2}$. The * indicates the value $Oa$ (fig. 4, p. 339) of $x$, for the zero of effective action of the molecules. The sign † indicates the value $Ob$ of $x$ for the maximum of effective attraction of the molecules.

It appears, therefore, that substances for which the ratio $\frac{n}{m}$ is near the value 6·9, should be highly elastic, since their molecular envelopes, and therefore the mutual effective action of the molecules, are but slightly affected by considerable changes in the distance between the molecules.

We are accordingly not only able to see in what elasticity essentially consists, but are enabled to assign to elastic substances their rank on the scale of effective molecular action. It should be added, that a high degree of elasticity is also theoretically possible for ratios $\frac{n}{m}$ materially greater than 6·9, provided the molecules are in the primary condition noticed on p. 441; and also for ratios less than 6·9, provided the molecules are in the secondary condition. Liquids, and solids of feeble tenacity, less than that of india-rubber, may be elastic from the latter physical characteristics. Iron is the only substance whose elasticity is to be attributed to the former characteristics. Of all simple substances, iron has the greatest tenacity; its molecules should therefore have the maximum value of $\frac{n}{m}$.

*Inelastic substances*, so called, must either be those for which the ratio $\frac{n}{m}$ is greater than 6·9, and which are in the secondary molecular condition, or those for which the same ratio is less than 6·9, and are at the same time in the primary condition. In both of these cases the molecular envelopes will either expand or contract when the distance between them is altered, and the changes which the envelopes undergo will be attended with a diminution of the molecular actions that are opposed to the force of distortion.

Since reaching this conclusion, with regard to the physical cause of imperfect elasticity, and the precise molecular state of inelastic substances, I have met with a striking confirmation of it in the results of the recent experiments of Dr. Warburg on heat developed by sound. On referring to the table on page 444, it will be observed that for all substances for which the value of $\frac{n}{m}$ is greater than 6·9 (that is, for all the harder and more tenacious substances), the maximum attraction between their molecular envelopes occurs at distances greater than that of quiescence, *Oa*, and that in consequence the diminution of this attraction will be greater for small diminutions of the distance between the molecules than the increase of the same for small increments of the distance. Now a diminution of this attraction will be attended with a contraction of the molecular envelopes and a consequent evolution of heat, while an augmentation of the attraction will be attended with an expansion of the envelopes and a consequent absorption of heat-pulses from without. Since the vibrating body is not perfectly elastic, each momentary expansion will be succeeded by a small residual expansion, and each contraction by a small residual contraction; but since, as we have just seen, in each vibration the contraction will exceed the expansion, the amount of the residual contraction should exceed that of the residual expansion. The result, after any number of vibrations, should then be that there will be a permanent contraction of the molecular envelopes, and therefore a certain amount of heat given out. The gradual subsidence of the vibrations, after the inciting cause has ceased to act, results from the process of contraction of the envelopes, attendant upon each vibration, and the consequent evolution of heat-energy.

India-rubber must belong to that class of substances for which the ratio $\frac{n}{m}$ is less than 6·9, for the heat given out by it when it is stretched, shows that its envelopes must contract when the molecules recede from each other (p. 443). Still as it has a high degree of elasticity, its ratio $\frac{n}{m}$ cannot be very much below 6·9. Again, the fact that heat applied to india-rubber induces a contractile action, shows that its molecules are in the primary condition. These conclusions with regard to the molecular condition of india-rubber, are confirmed by its great extensibility; for as when it is stretched the molecular envelopes contract, and their attractive action diminishes in consequence (p. 442), the ratio $\frac{n}{m}$ will decrease, the curve of molecular action (fig. 4) become depressed, and the distances *Oa* and *Ob* increase. The effective attraction between the molecules that puts itself in equilibrium with the stretching force, as this increases, must then obtain at a distance that augments with *Oa*, as well as in the ordinary way. Its moderate tenacity also assigns to it a comparatively low value of the ratio $\frac{n}{m}$.

The explanation here given of the peculiar properties of india-rubber is strikingly sustained by the results of recent experiments by Prof. E. Villari, published in the Philosophical Magazine (Feb., 1872). He finds that while india-rubber gives out heat on being stretched, it also loses sensible heat on suffering contraction, and the loss in the second case is less than the increase in the first. Now we have seen that according to the position assigned to india-rubber on the molecular scale, its molecular envelopes will contract when the rubber is stretched, and heat consequently be given out; a contraction of the rubber should, of course, have the opposite effect on the envelopes, and heat therefore be absorbed from without. Also, as it is not perfectly elastic, the envelopes contracted by the stretching should not expand to their original dimensions when the force is withdrawn, and hence the fall of temperature during the contraction of the rubber should be less than the rise during the stretching. In fact that it was imperfectly elastic, or did not recover itself after the stretching weight was removed, was directly established by the experiments of Prof. Villari.

12. The principle of the varying physical condition and mechanical action of molecules with varying circumstances (p. 442) also appears to be the originating cause of crystalization and solidification in general, chemical combinations, and in fact all those classes of phenomena which have hitherto been ascribed by most physicists to an inherent polarity of atoms. According to this principle, if upon any side of a primitive molecule the amount of heat received varies, or the attractive action exerted by a contiguous molecule upon its envelope varies, this envelope, at the point considered, will either collapse or expand, and in consequence the effective action exerted by the molecule upon the contiguous one, on the side supposed, will either vary in its intensity or its character. Let us see, in the light of this general conception, how *chemical attraction* may spring up. Two primitive molecules of different substances, when brought into contiguity, will at first come under the operation of their mutual exterior repulson (p. 339), and it is plain that unless this repulsive action be in some way changed into an attractive one, no union of the two molecules can take

place. Now we have seen that contiguous molecular envelopes attract each other; and that the molecules at the surface of bodies, and of gases are, in all probability, in that "primary condition" in which any expansion of an envelope enhances its attractive action. The tendency of the mutual actions of the two molecules supposed, is, therefore, to augment the range of the effective attraction of each (that is, to increase the distance *Oc*, fig. 4), and diminish the exterior repulsion. It is conceivable that the relations of the two molecules, and favoring thermal or other circumstances, may be such that the range *Oc* of the effective attraction may be caused to extend beyond the distance that separates the molecules, and so their union supervene under the operation of this attraction. But it is to be observed that the attractive action exerted by each molecule on the envelope of the other induces an excess of electric ether, or a *positive electric polarity* on the contiguous sides of the two molecules, and so originates an electric repulsion of each envelope for the other, and each molecule for the other. In the instance of two similar molecules these positive polarities should be of equal intensity, and such electric repulsion of necessity be in operation, to a certain extent; but if the molecules are dissimilar the induced polarity of the one may predominate over that of the other sufficiently to superinduce by its action a deficiency of electric ether, or a *negative polarity*, on the contiguous side of the other, and so an *electric attraction* be developed. If this should suffice to bring them within the range, *Oc*, of their natural effective attraction, their union will take place under the operation of this attraction. That this result may be brought about it is necessary that the molecules should have certain special relations to each other; and it is these natural relations that constitute what is called chemical affinity.

These relations are liable to modification, by heat, disturbances of electric equilibrium, and other causes that may tend to disturb the molecular envelopes. Thus heat promotes combustion, and oxidation generally; for it tends to expand molecular envelopes, and so, in that "primary condition" which appears to prevail at surfaces of contact, and in the interior of gases, to augment the attraction subsisting between the envelopes, which we have seen to be the originating cause of chemical union. This tendency may prevail over the direct repulsive action of the heat. On the other hand, heat may operate to dissociate molecules, for it is a repulsive energy, and tends directly to separate them; and we have seen (p. 441) that it is apparently only in a few exceptional cases that the interior molecules of a liquid or solid are in the primary condition in which heat tends indirectly to induce an attraction. In fact the same amount of heat which has been developed in the union of two molecules ought to suffice to dissociate them.

It will be seen, in view of what has been stated, that two primitive molecules of the same substance should seldom, if ever, unite unless their envelopes are brought by heat, or a disturbance of electric or mechanical equilibrium, into different conditions of expansion or electric accumulation. In fact, solidification appears in all cases to begin at certain points of the liquid mass, as the result of thermal or other changes, and proceed outward from these points, from molecule to molecule, along certain lines of direction.

(To be concluded.)

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ART. LXI.—*On the Structure of the Skull and Limbs in Mosasauroid Reptiles, with descriptions of new Genera and Species*; by O. C. MARSH. With four Plates.

AN examination of the very extensive series of *Pythonomorpha* remains recently acquired by the Yale College Museum, through contributions from the late expeditions to the Rocky Mountains, has enabled the writer to make out several new points in the structure of these reptiles, in addition to those already announced,* and also to correct some errors of previous observers who have written on the subject. These new results, here briefly recorded, will be more fully discussed in a future communication.

1. *Position of the Quadrate bone.* The great importance of the quadrate bone in this group, in affording generic and specific characters, was first recognized by Prof. E. D. Cope, to whom science is so largely indebted for its present knowledge of this most interesting order of reptiles. In his valuable Synopsis of Extinct Batrachia, etc., p. 183, Prof. Cope pointed out the principal features of this bone in the Pythonomorpha, and proposed a number of terms to designate its most characteristic parts, which were well illustrated by figures in different portions of the work, and in some of his more recent publications.† In the position there assigned to the quadrates in the skull, it appeared to the writer, at the time, that Prof. Cope had reversed these bones, placing the right quadrate upon the left side, and *vice versa*, although retaining their true antero-posterior position. A careful examination of the quadrates in several genera of recent lizards, and especially in the genus *Trachydosaurus*, strongly confirmed this view; and its correctness was finally placed beyond a doubt, during the past summer, by Mr. O.

* This Journal, vol. i, p. 44, June, 1871, and vol. iii, p. 290, April, 1872.

† Synopsis, plate XII, and Proceedings American Association of Science, vol. xix, pp. 217 and 220.

Harger, of the Yale exploring party, who discovered a quadrate bone of *Lestosaurus latifrons* Marsh, in place, and firmly united to the suspensorium. Another specimen in the Yale Museum is equally conclusive. The natural position of the quadrate, therefore, in the Pythonomorpha is with the great ala external. This clears up, at once, several difficulties in regard to the motion of the jaws, which could not be satisfactorily explained when the quadrates were reversed. This discovery of its true position necessitates a change of terms used in describing this bone, and those proposed by Prof. Cope may be amended as follows:—The "external angle" may be called the *internal angle;* the "external ridge," the *internal ridge;* and the "distal-external longitudinal ridge" may be termed the *internal longitudinal ridge.*

2. *Discovery of the Stapes.* This element of the cranium, which had not previously been observed in the Pythonomorpha, was first detected by the writer in the skull of a species of *Lestosaurus.* In this specimen the proximal third of the stapes was attached to the exoccipital, lying in place, in the groove on its lower posterior surface. In another specimen of the same genus (*L. felix* Marsh), the entire stapes, apparently, was found adhering to the base of the skull. In each case the bone was a slender rod, nearly round, expanded proximally, and to some extent also at its distal extremity. The natural position of the stapes was evidently in the groove on the postero-inferior face of the suspensorium. Its proximal extremity was probably in the fenestra ovale, and its distal end in the meatal pit of the quadrate.

3. *Discovery of the Columella.* No evidence of the existence of this bone in the skull of any Mosasauroid reptile has hitherto been adduced, and Prof. Cope asserts that it does not exist in the group.* In removing the rock from the remarkably perfect skull of *Lestosaurus felix,* which had the stapes preserved, the writer found a slender cylindrical bone adhering to the basisphenoid, which is evidently the *Columella.* The bone is somewhat compressed throughout, slightly sigmoid, and has both ends moderately expanded. The lower, or larger, extremity has a deep broad groove in the direction of its greatest diameter, apparently for union with the pterygoid. The opposite end is also excavated, probably for an attachment of cartilage.

4. *Quadrato-parietal arch.* Evidence of the existence of this arch was first observed by the writer during the explorations of the Yale party in Kansas in the autumn of 1870, and on the expedition of the following summer its presence was fully proved for the genera *Edestosaurus, Clidastes, Lestosaurus* and

* Synopsis of Extinct Batrachia, etc., p. 176.

*Rhinosaurus.* This arch, portions of which have recently been observed also by Prof. Cope, is not formed in most of the genera by a posterior extension of the parietal to the suspensorium, as in many recent lizards, but mainly by an intervening bone which is apparently the squamosal. This unites in front by suture with one of the posterior prolongations of the parietal, and at its distal end is joined to a flat uncinate process of the opisthotic, which is sent off forward and inward to meet it.

5. *Discovery of the Malar arch.* The existence of this arch, hitherto unknown in this group, was conclusively demonstrated by the same remarkably perfect cranium of *Lestosaurus felix*, which retained the stapes and columella; and it is also shown in a specimen of *Edestosaurus.* In the former skull, the jugal is a stout bone, somewhat flattened, and bent at an obtuse angle. It unites by suture with an external process of the post-frontal, the joint being strengthened by a short hook at the extremity of the jugal, which fits into a corresponding pit. Its anterior extremity is united with the maxillary. In all the species of this genus in which this bone has been observed there is a pointed tubercle at the posterior external angle. In *Edestosaurus*, the jugal has a less complicated union with the post-frontal, and is throughout a more slender bone. This arch is apparently well developed also in *Rhinosaurus.*

6. *Pterotic bone.* Among other new points brought to light during the present investigation of the cranium of the Pythonomorpha, may be mentioned the discovery, in *Edestosaurus*, of a distinct ossification at the distal end of the suspensorium, which is evidently the element called the *pterotic* by Huxley. It is a small oval bone, which is attached to the opisthotic, and rests on the superior surface of the quadrate. In several of the genera of this group, the cartilaginous wall which extended from the quadrate to the base of the skull was so much ossified that large sheets of this membrane are frequently found preserved, adhering to the quadrate, or the lower part of the skull.

7. *Anterior Limbs.* Until very recently the nature of the limbs of Mosasauroid reptiles was almost unknown, and in our latest and best Manual on the Anatomy of Vertebrates this deficiency is still acknowledged.* The Cretaceous deposits of this country, however, have of late yielded ample material to prove that these limbs were paddles, and in the present paper several new facts in regard to their structure are adduced. Plate X contains an illustration of the right anterior paddle of *Lestosaurus simus* Marsh, which shows at a glance the structure of the scapular arch and the corresponding limb. This unique specimen, with other important parts of the same skeleton, was found, by the writer, with the various bones almost in the exact

* Huxley, Anatomy of Vertebrated Animals, p. 230, 1871.

position given in the plate, the only exception being that a few of the distal phalanges which were somewhat displaced have been restored to their natural position. The carpal bones, which are given as found, were considerably disarranged, and some of the series had probably disappeared. With this exception, the plate admirably represents the natural position of all the bones of the anterior limb in the genus *Lestosaurus*, and this position may be regarded as typical of the entire group.

This specimen clearly establishes the fact, hitherto unknown, that the number of digits in the manus was five, and that the longest digits had six phalanges and the shortest but four. Moreover, that the paddle was expanded as in some of the Cetaceans, and not contracted as in *Ichthyosaurus*, *Plesiosaurus*, and other Enaliosaurs. Another point of interest is, that, in the genus *Lestosaurus*, the coracoid has a deep emargination, as in many recent lizards, a feature not before observed in any Mosasauroid, and probably existing only in a few genera of the order. There is certainly no emargination in the coracoid of *Clidastes*, *Edestosaurus* and *Baptosaurus*, as specimens in the Yale Museum conclusively prove. The larger bones, as well as the phalanges, had their articular faces covered with a thick cap of cartilage. The terminal phalanges were evidently inclosed in the paddle, and not furnished with nails. The entire manus in *Lestosaurus* is remarkable for its large size, and also for its breadth. In *Edestosaurus*, it had an equally powerful development. The humerus was even shorter and stouter, and the whole paddle apparently broader in proportion. In *Rhinosaurus*, the anterior limbs were proportionally much smaller, and more slender.

8. *Posterior Limbs.* The absence of these extremities in the *Pythonomorpha* was considered satisfactorily established, when the discovery of an unusually well-preserved specimen of *Edestosaurus* revealed to the writer the pelvic arch represented on Plate XI.* Equally conclusive evidence of the existence of these limbs in nearly all the other genera was soon after obtained while investigating the subject, and at the present time there can be no reasonable doubt that they are common to the entire order. In general structure, the hinder extremities correspond essentially with the anterior paddles already described, but in most of the known genera they are of smaller size. The pelvic arch, however, presents some peculiar features, and its elements, which are here figured for the first time, deserve a detailed description.

The acetabulum was formed by the coadapted ends of the ilium, ischium and pubis, which contributed nearly equal portions to its articular surfaces. The direction of the cup is out-

* This Journal, vol. i, p. 447, June, 1871.

ward, downward and backward. The ilium, which is usually the longest of the three pelvic bones, has, in *Edestosaurus*, a nearly round shaft, slightly sigmoid, and tapering gradually to its distal end. This is truncated nearly at right angles to the axis of the shaft, and covered with an articular face. There was evidently a cartilaginous union with a vertebra of the sacral region, although there was no true sacrum in any of the group. This vertebra was probably the last without chevrons, as in a specimen of *Lestosaurus*, with the pelvic arch complete, the right ilium was found by the writer adhering to the right diapophysis of this particular vertebra.

The inferior end of the ilium is in *Edestosaurus* much dilated, with a sub-rhombic transverse outline, and three terminal facets, the largest of which forms part of the acetabulum. The direction of the ilium in this genus, and probably in all the other genera, was oblique, the superior end being turned forward, and the shaft nearly on a line with that of the ischium, as shown in Plate XI, fig. 2. In *Lestosaurus* and *Rhinosaurus*, the shaft of the ilium appears to have been more or less compressed, and the articular face at the upper end somewhat oblique. The bone called "ilium" by Prof. Cope, in his description of *Liodon dyspelor*,* is evidently the *ischium*, and *vice versa*, as is clearly shown by several very perfect pelvic arches in the Yale Museum, some of which were found not only with the elements in position, but, what is much more conclusive, actually united. Moreover, a careful comparison of these bones with the corresponding parts of the pelvic arch in recent lizards, as well as in the extinct swimming Saurians, strongly confirms the interpretation here given.

The ischium in *Edestosaurus* (Plates XI–XII) has the acetabular end expanded and thickened, and just below, on the posterior margin, the *tuberositas ischii* is well developed. The shaft is constricted in the middle, and the distal end has a subtriangular articular face for union with its fellow, although Prof. Cope, in the article above quoted, states that "the pubes are the only elements united below." In *Lestosaurus* (Plate XII, fig. 2, b) the ischium is a broad flat bone with a posterior projection on its proximal third. The distal end is expanded, with the anterior angle especially produced. This extremity has an articular face along its fore-and-aft extent, showing clearly that it was united below to the opposite ischium. In the genus *Rhinosaurus*, the ischia were also flattened, and the posterior process well developed. Their distal ends were moderately expanded, and closely united on the median line.

The pubis is longer than the ischium in all the genera investigated. In *Edestosaurus*, its extremities are about the same

* Proceedings American Philosophical Society, Dec., 1871.

size as those of the ischia, but the distal end is more compressed. There is a prominent anterior process just below the articular end, and the usual foramen is present near the anterior margin. The pubis of *Rhinosaurus* has the acetabular end dilated, the shaft straight and slender, and but little expanded. In all the known genera of the group, the pubes are united on the median line below.

The femur in *Edestosaurus* is slightly shorter than the humerus, and much more slender, being scarcely more than one half as wide. It is moderately expanded at its proximal end, and has a distinct trochanter at the postero-internal margin, which is separated from the head by a shallow groove. The distal end is more expanded, and has the outer posterior angle thickened into a stout obtuse tubercle. In *Lestosaurus*, the femur is very small compared with the humerus, and of much more slender proportions. The articular head is small and convex, and broadly oval in outline. The trochanter is an obtuse ridge, with a rounded articular summit. It is situated some distance below the head, on the outer surface of the bone. The shaft is subtriangular in transverse section, and the distal end is expanded and thickened, especially in the middle. The femur, in the genus *Rhinosaurus*, nearly or quite equals the humerus in size, and has its general proportions similar. Both extremities are moderately expanded, the distal one being the largest. The trochanter has a position similar to that in the last genus.

The tibia in *Lestosaurus* is a very short, stout bone, with the shaft nearly round, and the proximal articular face flat, and broadly oval in outline. The distal end is more expanded, with the articular face narrow, and curving upward at the inner angle to meet the fibula. The latter is a broad discoidal bone, much larger than the tibia. In *Rhinosaurus* the tibia and fibula are both flattened, the latter being as usual the broader bone. In all the known genera, the phalanges of the posterior limbs resemble in their general character those of the manus.

In view of the extensive material now available for comparison, it will not be difficult to identify with tolerable certainty the limb-bones of *Mosasaurus* originally figured by Camper and Cuvier, which have so long been a puzzle to anatomists. The bone called "pubis" by Cuvier, in *Ossemens Fossiles* (Fourth Ed., Plate 247, fig. 10), and since regarded by Prof. Cope as a scapula (Synopsis, p. 219), is evidently an ischium. The two represented in figures 9 and 14 of the same plate are apparently both coracoids, and that in figure 15, a scapula. On Plate 248, the specimen in figure 4 appears to be a radius, and that in figure 6, a phalanx. The bone represented in figure 24, which was thought to be a humerus by Camper, and an ulna by Cuvier, is without doubt an ilium.

*Number of Cervical Vertebræ.* In all the genera examined during the present investigation, the skull was supported on a very short neck, much shorter, in fact, than any species of the group has been supposed to possess. Prof. Huxley, in the work already cited (p. 224), places the *Mosasauria* with the Reptilia having more than nine cervical vertebræ; and Prof. Cope states (Synopsis, p. 218) that in *Clidastes propython* there are ten cervical vertebræ with articulated hypapophyses. In the Yale Museum are numerous series of cervical vertebræ of *Lestosaurus*, all apparently complete, and several of them known to be so, as they were found in position. None of these series have over four vertebræ with articular faces for hypapophyses behind the axis, and following these one, or sometimes two, with a tubercle more or less developed. In *Edestosaurus*, judging from several series of cervicals apparently complete, there were probably but five vertebræ with free hypapophyses, in addition to the atlas and axis, and, posterior to these, two or three with small rugose tubercles. The same number was observed in a specimen of *Rhinosaurus*. It is evident, therefore, that the neck in this group was unusually short, resembling very nearly, among swimming Saurians, that of *Ichthyosaurus*.

### *New Genera and Species.*

In a catalogue, recently published, Prof. Cope has given a complete and instructive list of the species of Pythonomorpha now known from the Cretaceous deposits of Kansas.* These species are arranged under various generic names, which do not, in all cases, meet the requirements of our present knowledge of these reptiles, especially in view of the light thrown on the subject by the very large collections made in that region by the two expeditions from Yale College. An attempt is therefore made below to define more closely the generic relations of the groups best represented in the West. The material for a similar definition of some of the rarer forms, as well as those from the Eastern Cretaceous beds, has not yet been brought together.

### *Lestosaurus*,† gen. nov.

United premaxillaries small, forming a very short obtuse muzzle, that extends little if any in front of the premaxillary teeth: posteriorly they contract rapidly into a narrow wedge. Parietal foramen large. Teeth slender, curved and faceted. Palatines flattened, with palatine teeth more or less pleurodont. Quadrate large, with very large posterior hook. Coracoid with deep emargination. Humerus short and broad. Manus much

* Proceedings American Philosophical Society, vol. xii, Dec., 1871.
† Λῃστής, *pirate*, and σαῦρος, *lizard.*

larger than pes. Vertebræ with rudimentary zygosphenal articulation. Cervical vertebræ with articulated hypapophyses six. Chevrons articulated.

Several species with the above generic characters have been referred to *Liodon* and to *Holcodus* by Prof. Cope. From the former they are widely separated by the teeth, which in *Liodon anceps* Owen, the type species, are compressed, and smooth, as the name implies. The *Holcodus* of Gibbes was based on teeth of *Hyposaurus*, and a single dental crown, which indeed somewhat resembles the teeth of *Lestosaurus* in surface characters, but evidently indicates a different type, as an examination of the original specimen clearly shows. In form, it corresponds essentially to the teeth of *Mosasaurus*, rather than to the slender, pointed, and curved teeth of the present genus, and it approaches more nearly those of *Mosasaurus Copeanus* Marsh, from New Jersey, although there is good evidence to show that the latter species is quite distinct generically from *Lestosaurus*. There is, moreover, no satisfactory proof that the typical species of either *Holcodus* or *Liodon* possesses any of the more important characters adduced for *Lestosaurus*, and there is considerable probability against it. It was certainly very proper to place provisionally in those genera allied species based on fragmentary remains, but to refer to them whole groups with well-marked and clearly established characters, without any conclusive evidence of identity, is to retard rather than to advance science. From *Baptosaurus*, which in some respects appears to be a near ally, the genus *Lestosaurus* may be distinguished by the articular hypapophyses, and emarginate coracoid. It is widely separated, also, from *Mosasaurus*, *Platecarpus*, *Clidastes*, and *Edestosaurus*, by the articular chevrons, as well as by other marked characters.

### *Lestosaurus simus*, sp. nov.

This species is established on the complete anterior portion of a skeleton, including skull, paddles and vertebræ, of one individual, and portions of several others which fully supplement the parts wanting in the first specimen. This was found not only in perfect preservation, but with nearly every bone in its natural position, so that the characters of all were readily interpreted. The right paddle with its corresponding half of the scapular arch is so well represented in Plate X, that this part of the skeleton needs little or no description beyond that already given. The plate was made directly from a photograph of the bones themselves, placed almost exactly as they were found by the writer, in the yellow shale of Western Kansas, in July last. A sketch of the paddle was taken before it was removed from the rock, and every bone numbered, so there can be no doubt that the illustration given truly represents the natural position of the entire limb, and of its various elements. In Plate XII, fig. 2, the right half of the pelvic arch and femur of another individual of this species is represented, although without placing the bones together in position, except merely to indicate their mutual relations.

The skull in this species is of moderate length, the snout very short and depressed. The premaxillary suture is oblique and quite steep in front, and the anterior nareal expanse is opposite the third maxillary tooth. There are eleven teeth in the maxillary, and thirteen in the mandible. The suspensoria are much depressed, the transverse exceeding the vertical diameter. The basisphenoid is grooved on the median line below, at the junction of the posterior processes. The teeth have their external faces faceted, and marked with irregular striæ, and the inner side strongly striate. The dermal scutes preserved are smooth, and imbricate in arrangement.

The quadrate is large, with a stout elongated hook. The internal angle is nearly a right angle. The distal articular face is prominently convex, with its anterior margin but slightly inflected. There is a large tubercle on the inner margin of the hook opposite the meatal pit, but no articular button. The cervical and dorsal vertebræ have transverse broadly oval articular faces, slightly emarginated above for the neural canal. The articular faces for attachment of the free hypapophyses are sub-trilateral in outline, the smallest angle being in front. The rudimentary zygosphenal articulation is well marked.

*Measurements.*

| | |
|---|---|
| Distance from end of snout to premaxillary suture, | 34·mm· |
| Depth of maxillary at anterior nareal expanse, | 39· |
| Length of alveolar portion of dentary, | 275· |
| Width of basioccipital on condyle, | 55· |
| Depth of basioccipital, | 28· |
| Length of quadrate, | 93· |
| Greatest diameter of distal articular face, | 47· |
| Least diameter, | 24· |
| Length of posterior hook, | 63· |
| Length of axis, with odontoid process, | 98· |
| Length of axis alone, | 66· |
| Vertical diameter of articular ball of axis, | 27· |
| Transverse diameter, | 36· |
| Length of centrum of first dorsal vertebra, | 58· |
| Vertical diameter of ball, | 33· |
| Transverse diameter, | 48· |
| Length of humerus, | 141· |
| Greatest diameter at proximal end, | 95· |
| Greatest diameter at distal end, | 131· |
| Length of radius, | 99· |

| | |
|---|---|
| Length of ulna, | 104· mm. |
| Length of ilium, | 153· |
| Length of ischium, | 138· |
| Length of pubis, | 175· |
| Length of femur, | 116· |
| Length of tibia, | 56· |
| Greatest diameter of proximal end, | 40· |
| Least diameter, | 33· |

This species may be distinguished from *Liodon curtirostris* Cope, perhaps its nearest known ally, but a smaller species, by the number of teeth in the maxillary, which are eleven instead of ten; by the more anterior nareal expanse; and by the supra-occipital keel, which is inclined obliquely forward. The two latter characters separate it also from *Holcodus coryphæus* Cope, from which it differs likewise in its large quadrate. From the other allied species, the description given above will readily separate it.

The remains of this species here described were found last summer by Mr. F. Mead, Jr., of the Yale College party, and the writer, in the upper Cretaceous shale, near the Smoky Hill River, in Western Kansas.

*Lestosaurus felix*, sp. nov.

This well-marked species is considerably smaller than the one just described. It is represented in the Yale Museum by the specimen, already mentioned, with the skull and numerous vertebræ so remarkably well preserved; and by portions of several other skeletons. The muzzle in this species appears to have been much less depressed than in the other known species of this genus, although this character may have been increased in the type specimen by pressure. The nareal expanse is opposite the interspace between the second and third teeth behind the intermaxillary suture. The frontal region was narrow, and the entire skull was of rather slender proportions. The basioccipital keel is inclined obliquely backward, projecting beyond the basioccipital condyle. The suspensoria have a greater vertical diameter than in the last species, and the basioccipital has its posterior margin deflected. The basisphenoid is deeply excavated below on the median line in front, and its anterior lateral processes are slightly deflected. The stapes and columella found with this skull have already been described. The teeth are slender, faceted and incurved, with striæ on the inner face. There are eleven in the maxillary, and twelve in the mandible. Adhering to the jugal bone, is a single dermal scute, which is thick, and pitted externally.

Both quadrates are perfect, and the left is represented on Plate XIII, fig. 4. The great ala is nearly in the same plane as the external margin of the hook, and hence the inner angle is much greater than a right angle. There is a broad, shallow depression on the front face of the ala near the middle, and below this a deep pit on the inner face above the internal angle of the distal end. The anterior margin of the distal articular face is strongly reflected near the middle.

The cervical vertebræ are short, with broad transversely oval faces, faintly emarginated for the neural canal. The axis has a short spine, much elongated fore and aft, and with caps of cartilage at its anterior and posterior angles, connected by an obtuse ridge. The hypapophysis of the axis stands on the middle of the centrum, and the articular faces for these processes are nearly round, and rest on a prominent ridge, as in *Edestosaurus*, mainly produced by the deep excavation of the infero-lateral surfaces of the centra. The dorsal vertebræ have neural spines much extended antero-posteriorly, and abruptly truncated.

*Measurements.*

| | |
|---|---|
| Depth of maxillary at anterior nareal expanse, | 33· mm· |
| Width of frontals at posterior margin, | 115· |
| Width in front of orbit, | 73· |
| Distance from center of occipital condyle to end of suspensorium, | 90· |
| Expanse of suspensoria, | 170· |
| Length of stapes, | 61· |
| Length of columella, | 51· |
| Length of quadrate, | 81· |
| Transverse diameter of distal articulation, | 39· |
| Antero-posterior diameter, | 20· |
| Length of posterior hook, | 54· |
| Length of axis without odontoid process, | 48· |
| Vertical diameter of ball, | 21· |
| Transverse diameter, | 32· |
| Length of anterior dorsal vertebra, | 60· |
| Transverse diameter of ball, | 38· |
| Vertical diameter, | 32· |

The remains on which this species is established were obtained by the Yale party last summer in the upper Cretaceous yellow shale, near the Smoky Hill River in Kansas.

## *Lestosaurus latifrons*, sp. nov.

The present species, which was similar to the preceding in size, is mainly based on portions of two skeletons, one of which contains nearly all the more important portions of the cranium, and vertebral column; and the other consists of numerous vertebræ, with parts of the skull, including a quadrate attached to the suspensorium, to which reference has already been made.

The frontals in this species are broad, especially anterior to the orbits, where there is a lateral expansion. On the median line near the middle there is a sharp crest. The supra-occipital keel projects obliquely backward, and its posterior edge is sharp. The basisphenoid has the anterior lateral processes expanded, and strongly decurved, thus showing a marked difference from the last described species. There are eleven maxillary and twelve mandibular teeth, which have unequal facets externally, and irregular striæ on the inner face. The palatines are alate, sigmoid in fore-and-aft outline, with the pointed anterior ends converging. There are ten palatine teeth, all more or less pleurodont, the anterior four being entirely so. The quadrate has an elongated depression on the back of the ala near the middle; and a deep semi-circular excavation under the hook, and behind the meatus. There is also a prominent smooth knob on the inner face, between the meatus and the large rugose knob at the end of the hook. The distal articular face has its anterior margin reflected. Its inner angle is acute, and connected superiorly with a sharp vertical ridge. The internal angle of the proximal end is greater than a right angle, and the hook has no articular button. The cervical vertebræ are small, their articular ends transversely elliptical, with no superior emargination. The articular faces for the hypapophyses are round, and that of the axis meets the anterior margin of the ball. The dorsals are elongated, and slightly excavated above. A rudimentary zygosphene is represented by short processes projecting from bases of anterior zygapophyses. The spine of the axis is keeled behind.

*Measurements.*

| | |
|---|---|
| Width of frontals between posterior angles, | 115· mm. |
| Width in front of orbits, | 85· |
| Depth of maxillary at anterior nareal expanse, | 33· |
| Transverse diameter of basi-occipital on condyle, | 44· |
| Vertical diameter, | 26· |
| Length of quadrate, | 77· |
| Length of posterior hook, | 52· |
| Transverse diameter of distal articular face, | 40· |
| Antero-posterior diameter, | 20· |
| Length of axis with odontoid process, | 68· |

This species may be distinguished from *Liodon curtirostris* Cope, and *Holcodus coryphæus* Cope, by the number of teeth in the jaws, or in the palatines, as well as by other characters mentioned above, which also separate it widely from more distantly related species. The known remains now representing it were found last summer, in the upper Cretaceous shale, by Mr. O. Harger, of the Yale party, Mr. E. S. Lane, guide, and the writer, during our explorations, near the Smoky Hill River, in Western Kansas.

*Lestosaurus gracilis*, sp. nov.

This species, the smallest of the genus so far as known, differs widely from those already described, both in the skull, quadrate and vertebræ. It is at present represented in the Yale Museum by an only single specimen with characteristic remains, and probably by several others with the less important parts preserved. A marked feature in the skull of this species is the superior surface of the parietals, which is small and subtriangular in outline, with the sides incurved. The parietal foramen is nearly round, and larger than in any known species of the genus. The quadrate is likewise very characteristic. The internal angle of the proximal end is much less than a right angle, although the great ala is nearly in the same plane as the outer margin of the hook. This leaves a deep broad notch between the alar process and the internal angle. There is a deep groove below the meatal pit. The distal articular face is convex in its longer direction, but concave antero-posteriorly, owing to a shallow depression which divides the inner third from the outer portion. The lower margin of the ala extends inward nearly horizontally, and is produced into a compressed process, which meets the free end of the hook. The borders of the articular surfaces are strongly striated.

The articular ends of the cervical and dorsal vertebræ are transversely oval, with a distinct excavation on the superior margin. The axis has a low compressed spine, marked with deep striæ. Its anterior margin is oblique and sharp; the articular face for the free hypapophysis is on the middle of the vertebra, and on the other cervicals further back. There is a broad shallow groove around the articular ball in the cervicals and dorsals, and the anterior projection of the diapophyses receives a cap of cartilage from the cup. A rudimentary zygosphene exists in the form of a roof, extending forward over the neural canal, between the anterior zygapophyses, as in several species, but there is no groove between these and the sides of the roof. The zygantral excavations are well marked.

*Measurements.*

| | mm. |
|---|---|
| Length of parietal on median line, | 46· |
| Width in front, | 80· |
| Antero-posterior diameter of parietal foramen, | 11·5 |
| Transverse diameter, | 9· |
| Length of quadrate, | 76· |
| Length of posterior hook, | 55· |
| Transverse diameter of distal articular face, | 34· |
| Antero-posterior diameter, | 18· |
| Length of centrum of axis, | 53· |
| Height of neural spine of axis above floor of neural canal, | 41· |
| Antero-posterior diameter at base, | 34· |

The type specimen of the present species was discovered last summer by Mr. G. G. Lobdell, Jr., and vertebræ of a second individual by Mr. J. F. Quigley, of the Yale party, in the same formation, in Kansas, as the fossils already described.

The additional species, previously described from the West, that can now be referred with certainty to the genus *Lestosaurus*, are as follows:—*Lestosaurus curtirostris*, = *Liodon curtirostris* Cope, *Lestosaurus ictericus*, = *Holcodus ictericus* Cope, and *Lestosaurus coryphæus*, = *Holcodus coryphæus* Cope.

*Rhinosaurus*,* gen. nov.

United premaxillaries large, forming anteriorly an elongated cylindrical muzzle, that projects some distance in front of the teeth; posteriorly they contract gradually, and coalesce with a broad nasal element. Mandibles closely in contact at distal ends, and projecting beyond the dental series. Parietal foramen of moderate size. Teeth stout, and more or less compressed and faceted. Palatines narrow, with bases of teeth unequally exposed. Quadrate small, with short posterior hook. Humerus small and slender. Manus and pes of nearly equal size. Caudal extremity comparatively short, with articulated chevrons.

*Rhinosaurus micromus*, sp. nov.

The present species is established on the greater portion of one skeleton, in good preservation, and fragmentary remains of several others. In the former skeleton, the skull is nearly entire, and shows well the more important characters of the genus. The muzzle is much produced (Plate XIII, fig. 2), and has a rounded obtuse extremity. The premaxillary suture is elongated, and the anterior nareal expanse is opposite the interspace between the fourth and fifth maxillary teeth. The frontals are short, and have a low median crest on the anterior two thirds. There were thirteen teeth in the maxillary, and the same number in the mandible. The teeth are oval at base, compressed above, with their faces marked by facets, and irregular striæ. Both cutting edges are well developed. The mandibles project in front of the teeth, and their inner faces were distally in contact. The articular faces of the joint in the lower jaw are large, and inclined from a vertical. The palatines are narrow in front, rounded above, and have the bases of the teeth unequally exposed, the outer side being protected by a very low parapet of bone. The quadrate is very small, the hook short, and its extremity pointed. The internal angle is very prominent, and continued as a ridge to the antero-internal angle of the distal end. The meatal pit is large, sigmoid in outline, and oblique to the vertical axis of the quadrate. There is a prominent knob below the end of the hook. The distal end has its articular face twisted, and an oblique depression on the inner half.

* From ῥίς, nose, and σαῦρος, lizard.

The humerus is very small and slender, and moderately constricted in the middle. The deltoid crest is represented by a round articular tubercle, separated from the head by a deep groove. The distal end is somewhat broader than the head, and has, on the inner margin of the ulnar side, an oblique groove, which is much larger than in the other species where it has been observed. The ilium and pubis are slender. The ischium has a well-developed posterior process, and is expanded distally.

The cervical vertebræ have the articular faces but slightly transverse, with a faint superior emargination. The anterior dorsals are subcordate at their extremities, and the posterior dorsals have their articulations still more depressed. The caudals are elevated, and have the chevrons articulated.

*Measurements.*

| | |
|---|---|
| Length of dentigerous border of maxillary,............ | 320· mm. |
| Depth of maxillary at anterior nareal expanse,.......... | 44· |
| Space occupied by twelve anterior teeth in mandible,.... | 295· |
| Anterior extent of mandible beyond center of first tooth,. | 32· |
| Depth of mandible under first tooth,.................. | 30· |
| Extent of seven anterior palatine teeth,............... | 98·5 |
| Transverse diameter of basioccipital on condyle,......... | 54· |
| Vertical diameter,.................................... | 25· |
| Length of basioccipital,.............................. | 69· |
| Length of quadrate,.................................. | 81· |
| Transverse diameter of distal end,..................... | 44· |
| Antero-posterior diameter,............................ | 19· |
| Length of posterior hook,............................. | 43· |
| Length of humerus,.................................. | 96· |
| Greatest diameter of articular head,.................. | 44· |
| Greatest diameter of distal end,...................... | 57· |
| Length of ischium,................................... | 106· |
| Length of axis with odontoid process,................ | 68· |
| Length of centrum of axis,........................... | 44· |
| Vertical diameter of articular ball,.................. | 34· |
| Transverse diameter,................................ | 37· |
| Length of proximal caudal,.......................... | 39· |
| Vertical diameter of ball,............................ | 49· |
| Transverse diameter,................................ | 47· |

It is only necessary to compare this species with *Liodon crassartus* and *Liodon proriger*, both described by Prof. Cope. From the former it is widely separated by the humerus, which in that species is remarkably short and stout. In the latter, which is three or four times as large as the present species, the cervical vertebræ have vertically ovate articular faces.

The type specimen, on which the above description is based, was found, by the writer, in July last, on the south side of the Smoky Hill River, in Kansas. The geological horizon is the gray shale of the upper Cretaceous.

The remaining known species which clearly belong to the genus *Rhinosaurus* are the following:—*Rhinosaurus proriger*, = *Macrosaurus* (*Liodon*) *proriger* Cope; *Rhinosaurus dyspelor*, = *Liodon dyspelor* Cope; and *Rhinosaurus Mudgei*, = *Liodon* (*Holcodus*) *Mudgei* Cope.

### *Edestosaurus*, Marsh.

This Journal, vol. i, p. 447, June, 1871.

United premaxillaries moderately developed, forming anteriorly a short, obtusely pointed muzzle; and posteriorly tapering gradually. Parietal foramen small. Palatines horizontal in front, but nearly vertical at posterior extremity. Palatine teeth more or less pleurodont. Quadrate small, with internal angle produced. Humerus very short and stout. Manus larger than pes. Femur slender. Vertebræ with complete zygosphenal articulation. Caudal extremity much elongated, and attenuated. Chevrons coössified with centra.

### *Edestosaurus rex*, sp. nov.

This species, one of the largest of the genus at present known, is well represented in the Yale Museum by one very perfect specimen, and the more important portions of several others. The skull is elongated, the frontals converging very regularly in front, and supporting a low median crest, which becomes more prominent anteriorly. The parietal foramen is small and round. The parietals are elongated posteriorly, and the quadrato-parietal arch is proximally lamelliform. The suspensoria are slender. The pterotic bone is oval in transverse outline, and flattened below where it meets the quadrate. The teeth are nearly smooth and compressed, with strong cutting edges. The palatines have fourteen teeth, apparently all with antero-external and posterior cutting edges.

The right side of the pelvic arch and the corresponding femur are represented in Plate XII, fig. 1. The relative position only of the pelvic elements is given. All the specimens have suffered somewhat from pressure, the femur least so. The shaft of the ilium is less sigmoid than in *E. dispar*, and the ischium more expanded distally. The pubis appears to have had a more prominent anterior process. The femur is slender, with its shaft moderately constricted. It is peculiar in having the trochanter at the inner posterior angle. The dermal scutes, like those in *E. dispar*, are smooth externally, and have a complicated imbricate arrangement.

The cervical vertebræ have very broad transversely oval faces, with indication of emargination. The dorsals are elongated, with transverse faces, and distinct superior excavation for neural canal. The articular ends of the anterior caudals are vertically oval.

*Measurements.*

| | |
|---|---|
| Width of frontals between posterior angles, | 124· mm. |
| Distance from parietal foramen to end of suspensorium, | 170· |
| Length of dentigerous portion of palatine, | 164· |
| Length of ilium, | 124· |
| Length of ischium, | 102· |
| Length of pubis, | 108· |
| Length of femur, | 84· |
| Transverse diameter of proximal end, | 42· |
| Transverse diameter of distal end, | 47· |
| Length of a posterior cervical vertebra, | 44· |
| Vertical diameter of ball, | 24· |
| Transverse diameter, | 29·5 |
| Length of a dorsal vertebra, | 62· |
| Length of anterior caudal, | 38· |
| Vertical diameter of ball, | 38· |
| Transverse diameter, | 36· |

This species differs from *Clidastes cineriarum* Cope, in the transverse articular faces of the dorsal vertebræ; from *Edestosaurus tortor* Cope, and *E. dispar* Marsh, in the less number of palatine teeth, and in other characters. *E. stenops* Cope, the only other large species, has the teeth faceted. The known specimens representing the present species were discovered last summer by Mr. G. G. Lobdell, Jr., Mr. G. M. Keasbey, Mr. T. G. Peck, and the writer. The localities were in the upper Cretaceous, on the Smoky Hill River, in Western Kansas.

The remaining species of the genus *Edestosaurus*, that have now been fully identified as such, are the following:—*Edestosaurus dispar* Marsh, the type species, *Edestosaurus velox* Marsh, *Edestosaurus Vymani* Marsh, = *Clidastes Vymani* Marsh, *Edestosaurus tortor* Cope, and *Edestosaurus stenops* Cope.

Yale College, New Haven, Ct., May 15th, 1872.

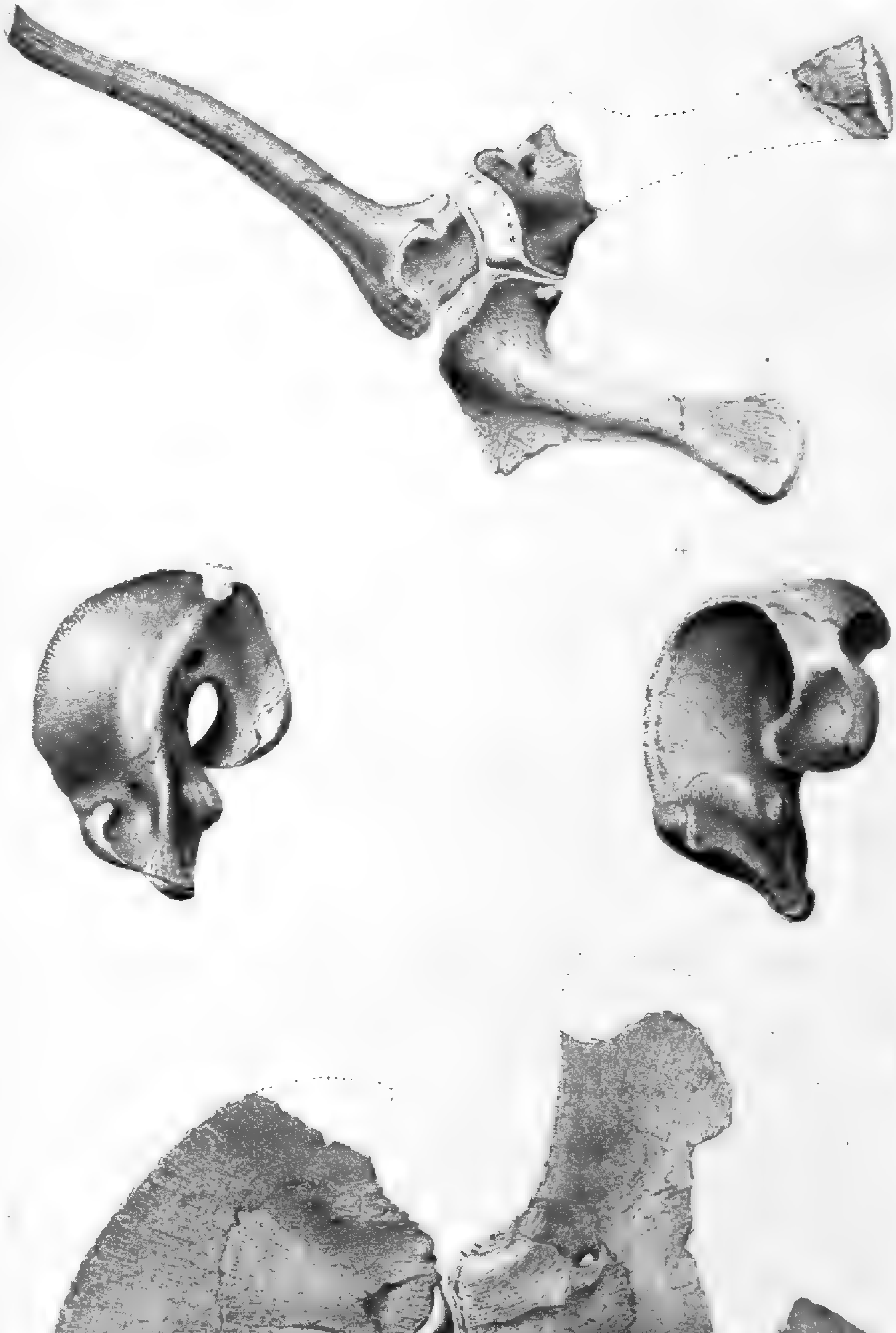
EXPLANATION OF PLATES.

Plate X. Right anterior paddle, with corresponding part of scapular arch of *Lestosaurus simus* (pp. 450 and 455). *a*, coracoid; *b*, scapula; *c*, humerus; *d*, radius; *e*, ulna; *f*, four of the carpal bones; *g*, metacarpal of first digit; *h*, first phalanx of fifth digit. Side view. (½ natural size.)

Plate XI. Right half of scapular and pelvic arches, and the quadrates of *Edestosaurus dispar* (p. 451). Figure 1, *a*, coracoid; *b*, scapula. Figure 2, *a*, ilium; *b*, ischium; *c*, pubis. Figure 3, right quadrate, front view. Figure 4, left quadrate, posterior view. (½ natural size.)

Plate XII. Figure 1. Right side of pelvic arch and right femur of *Edestosaurus rex* (p. 463). *a*, ilium; *b*, ischium; *c*, pubis; *d*, femur. Figure 2. Right side of pelvic arch and right femur of *Lestosaurus simus* (p. 453). *a*, ilium; *b*, ischium; *c*, pubis; *d*, femur. Side view. All somewhat flattened by pressure. (½ natural size.)

Plate XIII. Figure 1. Left side of pelvic arch and left femur of *Rhinosaurus*. *a*, ilium; *b*, ischium; *c*, pubis; *d*, femur. Figure 2. Muzzle of *Rhinosaurus micromus*, seen from below. Figure 3. Muzzle of *Lestosaurus latifrons*, inferior view. Figure 4. Left quadrate of *Lestosaurus felix*, anterior view. (½ natural size.)



# SCIENTIFIC INTELLIGENCE.

## I. CHEMISTRY AND PHYSICS.

1. *On the Reversal of the Spectrum-lines of Metallic Vapors.*—While engaged in photographing the most actinic ray in the magnesium spectrum,—a triple band situated between H and L in the ultra-violet—CORNU observed that on increasing the intensity of the induction-spark, not only was a longer exposure required, but the band became a quintuple one, the two least refrangible rays being doubled. The experiment was repeated twenty-five times, with the same result. The author having obtained this effect in the visible spectrum also, attributes it to a reversal of these doubled lines, produced by an atmosphere of incandescent metallic vapor surrounding the path of the spark. Indeed, by covering one-half the slit of the spectroscope with the metallic spark from a weak coil, and the other with the spark from a powerful coil, it is possible to see the rays superposed, the bright and the reversed line being continuous. For the positive pole, Cornu uses a carbon disk 6 to 8 centimeters in diameter, in which are cavities for the reception of the metal. The negative carbon is lowered until the spark passes, and then raised till the arc is four or five millimeters long. An image of this spark is formed on the slit by means of a lens, the spectrum, in the case of magnesium, showing the triple green ray *b* with great sharpness. On lowering now the upper carbon, the bands widen, become ill-defined, and soon a fine black line appears on the least refrangible of them. If the lowering of the carbon be continued, the second, and at last the third, are reversed also. In this way the author has succeeded in reversing rays in the spectra of sodium, thallium, lead, silver, aluminum, magnesium, cadmium, zinc and copper; the facility of reversal being in the order given. The result was also obtained with sodium and lithium chlorides. Applying this discovery to the sun, the author concludes: (1) that an exceedingly thin stratum of vapor suffices for the reversal; one, the thickness of which could not possibly be seen from the earth; and (2) that it is by no means necessary to suppose a continuous atmosphere, even of this thinness, around the sun; the absorption may be purely local, produced spontaneously by exterior cooling around each incandescent point.—*C. R.*, lxxiii, 332, July, 1871. G. F. B.

2. *A new and powerful Thermo-Battery.*—In this battery, invented by Noë of Vienna, the negative metal is an alloy like German silver, in the form of a wire; the positive, also a secret alloy, is in cylinders, cast round the wire. The wire is protected from the flame by a copper cylinder, insulated from the positive metal by a piece of mica. One of these elements equals in electromotive power 1·24 to 1·36 Jacobi-Siemens' units; therefore 9 to 10 Noë's elements equal one Daniell cell, and 20, one of Bunsen's. A battery of 72 elements, when arranged for intensity, decompo-

ses water rapidly; in two series of 36, puts in complete action a moderate sized Ruhmkorff coil; and in four series of 18, produces powerful electro-magnets.—*Pogg. Ann.*, cxliii, 113. G. F. B.

3. *Anomalous Production of Ozone;* by HENRY H. CROFT, Professor of Chemistry, University College, Toronto (Canadian Journal, vol. xiii, No. 3). About six years ago, when evaporating some syrupy iodic acid, prepared according to Millon's process, over sulphuric acid, I noticed that when the acid began to crystallize, the air in the jar (covering the drying dish) had a strong smell of ozone, or active oxygen. A couple of years afterward, on again making iodic acid, this observation recurred to my mind, and I carefully tested the air in the jar during the evaporation; no trace of ozone could be detected until the acid began to crystallize, when the smell of ozone became immediately perceptible, and all the usual tests for that body succeeded perfectly.

During the last month I have had occasion to convert two ounces of iodine into iodic acid, and exactly the same result has been observed.

The acid usually solidifies to opaque verrucose masses; but on this occasion, the crystals formed were clear and brilliant. The solution had in this, as in all the former cases, been boiled down to thin syrup, so that no trace of chlorine, or nitric acid, could possibly have remained to act on the ozone paper. The air in the jar was tested from day to day, both by the smell, and the action of iodized starch paper. Even when a few crystals began to form no change was noticed, but when the crystallization set in fully the evolution of ozone was most remarkable, the strong smell being quite characteristic, entirely different from that of chlorine or nitric acid.

I am quite unable to account for this ozonification of the air (or oxygen) over crystallizing iodic acid. My friend, Mr. Sterry Hunt, has suggested that it may arise from a partial deoxidation similar to that which produces ozone when hypermanganates are decomposed, as observed by him and other chemists. As the crystallizing acid remains perfectly white, either opaque or transparent, and as the lower oxides of iodine are of a yellow, or even brown color, according to Millon, I cannot accept this explanation, and even if it were true, the phenomenon would be equally unintelligible—a reduction taking place during crystallization. I can offer no explanation of the *simple fact* that air over crystallizing pure iodic acid, becomes ozonized, but I think that the observation seems to offer a wide field for further experiments, which I have unfortunately not the time to carry out.

## II. GEOLOGY AND NATURAL HISTORY.

1. *Remarks on the Taconic Controversy;* by E. BILLINGS, (From the Canadian Naturalist, vol. vi, No. 3.)—It frequently happens that a science, such for instance as that of geology, possesses a sort of an aristocracy, consisting of the most talented, learned, active and influential of its devotees. The views of

this body of men on any difficult problem that may present itself are usually regarded as conclusive, and are quietly adopted by the less distinguished members. Indeed, the opinion of any one of these latter would be scarcely listened to, provided it should happen to be contrary to the established creed of the dominant party. As a general rule, the leading men are right, and yet it will sometimes happen that they are wrong. One of the most remarkable instances on record is that of the great question in American geology, relating to the age of the rocks which Dr. Emmons called "The Taconic System." Upon this question nearly all of the leading geologists of North America arranged themselves upon one side, and, as it turned out after more than twenty years discussion, *on the wrong side.* Although they were wrong, yet so overwhelming was the weight of their authority, that for nearly a quarter of a century Dr. Emmons stood almost alone. He had a few followers, but they were not men who had made themselves sufficiently conspicuous and influential to contend successfully against an opinion that was supported by all the great geologists of the continent in one compact body. In consequence of this powerful opposition, the Taconic theory gradually sank so low in reputation, that it was at length considered to be scarcely worthy of the notice of a scientific man.

During the last thirteen years, a great revolution of opinion has occurred with regard to the views of Dr. Emmons. Although not entirely adopted, they are now considered to be, in a general way, well founded. The opposite theory, that all of those rocks which he placed in the Taconic system are above the Potsdam sandstone, instead of below it, as he maintained, is completely exploded. It is at this moment dead, more so than was the Taconic theory in 1859, the year in which the subject was reopened. As I understand it at present, some of the Taconic rocks are certainly more ancient than the Potsdam, others may be of the same age, and perhaps some of them more recent. The details are not yet worked out, and judging from the manner in which the strata are folded, broken up and thrown out of their original position by almost every kind of geological disarrangement, I venture to say that no man, at present living, will ever see a perfect map of the Taconic region.

The theory that the Taconic rocks belonged to the Hudson river group, was an enormous error, that originated in the Geological Survey of New York, and thence found its way into the Canadian Survey. No doubt the mistake was due, in the first instance, to the extraordinary arrangement of the rocks, the more ancient strata being elevated and often shoved over the more recent. Thus, without the aid of paleontology, it was impossible to assert positively that they were not, what they appeared to be, of the age of the Hudson river formation. The attitude of the strata, together with their numerous disturbances, might be explained physically, so as to meet either theory. If, for instance, the trilobites of Vermont and Point Levis had turned out to be of the age of the fauna of the Hudson river group, the rocks would be to this day called Hudson river. There is no apparent physical arrangement to contradict this view, but rather to support it. I do not consider that originally either the physical geologists, or the paleontologists, were much to blame. With regard to the first, when a geologist finds one rock overlying another, he is obliged to accept that as the natural arrangement. Then as to the fossils, with all our increased knowledge, I doubt that any good paleontologist of the present day would feel himself justified in deciding against physical appearances, on the few imperfect specimens figured in 1847, on pl. 67, Pal. N. Y., vol. i. Be this as it may, the object of this note is to show that while the error originated in New York, it was corrected by the Geological Survey of Canada. Dr. Hunt, in his published Address to the American Association in August last, indirectly associates Prof. Hall with me in the rectification of the mistake, whereas neither Prof. Hall nor Dr. Hunt contributed any aid whatever, but, on the contrary, opposed the change that has been made to the utmost.

[These remarks are followed by a history of the observations on the Vermont trilobites, and on the determination of the age of the Black Slate and Red Sandrock of Vermont, substantiating Mr. Billings' claims to having first ascertained the primordial character of the fossils and rocks.—EDS.]

2. *On the True Taconic;* by JAMES D. DANA.—The following, with the exception of some sentences since added, is from a friendly letter to Mr. Billings, addressed to him by the writer on receiving a copy of the paper from which the preceding article is extracted.

You see by the enclosed* that we differ about the Taconic. And yet we do not differ materially. For, viewing the Taconic as you do—the system developed by Professor Emmons through successive interpolations, year after year—you are essentially right, But if you will take his final Geological Report, of 1842, and there see what the Taconic system is as first fully announced, you will find that I am right too. In that report the system is based on a section, fifteen miles long, made across the Taconic range through Williamstown and Graylock to North Adams on the east, and to Petersburg or Berlin (places now on the Harlem railroad) on the west.† It was worked out in that part of Berkshire Co. after

* A copy of a brief article from the May number of the American Naturalist.

† Professor Emmons opens the subject of the "Taconic System" in his final Report (1842) by saying that it extends north through Vermont to Quebec, and south into Connecticut; but the only rocks he describes as the rocks of the system are those of Berkshire County, Massachusetts, and their continuation westward into New York. These are the typical rocks on which the system was founded. On plate xi four figures representing sections across this particular region are given. The only Vermont observations are contained in the only other section on the same plate representing a section from Lake Champlain to Richmond, Vt., through Charlotte. No description of the rocks of this section is to be found in the text of the volume.

In figure 4 of plate XI representing a section through Graylock, the "Taconic slate" stops just west of Berlin, Rensselaer county, New York, the slates on the west years of residence there; and it was named from the Taconic range because the rocks of this range constitute much the larger part of the section. It was pronounced unfossiliferous, and was stated on conjecture, not from ascertained facts, to range from the "Lower Cambrian" to the lower part of the Silurian.

The dip being throughout to the eastward,* Mr. Emmons very reasonably made the beds to the west the older, only suggesting, and this also very reasonably, and no doubt rightly, that faults might have occasioned some repetitions among the rocks. With regard to this point—the relative age of the beds of the Taconic—he says, in the report of 1842, on p. 145,—after giving a section with the dips to the eastward,—that the view which he adopts is, contrary to that of others, as far removed from complexity as possible, namely that the dip is an indication of age and superposition. Again, on page 147, after having spoken of the three limestones and discussed the question whether they might not be repetitions of the same formation, he decides this question adversely as regards the western bed, and says: "There seems to be no valid reason against the opinion that the most western belt of limestone is, after all, the oldest of the Taconic limestones. All being destitute of fossils, we must judge of age by their relative position, or by superposition; and so long as the most western belt is the inferior limestone, I can see no necessity in the case to suppose a series of complicated changes in order to make it coincide with our conjectures." Accordingly he makes the Stockbridge or North Adams limestone, the most eastern rock in his section, the most recent. He concludes his chapter on the Taconic by the statement that "the Taconic rocks appear to be equivalent to the Lower Cambrian, and are alone entitled to the consideration of belonging to this system, the upper portion being the lower part of the Silurian system:" which obviously means that the slates of the Taconic range, with the western limestone (before called the oldest of the limestones), were true Taconic, while the upper portion, that is, the Hoosic Mountain rocks (see section, p. 159), or else the North Adams or eastern limestone, with or without the quartzite, was, or might be, the lower part of the Silurian system.

But during the year following the publication of the Geological Report of 1842, Prof. Emmons met with a new discovery, and in consequence made most desperate blundering in American geology. He found a "Black Slate" at Bald Mountain, in Columbia Co., N. Y. (west of Berkshire), to contain fossils. As the locality lay to the *west* of the Taconic, it seemed to prove, on the

being put down as "Hudson river shales," and in figs. 2 and 3 the boundary is near Petersburg, north of Berlin, and, on page 138 of the volume, the distinction of the Taconic from the Hudson river shales or slates adjoining (or "upper members of the Champlain group") is particularly dwelt upon. The extension of the Taconic to the Hudson river, so as to include the "slates and masses" of the "Champlain group," appears first in Prof. Emmons's Agricultural Report, published in 1843.

* Prof. Emmons says that the strike of the rocks is very uniformly between N. 10° W. and N. 10° E., and the dip throughout easterly, averaging 30° to 35°. The dips he regards as a result of monoclinal uplifts (pp. 141, 142).

principle adopted in 1842, that all his Taconic system, announced before as unfossiliferous, was *newer* than this Black Slate, that is, *newer than a fossiliferous rock.* This, *to his mind*, was impossible; and he was thence led to think out a way by which rocks might dip eastward and still be newer to the westward; and, without a fact, or even an argument, to sustain it, he announced, in his Agricultural Report published in 1843, this as the true order. He thus, by a stroke of his pen, tipped over the Taconic system, and got the Black Slate to the top, with all other Taconic rocks beneath it; and so, in his mind, it ever remained.* This Black Slate, interpolated in 1843, thus brought mischief to the Taconic system and to much American geology. Its introduction was an error, and a source of greater errors, and it has been an occasion of confusion in the science ever since. It soon followed that these black slates, including that of northern Vermont, so far usurped attention as "Taconic" beds, that the determination of their age was regarded as fixing the age of the Taconic system. Thanks to yourself, the science has escaped from part of the entanglement; and an appreciation of the fact that *the addition of the Black Slates to the system was an error at the start*, will liberate the science from the rest of it.

The quartzite was not put at the bottom of the Taconic in 1842 because, in the Williamstown section, the only quartzite, that of Stone Hill in Williamstown, occurs toward the middle of the section, between Graylock (the highest summit of western Massachusetts) and the Taconic ridge, and the order of superposition seemed therefore to be against it. [The "Oak Hill" quartzite, which has a corresponding position in a second section in the same report (1842), on page 159, has no right there, as it lies wholly to the north of the line of the section.] But in 1843, the quartzite was placed at the bottom of the Taconic series. Hence, in the perfected Taconic of that date and later, the rocks which you have shown to be nearest to the pre-silurian of all the Taconic beds were those which were, by his determination, at the remote ends of the system, the black slate of the top and the quartzite of the bottom; and the former, of *primordial* age, is the only rock of the series which is yet *proved* to be *pre-potsdam.*

The only way for geology to get out of the Taconic perplexity is to go back to Emmons's Report of 1842, where the original basis of the system is presented by its author. The Williamstown section, figured on plate xi of this report, is, as I have said, fifteen miles long; and the quartzite with the associated slate in Stone

* It is probable, from the facts stated by Professor Emmons and others observed by me elsewhere, that the Bald Mountain Black Slates are unconformable to the Taconic rocks. This point I propose soon to investigate. The Taconic slates and the associated limestones I have particularly examined, and have not yet found any evidence that the rocks are newer as you go west, against the order of superposition. The slates of the Taconic range are certainly not newer than those of Graylock; and no fact has yet been brought out that proves the limestone at the western base of the Taconic range to be newer than the Stockbridge limestone.

Hill do not make a thirtieth of its length. The true typical Taconic is therefore not the quartzite portion, but the slates and limestones of the Taconic range, as he has directly declared. In fact, there is some reason for believing that *this quartzite portion* underlies the rest of the Taconic rocks of the section *unconformably*, and hence never was rightly a part of the Taconic series. Whether this last be true or not, the name Taconic belongs only to the era represented by the rocks of Taconic mountain, about which and out of which the system was engendered.

Professor Emmons is deservedly honored for combating the old idea, which prevailed among prominent geologists and paleontologists before and after 1843, that the Taconic slates were slates of the "Hudson river" period. Yet while doing this good work he blundered in everything else, determining nothing correctly as regards the age or order of succession of the rocks of his system; his assumptions after 1842 were so great as to order of stratification and faults, and his way of sweeping distant rocks into his system so unscientific, that his opponents had abundant reason for their doubts. No one knows even now what is the precise age of the slates of Taconic mountain, or, with small exceptions, of the slates over the wide region west to the Hudson (added to the Taconic system by him in 1843), although Logan's view that these rocks belong to the Quebec group is that which appears to be nearest the truth; and no one has sufficient grounds yet for asserting that the "Hudson river beds" (those above the Trenton) may not be included among the beds of the Taconic formation overlying the Stockbridge limestone.

3. *The Development of Limulus Polyphemus;* by A. S. Packard, Jr., M.D. 48 pp. 4to, with 3 plates. Memoirs Bost. Soc. Nat. Hist. (Printed without date.)—In this memoir, Dr. Packard makes an interesting and very important addition to our knowledge of the embryology of the Crustacea, in tracing the development of the horseshoe, or king-crab, of our coast. The changes from the impregnation of the egg to near the adult stage are fully described and illustrated. The account of the development of Limulus occupies only a part of the memoir, and is followed by discussions of the homologies of the Merostomata and their relation to the Trilobites, the classification of the Branchiopoda (with which Dr. Packard unites the Merostomata and Trilobites), and their geological succession and probable ancestry. Although fully appreciating the value of these investigations as a contribution to embryology, we cannot quite agree with the views of homologies and classification taken by the author.

Dr. Packard regards Limulus and all the Merostomata as zoëæform, homologizing the anterior portion of the body with the cephalothorax of the zoëa stage of Decapods, and the posterior part of the animal, including the spiniform caudal appendage, with the abdomen of the zoëæ; so that in Limulus the thorax would be wanting, or "potential, as far as regards the presence of external segments." Professor Dana, who regards the caudal spine of

Limulus as alone representing the abdomen, long ago stated the objection to this view. He says, in speaking of Limulus,* "It is an objection to viewing this segment [the middle portion which bears the branchial plates] as abdominal, that in no Entomostracan is the abdomen provided with branchial appendages. Moreover, the close relation to the Caligidæ,—the resemblance as regards the general form and subdivision of the shell, supposing the two segments to be cephalothoracic,—and the near resemblance between the foliaceous appendages and the cephalothoracic appendages, in certain Caligi as well as in Apus and the allied, are believed to be good reasons for adopting the opinion which we have here brought forward." Dr. Packard has apparently been led to his conclusions from seeking for a common embryonic prototype of all the Crustacea, but he seems to us to have gone too far when he is obliged to disregard the more direct relations of Limulus with the Entomostraca (to which he as well as Dana refers the Merostomata) in order to compare it with the young of the Decapods. Professor Dana's views are fully sustained by Owen in a recent paper on the anatomy of Limulus read before the Linnean Society of London.†

Dr. Packard makes four orders of Branchiopoda, which he regards as a subclass, as follows: 1st, Cladocera, 2d, Merostomata, including the suborders, Xiphosura and Eurypterida, 3d, Trilobita, and 4th, Phyllopoda. The fact that the Merostomata have "branchial feet comparable to those of the Phyllopoda," does not seem to us sufficient reason for uniting these groups so closely. The office of respiration in Crustacea is performed by such different organs, even in forms acknowledged to be closely allied, that no great taxonomic value can be attached to the presence of those of a peculiar character. Moreover, branchial feet of peculiar structure are found, among the higher crustaceans, in groups differing widely in other characters, as for example, in the Squilloidea and the Anomobranchiate Thalassinidea.

Under the head of geological succession and probable ancestry of the Branchiopoda, a convenient review of what is at present known of the geological distribution of the principal groups of the lower crustaceans is given, and their derivation from Haeckel's "Archicaris"—an hypothetical crustacean prototype—is discussed.

Although we may criticise Dr. Packard's views of homology and taxonomy, we cannot too highly commend the memoir which records his investigations. These investigations, however, seem to throw little light upon the affinities of the Limuloids, for, within a few months, we have had the most diverse views upon the subject from European naturalists, some regarding them, united with the Eurypterida and Trilobites, as one of the primary groups of Crustacea, while others would separate them entirely from the Crustacea and place them near the Arachnida. S. I. S.

4. *Absorption of Water by Leaves under certain circumstances.*—The investigations of Duchartre and others appeared to prove conclusively that leaves absorb neither water with which they

* U. S. Expl. Expd., Crustacea, p. 40.

† Reported in Nature, for Dec. 28, 1871, and Jan. 25, 1872.

are wetted nor vapor from surrounding air. M. Cailletet confirms this fully, so far as respects the foliage of plants established in the soil and supplied with moisture by the roots. But the revival of wilting leaves when sprinkled or enclosed in a moist atmosphere, however ingeniously explained away, always seemed to bear testimony to absorption. And M. Cailletet's experiments go to show, incontestably, that foliage does absorb liquid water (but not watery vapor) when supply by the root fails or is arrested. His experiments were made by introducing a leafy branch into a glass vessel with a double tubulure, filled with water, the increase or diminution of which was accurately and delicately measured by a manometer. A Bromeliaceous epiphyte, which grew under his care for six years, suspended by a fine wire without root, he found, was able to absorb and fix more than a hundredth part of its weight of water upon a short immersion. His note upon the subject was presented to the French Academy Sept. 11, 1871, and is printed in Ann. Sci. Nat., V, xiv, p. 243. A. G.

5. *Change of Habit.—Loranthus macranthus* of New Zealand, parasitic there upon trees of *Rutaceæ* and *Violaceæ*, is deserting these in favor of trees introduced by the European settlers, such as hawthorn, plum, peach, and especially laburnum, which was introduced as lately as 1859. Its flowers are abundantly visited by the European honey-bee. (*Garden*, i, p. 453.) A. G.

6. *Report on Botany read before the Albany Institute, Feb.* 6, 1872, by CHARLES H. PECK, A.M., notices additions to the botany of the State of New York, the herbarium of which is under his charge, gives an interesting account of the New *Handbook of British Fungi;* but omits all mention of the name of the author or publisher (which we will supply); gives illustrations of the importance of insects in the fertilization of blossoms from an economical point of view, and notes the history and mode of growth of the new *Arceuthobium* parasite on black spruces in the northeastern part of his State, of which Mr. Peck was one of the discoverers, and through whom it first came to the knowledge of botanists. He names it *A. pusillum*, which name being accompanied by a detailed account, will take precedence of the earlier printed *A. minutum* of Engelmann in the new edition of Mann's Catalogue, issued in February, and also recorded in the March No. of the American Naturalist. The printing of two names might and should have been avoided. It would have been well to have recorded the name of the other and earlier discoverer of this remarkable parasite, especially as the honor belongs to a lady. But it is duly stated in the Bulletin of the Torrey Club for November, 1871, and December, 1871; also in American Naturalist for March, 1872. Miss Millington of Glen's Falls is the lady who had the good fortune and acuteness to detect the little plant, at two widely separated stations.

The remainder of the paper is occupied with mycological subjects, in which Mr. Peck is a proficient, and especially with the history and nature of the *black knot* of plum and cherry trees, which is so great a pest in the northern part of the country. As the result of his own assiduous investigations, he concludes that the malady is really due to a particular fungus, the *Sphæria morbosa* of Schweinitz in ultimate development, but in earlier state a *Cladosporium;* that it is not at all the work of insects nor an autonomous malady. The only remedy as yet suggested is the knife. A. G.

7. *Cooke, Handbook of British Fungi, with full Descriptions of all the Species and Illustrations of the Genera.* London: Macmillan & Co., 1871, pp. 981, in two volumes, 12mo.—This is the work mentioned in the preceding article, and the one by which American students are to acquire a knowledge of our own *Fungi* until the wished-for day arrives in which we may have a Mycologia of our own. No better model than this could be asked for. By its aid good progress can be made in the study of our own species; and it will be interesting to know that the occurrence of any British species in this country, so far as yet recorded, is duly mentioned in these volumes. Copious and characteristic woodcuts are intercalated in the letter press, as well as separate plates of *Agarici*, etc. The whole is not only brought up to the latest matured views in mycology, but these views are most clearly and tersely presented. A. G.

8. *Intelligence.*—At the very time in which this welcome aid is supplied to those who would enter upon the study of our *Fungi*, we have to lament the sudden death of our veteran mycologist, the *Rev. Dr. M. A. Curtis*, of Hillsborough, North Carolina. He died on the 10th of April, just before completing the 64th year of his age. A biographical notice will be given later.

*Prof. Hugo von Mohl*, the prince of vegetable anatomists of our day, was found dead in his bed on the morning of the first of April.

*Prof. A. de Bary* is transferred from Halle to the University of Strasburg, and Dr. Hermann Count Solms-Laubach is appointed extraordinary Professor of Botany,—a strong botanical professorate for the new German University.

Dr. McNab, late Professor of Botany at the Agricultural College at Cirencester, has been appointed professor at the Royal College of Science and Arts, Dublin, in place of Dr. Dyer, who has taken the professorship at the Royal Horticultural Society, London. A. G.

9. *The Journal of Botany, British and Foreign*, since the death of Dr. Seemann, edited by Dr. Trimen of the British Museum, and Mr. Baker of the Royal Herbarium, Kew, has apparently entered upon a career of assured prosperity. An extremely good portrait of the late editor adorns the February number (and a biography is given in that for January which we have only now received).

Dr. McNab contributes some *Histological Notes;* one of them pointing out the fact that *Cynara Scolymus* (the *Artichoke*) has the woody bundles of the stem scattered through the cellular tissue after the manner of *Nymphæaceæ* and *Cucurbita*, giving it an apparently endogenous character. He also describes certain elongated thickened cells in Pine-leaves, which resemble bast cells in general character, but are widely separated from the fibro-vascular bundles, and apparently "sub-epidermal."

Dr. Bennett reports from Australia a case of poisoning from the seeds of *Macrozamia spiralis*, and an analysis, which shows that they contain binoxalate of potash as the poisonous element.

Mr. Baker, in the March number, reproduces from the *Refugium* the characters of his new Liliaceous genus *Symea*, with a figure and further remarks.

Rev. E. O'Meara begins an account of *Recent Researches in the Diatomaceæ*, principally German, which promises to be interesting and timely. He rather deprecates, but thinks correct, the proposed change of the name *Diatomaceæ* to *Baccillariaceæ*, on the ground that *Baccillaria* is an older generic name than *Diatoma*. Where does he find any rule requiring that an order should bear the name of its oldest genus?

Dr. Hance contributes a note on *Castanea vulgaris* Lam. (the name he adopts for *C. vesca* L.), as profitably cultivated for its fruit in the very south of China; and adds some remarks about the geographical distribution and systematic extent of the species, which seem to imply that he would include in it even *C. pumila*, our *Chinquapin*.

The other leading articles relate to British Botany; but one of them, viz., *Notes on the British Ramalinas in the Herbarium of the British Museum*, by the Rev. James M. Crombie, is of general interest.

Among the short notes, extracts, etc., Prof. Dickson calls attention to Irmisch's papers in the Linnæa and Botanische Zeitung, showing that in *Delphinium*, *Anemone*, several *Umbelliferæ*, etc., the long petioles of the cotyledons in germination unite into a narrow tube, from the base of which the plumule usually bursts, giving the appearance of a hypocotyledonary bud, and that the case of *Delphinium nudicaule* mentioned in this Journal, vol. ix, is of this sort. The present writer had overlooked Irmisch's papers. A reference to them was promptly given in this Journal.

Dr. Kurz announces "dimorphism" in the Indian species of *Eranthemun*. From his account it is clear that the case is like that of *Ruellia*, so long familiar.

Dr. Carruthers contributes to the February number a Review of the Contributions to Fossil Botany, published in Britain, in 1871, with critical remarks.

Notices of other articles will be given hereafter. A. G.

10. *Fossil Flora of Great Britain.*—With much satisfaction we learn that Dr. Carruthers is editing a re-issue, in monthly parts, of Lindley & Hutton's Fossil Flora, to which he is to add a supplementary volume, to contain exact delineations, by means of wood-cuts and not less than 40 plates, of the discoveries in Fossil Botany since 1837, together with descriptions and a synopsis, which will bring the whole work up to the state of the science at the present day." This will be a most important work, sure to be ably and faithfully done. A. G.

11. *The Garden*, a "Weekly Illustrated Journal of Gardening in all its branches," is of about the size and extent of the Athenæum, i. e., smaller than the Gardeners' Chronicle, but of about the same number of pages, is published in London, and conducted by Mr. Wm. Robinson, who is so well and favorably known in his Parks and Gardens of Paris, his Alpine Flowers, Wild Garden, etc., as well as personally to those who had the pleasure of making his acquaintance during a recent visit he made to this country. The publication began toward the close of the last year, so that it is now in its first volume; No. 17, the number for March 16, extends to p. 388. It covers a somewhat different ground from that of the excellent and long established Gardeners' Chronicle, is more devoted to landscape gardening and ornamental cultivation, and seems admirably adapted to the wants and tastes of gentlemen who are interested in rural affairs. By such we hear it highly spoken of; and we think we do a favor to those of that class who know it not as yet, by calling attention to it. We shall probably have occasion to make some extracts, or at least should do so if we could find room. A. G.

## III. Astronomy.

1. Zöllner *on the Nature of Comets.**—Among a number of other matters relating to the history and progress of human knowledge, the volume whose title is given below contains some contributions to the theory of comets, which are so novel and remarkable as to merit more than a passing notice, and we give a brief abstract of the more prominent points of the discussion. As important to the history of the subject, the author has caused to be reprinted the two celebrated memoirs of Olbers and Bessel on comets. These are followed by his own memoir, entitled, "On the Stability of Cosmical Masses and the Physical Constitution of the Comets," in which it is his purpose to explain the observed phenomena by the application of well established principles of physical science, and these only.

Starting from the well known fact that water, mercury, and many other substances, even in the solid state, give off vapor, of a certain amount, though of very low tension, and inferring from the characteristic odors of the metals, that they also, even at very low temperatures, are constantly giving off vapor, though of an amount too small to be recognized by any of the tests yet employed in science, it follows that a mass of matter in space will ultimately surround itself with its own vapor, and the tension of the latter will depend upon the mass of the body, that is, upon its gravitative energy, and the temperature. If the mass of the body is so small that its attractive force is insufficient to give to the enveloping vapor its maximum tension, for the existing tempera-

* Ueber die Natur der Cometen Beiträge zur Geschichte und Theorie der Erkenntniss; von Johann Carl Friedrich Zöllner, Professor an der Universität Leipzig. Mit x Tafeln. Leipzig, Verlag von Wilhelm Englemann. 1872. 8vo. pp. c, 523.

ture, the evolution of vapor will be continuous until the whole mass is converted into it.

Then comes the question whether a mass of gas or vapor under these circumstances would be in a condition of stable equilibrium. The analytical discussion of this point leads to the result that, in empty and unlimited space, a finite mass of gas is in a condition of unstable equilibrium, and must become dissipated by continual expansion and consequent decrease of density. A necessary consequence of this result is that the celestial spaces, at least within the limits of the stellar universe, must be filled with matter in the form of gas, preëminently that of the terrestrial atmosphere.

The author then proceeds to discuss the density of atmospheric air upon the surfaces of the celestial bodies and in space. Assuming for the purposes of calculation, and in accordance with the above-mentioned considerations, that the space occupied by the stellar system is everywhere filled with atmospheric air, and taking the temperature as that of melting ice, he finds that the lower limit of density for a portion of gas in space is $\frac{1}{10^{246}}$ of that of the air at the earth's surface, a value so small that a mass of air which, at its ordinary density upon the earth's surface, would occupy a volume of one cubic decimeter, when reduced to the density expressed by this fraction, would fill a sphere whose radius would not be traversed by a ray of light in less than $10^{98}$ years. Such a medium could have no appreciable effect, either upon the rays of light or upon the motion of bodies in space. The value becomes still smaller if the temperature of space is taken at $-60°$ C. with Fourier, or at $-142°$ C. with Pouillet.

Any solid body in space must, by virtue of its gravitative energy, condense the gas to form an atmosphere upon its surface, and the density of this gaseous envelope can readily be calculated when the size and mass of the body are known. For the moon the value is found to be $\frac{1}{10^{332}}$ of that of the air at the earth's surface, a vanishing quantity, and one completely in accord with the fact that no trace of a lunar atmosphere has ever been detected. For the larger planets, on the other hand, the value becomes very great, so great in fact, that the high density of their atmospheres must occasion perceptible effects, by absorption, upon the light reflected from them, and the result lends a new interest to the peculiar spectra of Uranus and Neptune, as well as of Jupiter, which appear to exhibit lines resulting from atmospheric influences.

If a fluid mass, a meteoroid for instance, should exist at a distance from the sun or any body capable of radiating heat to it, its temperature would be that of the surrounding space, and, if its mass were not too great, a slow evaporation would convert it after the lapse of sufficient time into a sphere of vapor. Should the fluid mass, on the contrary, approach the sun, the solar heat would occasion a continuous development of vapor on the sun-ward side of it, until the whole were vaporized in a time incomparably short with reference to the interval necessary in the former case, and the smaller the amount of matter the shorter this time would be. The smaller comets, which often have the appearance of spherical masses of vapor, are examples of bodies of such a nature. Prof. Zöllner thinks there is no improbability of the existence of such fluid masses in space, consisting of water or of liquid hydro-carbons,* and the spectra of some of the nebulæ and smaller comets confirm the idea very strongly.

The peculiarities already mentioned are readily explained by reference to the general properties of fluid substances. The comets, however, offer others which are the result of other causes, namely, their *self-luminosity*, and the formation of a *train*, with a special relation of the latter, in its position and direction, to the sun.

As to the origin of the former of these phenomena, the question arises, under what circumstances can a vaporous or gaseous mass become self-luminous? and only two causes are known through the operation of which this can happen. These are, first, elevation of temperature, as by combustion, and second, electrical excitement. The former of these causes the author sets aside, on account of its insufficiency and the theoretical difficulties and contradictions which it involves. The second, therefore, must be assumed to be the efficient cause, unless recourse is had to unknown agencies, and this the purpose of the investigation excludes. Granting that electricity may be developed by the action of solar heat, if not in the process of evaporation, at least in the mechanical and molecular disturbances resulting from it, we have a cause sufficient to account both for the self-luminosity of the comets and the formation of their trains. It is shown, moreover, by numerous experiments, that the production of electricity by similar processes within the limits of our experience is a well established fact.

The spectrum of the vaporous envelope of a comet illuminated in this manner must necessarily be that produced by the passage of an electrical discharge through vapor identical in substance with a portion at least of the cometic nucleus, from which the envelope is derived. As, according to the supposition, water and liquid hydro-carbons are important constituents of these bodies, the spectra of the comets should be such as belong to the vapors of these substances, and in this manner the resemblance and partial coincidence of the observed cometic spectra with those of gaseous hydro-carbons is explained.

The author next proceeds to consider the formation of the train. The form and direction of this appendage to the comet indicate the action of a repulsive force. Olbers in 1812 had found the existence of a repulsive force necessary to the explanation of the direction and form of the train, and though in his memoir upon the great comet of 1811 he carefully abstains from the expression of a decided opinion upon its nature, he remarks that one can

* See note, p. 479.

scarcely fail to think of something analogous to electrical attraction and repulsion. Bessel also, in his memoir upon Halley's comet, published in 1836, shows a like caution, but clearly recognizes the similarity of the phenomena to those produced by electricity and magnetism, and feels compelled to admit the action of a polar force.* After citing these opinions, and remarking that the phenomena point to an action of the sun at a distance different from the force of gravitation, Prof. Zöllner asserts that the assumption of an electrical action of the sun upon the bodies of the solar system is necessary and sufficient to account for all the essential and characteristic phenomena of the vaporous envelope and the train.

He then discusses the quantitative difference in the effect of gravitative and electrical forces upon ponderable masses at a distance, and shows that, when a body is at the same time under the influence of both these agencies, with an increase of the mass there results a preponderance of gravitation over electricity, and with a sufficient decrease in the mass the contrary. Hence the nuclei of the comets, as masses, are subject to gravitation, while the vapors developed from them, as consisting of very small particles or molecules, yield to the action of the free electricity of the sun. An analytical investigation of the motion of a small sphere under the action of gravitation and atmospheric electricity, based upon Hankel's numerous and very careful researches upon the determination of atmospheric electricity according to an absolute standard (*nach absolutem Masse*), leads to the remarkable result that, supposing the free electricity of the sun to be no greater than that which has repeatedly been observed on the earth's surface, and to be uniformly distributed, it would communicate to a sphere having a diameter of 11 millimeters and a weight of $\frac{1}{100}$ of a milligram, and starting from the sun, by the time it had moved as far away as the mean distance of Mercury, a velocity of 3,027,000 meters, or 408·4 geographical miles per second, or such that in two days it would pass over a space of 70,540,000 geographical miles. The comet of 1680 developed in two days, when near its perihelion, a train of 60,000,000 miles.

* M. Faye assumed, for explanation of the peculiar appearances of a comet's train, a repulsive force as existing between bodies at a high temperature, and as an effect, or one of the modes of action, of heat, a cause which cannot be regarded as confirmed by known facts or by experiment.

Prof. W. A. Norton, in 1859, in discussing the phenomena of Donati's comet, assumed electricity to be the repelling force, and appears to have been the first to enunciate distinctly the adequacy of this force to produce the observed effects, and to give the rationale of its action. He says, "I conceive the telescopic nucleus of a large comet to consist of an atmosphere of aqueous vapor, or of a vaporous and gaseous atmosphere combined, condensed upon an inner nucleus more or less covered with water, or water partly in the condition of ice. In the case of the telescopic comets this central mass is probably altogether wanting. The vaporous atmosphere of the nucleus experiences variations of electrical excitement under the influence of the sun;—after the same manner that the earth's atmosphere is affected by the sun. * * * * It is these electric discharges * * * that, as I conceive, disengage the particles of aqueous vapor, or nebulous matter so-called; and impel them off with a certain velocity." This Journal, May, 1859, p. 100.—A. W. W.

These are magnitudes of the same order, and show that it is sufficient to attribute to the sun electrical energy not greater than that which is observed at the earth's surface, to account satisfactorily for the appearances presented by cometic trains, and that it is quite unnecessary to assume the existence of some otherwise unknown repulsive force.

Furthermore, comets have appeared with trains directed toward the sun, and such a direction is easily explained by the supposition of opposite instead of like electrical characters, which accords perfectly with the phenomena observed in the development of electricity by vapor-streams in the hydro-electric machine, where, as is well known, the sign of the electricity depends upon the presence or absence of various substances in the boiler or the tubes.

The theory acquires an additional interest, and a strong confirmation, from Schiaparelli's remarkable discovery of the identity of the paths of certain comets with great meteor-streams, since the meteoric masses must inevitably be converted into vapor on approaching the sun, even at great distances if composed of liquid matter, but only on a comparatively near approach if solid, with the exhibition of the characteristic appearances of the comets.

The author applies the results of these investigations to various details of the peculiarities observed in different comets, and to the related questions of cosmical physics in their bearing upon the moon's atmosphere, the corona, zodiacal light, polar auroras, and the phosphorescence of the nocturnal sky, and other phenomena. A later portion of the volume contains a lively discussion of Tyndall's theory of comets. A. W. W.

2. *New Planets.*—The planet (119), the discovery of which, by Prof. Watson, on the 4th of April, was announced in the May number of this Journal, was discovered independently, at a later date, April 9th, by Mr. Paul Henry, at Paris.

The planet (120) was discovered by Mr. Borelly, at Marseilles, on the evening of the 10th of April. On the evening of the 11th of April, this planet was also independently discovered by Prof. Peters, at the Litchfield Observatory of Hamilton College. The clouds prevented a second observation until April 16th. The following observations were made by Prof. Peters:

| | | |
|---|---|---|
| 1872 April 11, $14^h$ m. t. | R. A. $12^h\ 0^m\ 5^s$ | Dec. $-4°\ 59'$ |
| " 16, $13^h\ 37^m\ 29^s$ | $11^h\ 56^m\ 52^s{\cdot}42$ | $-4°\ 44'\ 39''{\cdot}1$ |
| " 17, $11^h\ 7^m\ 16^s$ | $11^h\ 56^m\ 20^s{\cdot}96$ | $-4°\ 42'\ 15''{\cdot}8$ |
| " 19, $11^h\ 52^m\ 8^s$ | $11^h\ 55^m\ 13^s{\cdot}69$ | $-4°\ 37'\ 1''{\cdot}6$ |

3. *Discovery of a new Planet*; by JAMES C. WATSON.—I have discovered another planet belonging to the group between Mars and Jupiter. It shines like a star of the eleventh magnitude.

The following are the only complete observations of it, which I have yet made.

| Ann Arbor M. T. | (121) $\alpha$ | (121) $\delta$ | |
|---|---|---|---|
| 1872, May 12, $14^h\ 13^m\ 42^s$ | $16^h\ 20^m\ 37^s{\cdot}58$ | $-18°\ 53'\ 9''{\cdot}4$ | 5 |
| 13, 11 13 22 | 16 19 59·35 | −18 52 46·2 | 6 |

Daily motion, $\Delta\alpha = -44^s$ $\Delta\delta = +0'26''$

## IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the occurrence of Petroleum in the Island of Santo Domingo;* by W. M. GABB. (Editorial correspondence, dated Sto. Domingo, April 20, 1872).—We must add to the known localities of bituminous products in the West Indies a single locality in the Dominican Republic. This is a spot about three miles north of the town of Azua, on a stream called "el Agua hediondo," or stinking water. The spot reminded me strikingly of the California petroleum springs, not less in the existence of oil, pitch, and gas, than in the usual broken-down steam engine and fragments of artesian well tools lying scattered around. The spring makes its appearance as a stagnant, torpid pool, exuding slowly through a heavy gravel deposit. A very small area in the vicinity is covered by deposits of pitch; for half a mile down the now dry bed of a rain-water stream the gravel or sand, as the case may be, is more or less cemented by an impure pitch, sometimes plastic, oftener hardened to asphaltum. The pools of the spring and neighboring excavations contain a dirty water rendered brown by contact with the oil, and on the surface is a thin pellicle of liquid petroleum, dark brownish-green to reflected light, and a reddish brown by transmitted light. On rubbing a drop in the palm of the hand it does not disappear as readily as the oil of California; and the odor is not so much like kerosene, but rather fetid.

An attempt was made during the "oil excitement" of 1865 or 1866 to bore here. The usual tools were taken to the spot and eventually abandoned. In the piece of pipe yet remaining is a small accumulation of oil, through which bubbles up a gas. It is inodorous and is not inflammable. At the distance of a few yards is a depression where there are several gas jets, and where, over the whole area, there is not a single blade of grass or any other vegetation.

I consider this locality especially interesting, because it is the only spot in the whole Republic of Santo Domingo where bituminous products are found, and because of its resemblance in so many respects to the localities I have seen in California. It also agrees with the springs of Trinidad in its appearance and mode of occurrence. See report of the Colonial Geologists, London, 1860, pp. 134 et seq. See also Schomburgh, Hist. of Barbadoes, pp. 553 and 569.

2. *Terrestrial magnetism, a measure of the sun's rate of rotation;* CH. HORNSTEIN.—The changes in the three elements of terrestrial magnetism, viz, the declination, inclination, and horizontal intensity, appear to run in a cycle of 26·33 days. In 1870, the periodic change in the declination at Prague was equal to $0'\cdot705$ sin $(x + 190°20')$, $x$ equaling 0 on January, 1870, and 360° on January, 1871. This oscillation is a little greater at Vienna. The oscillation in the inclination in 1870 was a third that of the declination, and that of the intensity about 24 units in the fourth place of

decimals. The cycle corresponds therefore with the time of the sun's rotation, the mean of which is 26·33 days. The magnetic needle thus affords a new method of determining the period for synodic rotation. By it we arrive at the true period of rotation of 24·55 days, which is almost identical in value with that deduced from the spots of the equatorial solar zone—24·541 days, according to Spörer.—*Acad. Sci. Vienna, from Les Mondes, April* 25.

3. *The Metric System of Weights and Measures;* An address delivered before the convocation of the University of the State of New York, at Albany, August, 1871; by FREDERICK A. P. BARNARD, S.T.D., LL.D., President of Columbia College, New York, 1872. 8vo. pp. 194.—President Barnard's address on the Metric System was delivered in obedience to a resolution of the Board of Trustees of Columbia College, requesting him to attend the convocation of the University of New York, at Albany, in August, 1871, and explain to that body how far the views of the Faculty of Columbia College, in respect to the Metric System of Weights and Measures, are in accordance with those of a committee made to the convocation on that subject the previous year. From this statement it is obvious that the discussion must partake somewhat of a controversial character; but it is managed with excellent taste and fairness in this particular. The singularly illogical positions of the eminent reporter of the former year, adverse to the adoption of the metric system, are controverted without the least acrimony and with a most charming geniality of humor.

But the scientific interest of Dr. Barnard's address is its feature of real and permanent value. Like all his writings this address is characterized by completeness, exactness and clearness of statement. He divides his subject under the following heads, "Origin and Nature of the Metric System; Recent progress of Metiological Reform; Objection to the Metric System considered;" and in a series of Appendices and Notes he adds important data "On the Unification of Moneys; Effect upon existing contracts of a change in the legal weight of coins; The New System of Coinage of the Japanese Empire; On Capacity Measures and the Weight of a given volume of water; On Kater's determination of the weight of a cubic inch of water; On the Legislation of Great Britain and of British India in regard to the Metric System; On the extent to which the Metric System has been adopted." This address must remain a classic in our language for its able and impartial discussion of the important subject of weights and measures, and cannot fail to exercise an important influence in advancing and strengthening the public appreciation of the worldwide importance of this subject, leading, it is to be hoped, at no late day to the adoption of the only system which has any chance of success as a universal standard, viz., the *Metric System.*

B. S.

4. *Die Naturgesetze der Fütterung der landwirthschaftlichen Nützthiere*, von Dr. PHIL. THEODOR VON GOHREN, 637 pp. 8vo., with 36 wood cuts, Leipzig, 1872. C. L. Hirschfeld.—This work,

so far as we have had time to examine it, appears to be an admirable digest of the vast mass of materials which has accumulated —within the last 20 years very rapidly—bearing on the subject of animal nutrition, considered both as a branch of physiological science and as an art. After an introductory chapter on "Matter and Force," the parts of the animal body are described, in respect to their structure and functions; then the Chemistry of the Tissues, Juices and Secretions; and thirdly the Processes of Life and Growth—Respiration, Metamorphosis of Tissues, Digestion and Resorption—are discussed. The titles of the other chapters are Individual Kinds of Cattle Food: the preparation of Fodder and Feeding: The availability (Ausnutzung) of Cattle Food: History of Doctrines of Nutrition: Present State of the Doctrines of Nutrition: The Production of Work: The Production of Fat: The Production of Flesh: The Production of Milk: The Production of Wool: Reproduction and Nutrition: The Practical Farmer and the Doctrines of Feeding. Appendices, Tables, and a copious Index complete the book.

The author, Professor at the Royal Bohemian Agricultural Academy at Liebwerd, gives equal justice to fundamental investigations like those of Pettenkofer and Voit, and to the many empirical trials which have been conducted with such patience and skill at the various experiment stations in Germany and elsewhere. He combines the hitherto too isolated results of physiologists, chemists and agriculturists, of philosophers and practicians, in a manner that cannot fail to be advantageous to all who have occasion to occupy themselves with the subjects of his treatise, whether for elementary or advanced study. The contrast between this masterly work and anything under a similar title which English literature has yet produced, is humiliating to the latter.

S. W. J.

5. *Pocket-book of Mechanics and Engineering, containing a memorandum of facts and connection of Practice and Theory;* by JOHN W. NYSTROM, C.E., 11th ed., revised and greatly enlarged with original matter, 512 pp., 12mo. Philadelphia, 1872 (J. B. Lippincott & Co.).—This "Pocket-book" is an exceedingly convenient companion for people of all trades and professions, far more so than is implied in the title. It meets the necessities not only of practical engineers and mechanics in the calculations which their work requires, but, also of all who have anything to do with figures beyond casting up ordinary accounts, and is especially a desirable hand-book for the scientific and even the ordinary traveler. Besides containing the many tables and formulas of use to the engineer and mechanic in all branches of work, it gives others for the use of the barometer in determining heights, tables of logarithms, and of logarithmic and natural sines, tangents, etc.; of squares, cubes, square roots and cube roots for numbers from 1 to 1,600; of the circumference and area of circles for diameters from 1 to 1,000; of the coins, weights and measures of the world; of the flags of nations; of the areas of the continents; of the distances

of places over this and other countries; also an almanac for the 19th century; an astrononical almanac; the deaf and dumb alphabet, etc.

6. *An Elementary Manual of Chemistry*, abridged from Eliot and Storer's Manual, with the coöperation of the authors, by Mr. Ripley Nichols, Assistant Professor of General Chemistry in the Massachusetts Institute of Technology. 370 pp. New York, 1872, Ivison, Blakeman, Taylor & Co.—This is an abridgement and revision of the Manual of Inorganic Chemistry, with which is incorporated, under carbon, the elements of organic chemistry in some 70 pages. It retains the excellencies of the Manual, by its dimensions, is better adapted to most of our colleges, academies, and schools, is much improved for the class-room by judicious paragraphing, and is unquestionably one of the best text-books in the language.

7. *The Popular Science Monthly*, conducted by E. L. Youmans. Each number 128 pp. 8vo. Published by D. Appleton & Co., New York.—The first number of this important monthly appeared in May. The two issued treat, as the title implies, of subjects that are now especially occupying the popular mind. The largest topic is man in his various relations, zoological, geological, social, political, educational, religious, etc.; and the widest range of opinion is presented on some of these subjects, in the different papers. Herbert Spencer commences in these numbers a series of able papers on Social Science or Sociology. Other articles treat of the eclipse of the sun; the sun's spots: Vesuvius; the superstitions of medicine; the artificial production of stupidity in schools; the physiological position of alcohol, and various miscellaneous topics of interest. The June No. has as a frontispiece an excellent portrait of Sir Charles Lyell.

## OBITUARY.

Dr. William Stimpson.—As these last pages are going to press, we learn that Dr. Stimpson died on the evening of the 26th of May. He had recently returned from a dredging expedition across the Gulf of Mexico, and had been very ill since his return. He has for many years been well known as one of the leading zoologists of this country, and has devoted himself chiefly to marine invertebrata. A more extended notice is deferred to the next number.

A Catalogue of the Birds of Kansas, by Frank H. Snow, Prof. Nat. Hist. and Meteorology in the University of Kansas, at Lawrence. Contributed to the Kansas Academy of Science. 8 pp. 8vo, Topeka, Kansas, 1872. This list contains the names of 239 species, with brief notes on many of them.

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## ERRATA.

Page 448, note, for p. 44, read p. 447.
Page 457, 14 lines from bottom, for basioccipital keel, read supraoccipital keel.

# INDEX* TO VOLUME III.



* The Index contains the general heads, Botany, Geology, Mineralogy, Zoology, and under each the titles of Articles referring thereto are collected.

## H



## I



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## S



## T



## U



## V



## W



## Y



## Z